Ecological and Socio-Cultural Trends
of Kaputiei Group Ranches in Kenya

By

Theuri J. Njoka

B.Sc. (University of Nairobi) 1973
M.S. (University of California) 1974

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Wildland Resource Science

in the

GRADUATE DIVISION

OF THE

UNIVERSITY OF CALIFORNIA, BERKELEY

Approved:

Harold F. Heady .... Dec. 21, 1979
Chairman Date

....

Herbert G. Baker .... December 5, 1979.

....

ABSTRACT

Ecological and Socio-Cultural Trends of Kaputiei Group Ranches in Kenya

by

Theuri J. Njoka

The purpose of this study was to analyze and to characterize the ecological and socio-cultural trends of Kaputiei Group Ranch Development Model in Masailand in Kenya. The field work was done between September 1976 and July 1978. The study was based on three main questions: (1) Has the group ranch scheme resulted in an improvement or deterioration of the Kaputiei grasslands? (2) Has the project significantly altered and/or improved the Masai subsistence livestock production system? And finally (3) has the group ranch development model accelerated the socio-cultural changes among the Kaputiei Masai?

In order to determine the success or failure of the group ranching scheme, many aspects of the Kaputiei environment were studied and these included, detailed reviews of background of pastoral nomadism and the Kaputiei project, vegetation and livestock resources and the demographic and behavioral aspects of the Kaputiei people.

The results of vegetation measurements in 1967, 1969 and 1977 on 24 permanent transects located inside Kaputiei show that the Athi-Kapiti grasslands on black-cotton soils have not deteriorated between 1969 and 1977. However, South Kaputiei and some parts of

Central Kaputiei grasslands on red soils sustained severe range degradation. The range condition reconnaissance survey of 1978 indicates that 46 percent, 18 percent and 7 percent of South Kaputiei, Central Kaputiei and Athi-Kapiti grasslands respectively are in poor range condition.

It was postulated that this range degradation was largely caused by overstocking and intensive development inputs. Cattle numbers between 1968 and 1972/73 increased 46 percent and 104 percent in Central/Athi-Kaputiei grasslands, and in South Kaputiei grasslands, respectively. Sheep and goat population also increased by a factor of 2.63 between 1968 and 1977.

The demographic trends indicate that Kaputiei human population increased by 52 percent between 1967 and 1977. This population growth resulted from the increase of number of wives per male head of family from 1.13 $\pm$ 0.38 in 1967 to 1.76 $\pm$ 0.47 in 1977, and from the number of children under 15 years per family which nearly doubled from 2.59 $\pm$ 0.79 to 4.82 $\pm$ 0.88 during the same period.

The majority of Kaputiei Masai favor the group ranch development strategy mainly because of development inputs (50 percent, N = 148) and legal land rights (46 percent, N = 148). The trend of many families opting for small size kraal camps with one to two families instead of the traditional large kraals show that the Kaputiei Masai are willing to settle down if ecological conditions permit.

The overall performance of Kaputiei Group Ranching Scheme cannot be based on the biophysical trends alone. The behavioral characteristics of the various interest groups such as the Masai people, the professionals, the public officers and the international agencies and donors must be taken into account. The success or failure of the Kaputiei Group Ranch Development Model therefore depends upon the choice of performance criteria by each of the various interest groups.

Abstract approved
Harold F. Heady
12-21-79

ACKNOWLEDGEMENTS

This work bears the marks of many persons and institutions who generously offered their time and money.

In particular I wish to acknowledge the great contributions by International Livestock Center for Africa, without whose generous contribution the field work and the writing of the manuscript would have not been possible.

Other donors who included: Aggrey Memorial Fund; Dean's Research Fund, University of Nairobi; Forestry Department, UC Berkeley; James B. Grubb, Oakland; all these institutions had their significant part in the completion of this work.

I acknowledge the cooperation and assistance of the personnel in Range Management Division, Ministry of Agriculture in Kenya during the field work. Mr. Paul Chara, my research assistant in the field work deserves a great deal of credit for his enthusiasm to learn and to do. I acknowledge the dedication of the enumerators and in particular Mr. Charles Maina.

My great vote of thanks to Professor Herbert G. Baker and Professor James W. Bartolome for their many hours in reading through the manuscript. I acknowledge the great contribution by Genny McNeil, for typing the manuscript.

To Professor Harold F. Heady, the Chairman of the thesis committee, for his great encouragement and advice during my graduate studies at Berkeley, I am greatly indebted.

Finally, my apologies to my family for the many hours of separation during the fieldwork and writing of this thesis.

Theuri Njoka

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

The purpose of the study was to analyze and evaluate the ecological and socio-cultural trends resulting from the implementation and operation of the Kaputiei Group Ranch Development Model in Masailand.

The Kaputiei Livestock Development Project in Kenya is a unique example of an intervention into Masai subsistence pastoral nomadism and it provides an opportunity for observation and analysis of modernization impacts. The Kaputiei Group Ranches began in 1968. My field study of these group ranches started in September 1976 and ended in July 1978.

The following questions formed the basis of this study.

(1) Has the group ranch model resulted in improvement or deterioration of range condition and trend?

(2) Has the project significantly altered the livestock management strategies in Kaputiei?

(3) Has the Group Ranch Development Model accelerated socio-cultural changes among the Kaputiei Masai?

The questions above describe two concerns. First, they point to issues of environmental impacts, appropriate livestock management practices and beneficial welfare of the Kaputiei human population. These questions touch on the most sensitive aspects of the stated original objectives of the Kaputiei model. The second concern was to define a broadly based systems approach to the problem. While any one of these questions could constitute a separate detailed study by itself, none of the questions alone characterizes the whole system of the Kaputiei project.

The chapters are organized along the theme of the three questions. Chapter 2 describes pastoral nomadic problems outside and to a certain extent inside Kaputiei. In Chapter 3, the history of the proposal, the proposal itself and the implementation of the Kaputiei project are analyzed. Chapter 4 sets the scene of the biophysical environment in which the Kaputiei project operates. Chapter 5 and 6 document the ecological trends of Kaputiei biophysical resources, and Chapter 7 characterizes the socio-cultural changes of the Kaputiei Masai. The last Chapter summarizes the important observations documented in earlier chapters and gives major conclusions of the overall performance of the Kaputiei Livestock Development Model.

Chapter 2

OVERVIEW OF PASTORAL NOMADISM

INTRODUCTION

PASTORAL NOMAD AND HIS ENVIRONMENT

SURVIVAL STRATEGIES

ADAPTIVENESS OF PASTORAL NOMADISM IN CRISIS

- Socio-Political Forces
- Sedenterization
- Livestock Interventions

SUMMARY

Chapter 2

OVERVIEW OF PASTORAL NOMADISM

INTRODUCTION

The phenomenon of pastoral nomadism is not unique to Kaputiei Masai of Kenya, but it is a common mode of lifestyle in many African and Asiatic countries. In these days of rapid political, social-economic and ecological changes, the role of pastoral nomadism in a modern state seems outdated. Yet application of modern technology in semi-arid and arid areas leaves a great deal to be desired as far as the risks and uncertainties that beset human subsistence in these areas are concerned.

We should boldly accept that social changes are taking place among the pastoral nomads. Any view that regards traditional pastoral nomadism as a stereotype of a happy, free-ranging, romatic lifestyle is out of step with the current human development in the rangeland. For the nomads to survive, they must change, for change is the very mechanism of adjusting them to a new dynamic biophysical and socio-political environment.

The dilemma we face today is how to direct current and political socio-cultural and ecological changes in the right direction and at a speed commensurate with the rapid transformation of values so often assumed by development models for generating a surplus for market economy. But our premise for inducing essential changes, however, should not be based on the models which implicate that the pre-condition for development is the severance of all roots of the backward subsistence economy and instantaneous adoption of every aspect of modern technology in aspiring toward an idealistic, modern industrial monetary economy. The reason for this cautious remark is that there is much we can learn from the traditional technology in combating the risk and uncertanties constraining efficient use of renewable natural resources in rangelands. The success of "modernization" of pastoral communities will depend on how closely we coordinate and encourage and amalgamate the good aspects of pastoral nomadic technology and modern livestock production systems.

This chapter focuses on the adaptation and survival of pastoral nomads in their harsh environments. The external forces working against the existence of pastoral nomadism, such as social-economic and political forces, are discussed. It is maintained throughout this chapter that the basic problem of the relative risks and uncertainties involved in shifting from traditional to a modernized set of resource use patterns remains a great challenge in mobilizing human development in these semi-arid and arid zones.

PASTORAL NOMAD AND HIS ENVIRONMENT

Nomadism is defined as a special type of life style of a people characterized by periodic change of their habitat in search for sustenance. Zadrozny (1959) defines nomadism as a "way of life which is characterized by constant migration, either to hunt wild animals or to herd domesticated flocks".

There are other aspects of nomadism which has been obscured by such a conventional definition. Salzman (1972) gives a comprehensive definition that encompasses the multifarious facets of nomadism. He defines nomadism as a "kind of movement which is a part of the cycle of food extraction" and which is "associated with several different types of resources such as hunting, gathering, cultivation, and labor sale". He therefore distinguishes nomadism from pastoralism, which he defines as "a management of and food extraction from a particular type of resource, domesticated or semi-domesticated animals". The term "pastoral nomadism", in this study is defined as one of the many resource use patterns whereby both nomadism and pastoralism are involved. Although pastoral nomadism certainly emphasizes the central role of livestock in a subsistence economy, it does not exclude the use of other non-livestock resources such as cereals, fruit and root gathering and wild animals. Winick's (1958) definition of a pastoral nomad is a "person who lives completely from his flock and does not domicile himself to plant" is rather narrow and untypical of the many cases of pastoral nomads observed in practice. In this paper, pastoral nomadism is viewed in the wide range of possibilities of combination of livestock with other resources used in a pastoral subsistence economy.

In addition to pastoral nomads, there are other kinds of nomads known under other names, for example, hunting and gathering nomads, tinkers or trader nomads, shifting cultivators and transhumants. These kinds of nomads are outside the scope of this chapter.

The pastoral nomads are found in semi-arid and arid zones. These environments can be described in terms of climate, vegetation and animals.

The major climatic factor is rainfall. In the Sahel the semi-arid and arid zones have been delineated by isohyets (Swift 1974). The 500 mm and 250 mm isohyets enclose the semi-arid zone. Within this region, rainfed agriculture may be attempted but it is hazardous. The zones between 250mm and 100 mm isohyets are the arid zones where no rainfed agriculture should be contemplated.

Annual rainfall in these semi-arid and arid environments is low, erratic and unreliable. The lower the annual rainfall, the greater the variability and unreliability of rainfall. Toupet (1972) estimated that the differences between the position of 100 mm isohyet in 1941-42 and 1951-52 amounted to an area of 340,000 km^2 or 31.5% of the total area of Mauritania.

Water sources are dependent on constant recharge from rainfall patterns. During the wet season, surface water is available in shallow pans distributed over most of the grazing area. As the dry season sets in, the surface water dries up. The next water source along temporary rivers is available for a long period. But at the peak of dry season, water is restricted to permanent rivers, and subsurface water such as water from wells, boreholes and oases.

Temperature is a major factor where the pastoral nomads utilize the pastures in the mountains. During summer when the temperatures are high, mountain pastures are ready for grazing. As the fall season progresses and winter begins, the mountains become too cold for animals and people and so they move down to the lowlands.

The forage resources of semi-arid and arid zones are marked by patchiness and seasonality. The forage quantity and quality is correlated with the amount of rainfall received during each season. The pastoral nomads follow the rains because forage and water are abundant in areas where it happens to rain.

The animals of semi-arid and arid rangelands are the primary consumers of forage. The domesticated animals such as cattle, goats and sheep are important in molding the cultural ecology of the pastoral nomads as will be discussed later on. But in order to gain some insight into how the nomads have adjusted to the ecological requirements of their animals, a brief mention of the ecology of undomesticated animals which co-exist in the same area with the domestic stock is pertinent.

The high densities of wild ungulates in the African semi-arid zones is achieved through some ecological separation mechanisms such as habitat preference, diversity of seasonal social behavioral patterns, and differential ability among various species to withstand water scarcity in the dry season (Lamprey 1963). Ecological separation of the domestic species such as cattle, sheep and goats allow the pastoral nomads to harvest more of primary production from an ecosystem as compared to specialization in any one of these species.

The territorial behavior of impala (Jarman 1973) and wildebeest (Talbot 1963, Estes, 1968) during the wet season is an adaptive strategy to distribute grazing pressure evenly over the range; but its collapse in the dry season allows the animals to track down the spatial and temporal distribution of forage and water resources rather than dissipate energy in territorial defense. For the same reason, the pastoral nomad moves in pursuit of these resources during the dry season.

The implications derived from these studies of adaptations of the wild ungulates to their dry environment are important in understanding how the pastoral communities have adjusted to requirements of their domestic animals throughout the year.

Disease vectors such as ticks, tsetse flies and nuance biting flies (Stomoxys, Tabanidae) do influence the migration distribution pattern especially of domestic animals. The Dinkil of Sudan move up to higher ground and down to the valley of the Nile River, not only in response to potential foods during rains, but also in order to reduce the incidence of biting flies near the marshes (Davies 1966). The tick-borne diseases tend to be more prevalent in higher altitudes and wet areas. Such places are purposely avoided by pastoral tribes like the Turkana.

SURVIVAL STRATEGIES

The study of pastoral communities manifests the existence of a very close interaction between a people and their environment which has been referred by anthropologists as cultural ecology (Netting ?). These communities have evolved adaptive features to cope with unpredictable biophysical environment. The subsistence risk describes the basic level of human performance in an environment below which any future interaction between a people and the environment leads to catastrophe. Porter defines subsistence risk for a human population as "a settlement negotiated between environment and a technology" (1965). Subsistence risk is a useful concept in defining the limits of human adjustments in semi-arid and arid zones. Since the environmental potentialities differ in spatial and temporal distribution, the levels of subsistence risk vary from place to place and most likely also, among various pastoral communities. In order to minimize the subsistence risk a people must continually accumulate knowledge and experience as a result of frequent hazard potential due to the natural causes such as drought, diseases and predation, and thereby evolve and adopt such resource use techniques as will ensure their short and long run survival. The very fact that the pastoral nomads have survived in such difficult environments attests to the need to find out this intricate mechanism between man and nature in the semi-arid and arid environment. Subsistence risk factor is defined here as the limit of interaction between a community and its environment, below which the human population faces starvation. It is assumed that since the survival factor is an important consideration in semi arid and arid areas, the pastoralist will always innovate resource use patterns which minimize subsistence risk factor, and vice versa.

For resource management planning, therefore, it becomes necessary to focus on the subsistence requirement for pastoral community rather than emphasize either the cultural or environmental factors out of proportion. These two factors define the minimum level of resource exploitation necessary in order to avoid subsistence risk. They are not static but in a dynamic interactive state.

The ecologic potential of the environment (i.e. the optimum production from the environment consistent with conservation constraint) determines the degree of subsistence risk factor. Precipitation, one of the components of the ecologic potential, is the most limiting factor in semi-arid and arid environment. The lower the precipitation, the lower the inherent capacity of that environment in producing renewable natural resources; and consequently the greater the problem of meeting the subsistence requirement to insure the survival of the household. Pristine pastoral nomadism, from my view point, portrays three major resource exploitation features which insure the minimum subsistence requirement of a household. These are mobility, multi-resource use patterns, and forms of social organization within pastoral communities.

There are many causes of mobility, among which the search for grazing and water resources are leading ecological causes, and socio-cultural factors (William, 1965, Gulliver 1978). The decision of when to move and where to move rests solely on the head of a household. A household is the basic unit of production. Each household is an independent stock-owning and self-sustaining unit, headed by a man (Gulliver 1955). The decisions of when to move are arrived at secretly and independently of other households. The decision by each head of a household constitutes his perception of the hazard of the environment and ways of coping with the subsistence risk factor. But such a free mobility is only possible where every member of a tribe is guaranteed free grazing rights within a tribal territory. Such indeed is the case among the pastoral nomads like the Karimojong, Turkana and Masai.

During the dry season animals congregate along permanent sources of water. But with the onset of the wet season the pastoral nomads disperse farther away from the water sources. This movement is an adaptive strategy for repeated seasonal grazing. By the time the animals move from the wet season grazing and therefore start grazing, around dry season areas the plants in the dry season grazing probably are in a post-flowering stage. In this way the vigor and subsequent pasture productivity are maintained.

Dyson-Hudson (1972) found that one herd had covered 3903 sq km (1507 sq miles) in twenty-six months, which is 37.5 percent of the

10360 sq km (4000 sq miles) of the Karimojong tribal land. The Turkana people in northwestern Kenya make at least five moves per year of two seasons and travel as much as 242 km (150 miles) (Gulliver 1955).

Western (1973) estimated that the carrying capacity of Amboseli in Kenya may increase by 50 percent as a result of mobility of the Masai with their livestock. The free movement of animals facilitates selection of the most nutritious and highly digestible forage following the erratic rainfall; and, in addition, this movement offsets some seasonal limitations due to the lack of water.

Porter (1965) postulated that mobility is a prerequisite for coping with subsistence risk, where environmental potential for rainfed agriculture is low. The Kamba people in Kenya are distributed in a continuum of environmental potential gradient of total annual rainfall. The community located in areas where the environmental potential is high ($>$ 625 mm rainfall) has low subsistence risk and is sedentary; but the community located at the extreme of low environmental potential ($<$ 625 mm rainfall) copes with the resultant high subsistence risk through mobility. The mobility strategy among the pastoral communities is therefore an essential survival feature in semi-arid and arid lands.

The stereotypic image of a pastoral nomad who strictly adheres to livestock husbandry alone is at variance with actual observations. The Turkana exemplify a case where multi-resource nomadism is reflected in the rich diversity of high dietary requirements. The

Turkana will supplement his diet through hunting of wild animals, fruit gathering, and grains bought from Somali traders, in addition to the usual livestock products such as blood, milk and meat (Dyson-Hudson 1974).

The Iranian Baluchistan people migrate with their livestock from summer pasture into the groves of date palms during the fall. They use the dates and date preserves from consumption during the winter period and to feed lambs and kids. The women use the palm fronds for making ropes and cords for tents and baggage. During winter most of the men seek employment in sedentary communities. This tripartite multi-resource of livestock husbandry, date cultivation and labor sale are adaptive features of coping with subsistence risk in the nomadic environment (Salzman 1972).

However, it is livestock rearing that forms the distinctive feature of pastoral nomadism. In order to appreciate some of the ways the nomads have adjusted to their livestock needs in the context of the prevailing environments, it is pertinent to examine some factors that are involved in herd management. Herd structure, as well as the mix of species and aggregates of these species into various grazing herds are essential features of traditional herd management practices.

Herd structure depends on the vital statistics of the species. These include calving rates, calving intervals, fertility levels, gestation period, and mortality rates. The herd structure of pastoral livestock usually involves a preponderance of adult females.

Dyson-Hudson (1974) estimated that in Turkana 60 percent (range 36 - 72 percent) of the animals over 3 years old were females. This percentage reflects a high fertility potential of the herd which is requisite for quick restoration of the herd size after a serious drought.

The mix of species is an adaptive strategy of maximizing range use through ecological separation among the various domestic species. For example, a Turkana may have cattle, sheep, goats and camels in his herd. Each of these species has different food habits, habitat preference and labor input requirements. Cattle and sheep require more moist habitats and prefer more grass in the diet, while camels and goats prefer drier habitats and browse constitutes a major portion of their diet. Cattle drink every 2-3 days during dry season, but sheep and goats drink every day. Camels require watering at intervals of 5-6 days during dry season (Swift 1974). A camel can endure 17 days without water with a body loss of 25 percent (Encyclopedia 1973); it also is capable of traversing (48 km) a day with water every third day. Such differential physiological adaptations of species determine the range use around permanent sources of water during dry season.

The pastoral nomad diversifies livestock production base by managing for a broad spectrum of species wherever possible. By doing so, he can produce more biomass of livestock and stabilize seasonal fluctuations compared to the production from single species such as cattle. The management of a mix of livestock species plus supplementation of livestock resources from labor sales, agricultural food, characterize the multiresource use strategy to minimize subsistence risk factor.

The tendency for the pastoralist to build up their herds without apparent limit has been regarded as an irrational behavior. Adaptive value of this human aspiration may be traced back into the nature of the environment itself. The animals on the hoof provided a form of security and food storage. More animals meant that a man could acquire more wives (there was no ceiling on the number of wives) and therefore more sons and daughters. The sons would fill the ever present labor vacuum in traditional livestock technology. This would in turn lead to a household independence from other households. This independence would allow more flexibility and quick response to natural hazards like drought and disease. More daughters would mean more animals from dowry paid later on in life, thus opening more possibilities of potential stock associates. Animals could therefore be translated to greater social density and hence a large herd becomes a strong hedge against subsistence risk.

The flexibility of the social organization of pastoral nomadic communities is another adaptive feature for survival in precarious environment. Various studies have shown that the pastoral tribes such as the Turkana, Masai, and Karimojong combine their herds into variable aggregates of grazing units for protection against outside raiders, predator control and efficient allocation of labor resources. The sizes of the aggregates depend on environmental and human demographic factors.

Swidler (1972) studied the human demographic factor regulating the formation of flocks and camps among the Brahui and Baluchistani in West Pakistan. He found that each entrant into a camp had a flock size of between 250 and 500 sheep. If the numbers exceed the upper bound, it becomes difficult for a shepherd and dog to manage the flock, and if the lower limit is not achieved, the sheep tend to scatter and thrive poorly. Swidler concluded that a camp represents an optimum group type in terms of grazing management and adaptive response in sheep raising.

Dyson-Hudson (1966) describes the social organization of a Karimojong tribe into association units which include settlement camps, group camps and camp clusters of increasing size and complexity in that order, and also decreasing ties of association among the livestock owners. While the herd owners who share a single settlement camp constitute a fundamental and permanent herding unit along very close affinity lines, a camp unit consisting of two or more herding units is only based upon ecological factors and the camp unit collapses as soon as these ecological limitations change for the better. Higher levels of camp aggregations such as cluster camps are even more transitory and less common compared to herding and camp units. Cluster camps are established when fears of outside invaders, wildlife predation and unusual scarcity of grazing resources occur.

Dyson-Hudson (1966) studied the question of boundaries among the Karimojong. This study indicated that social and territorial units do not normally coincide in a natural setting. For example, a section is a stable social group in Karimojong which tends to occupy an area of a country, but even in such a case, the boundary between sections is not a geometric line, but an extensive buffer zone of unoccupied bushland. In addition, such kinds of boundaries are not preceived as exclusive means of denying grazing rights to any individual or member of a different social group; consequently there is continuous movement and interaction among the sections. The flexibility of social organization in the event of ecological, and socio-political adversities confers greater survival value for the pastoral nomadic communities in the rangelands.

ADAPTIVENESS OF PASTORAL NOMADISM IN CRISIS

Socio-Political Forces

The adaptive features of pastoral nomadism are undermined by many socio-political and ecological changes. The pre-colonial era of pastoral nomadism in Africa was characterized by free movement from place to place in response to the sources of the various combinations of grazing and water or other factors. This period represents traditional pastoral nomadism insofar as there were negligible, if any, impacts of modern institutions. During the colonial era, which began after the scramble for Africa among the European nations in the 19th century, a new phase of socio-economic-political environment evolved, characterized by fixed territorial boundaries, and administrative boundaries within each territory.

By the late 1950's, the colonial era started to give way to sovereign independent African states. A new post-colonial era has now dawned in most parts of Africa and other continents. During this phase, the independent states are restructuring the social, economic and political forces to meet the needs of their people. Along this road to human development, the changes induced during the colonial era, the pre-colonial carry-over from traditional ideologies, and post-colonial innovations form a mixed bag of blessings and obstacles.

The demarcation of colonies in Africa and parts of Asia did not take into account the geographical distribution of homogeneous sociocultural groups. International boundary conflicts instigated by transnational free movement stem from problems related to smuggling, national security and an attempt to maintain political control of segmented pastoral communities. The border between Kenya and Somalia cuts across the Somali people. Following Kenya's independence in 1963, internal skirmishes between Somali people in north-eastern province and the central government suspended the grazing schemes which were ongoing during the colonial period. These abortive grazing schemes have created subsequent resistance where re-establishment of similar schemes are being considered. International border conflicts with similar causes, can be cited in other parts of Africa and Asia.

Even where a pastoral community is within the national boundary, conflicts still arise. In the Sudan, the range of resource exploitation for the long distant pastoral nomads such as Kenana and Rufa, overlaps with sedentary communities. During the wet season, the pastoral nomads migrate northward and return southward during the dry season. At the time of their southern movement, the central government has to step in to enforce regulations which synchronize nomadic movements with the time the farmers have removed their harvest; otherwise open conflict would result following pastoral-sedentary contact (Davies 1966).

With fixed boundaries, the natural flexibility of a tribal territory as perceived by the pastoral nomad can beget intertribal conflicts when resource scarcity during serious years of drought force the nomad beyond the limits of his boundary. With increasing marginal area being converted to grain cultivation, conflicts would intensify were it not for external governmental intervention to enforce stability.

The endeavor to localize every section of a tribe in a particuar region may escalate internal conflicts within otherwise homogeneous, stable communities. The past attempts, during the colonial period, to organize grazing schemes along sectional boundaries among the Somali of Kenya has aggrevated strife among some sections (Chambers 1969).

Herein we see an attempt to induce change that strikes at the root of pastoral nomadism. The planners of social-economic and political systems lack suitable institutional framework to accommodate the free mobility requirements of pastoral nomads. The attempt to define exact geometric land units is symptomatic of planners whose only experience relates to the institutional framework which evolved in sedentary communities.

If indeed boundary lines are pre-conditions for socio-economic and political development, our challenge is then to define that land unit that integrates the administrative, managerial, social and ecological subsystems, with minimum disruption of other desirable features of traditional pastoral technology. We need to assess the nature of the trade-offs involved as new innovations impinge upon the adaptive features which reduce subsistence risk factor in a pastoral economy.

Sedenterization

One of the greatest socio-cultural transformations the pastoral nomadism is undergoing is the sedentarization process. This is a process whereby a mobile population is settled permanently in a region, and in most cases it can be equated to a shift toward agriculture. In North Africa, a settlement starts around an oasis. Other preferred sites are along permanent rivers. Sometimes a settlement occurs around industrial centers such as mining and oil fields. Other times, a settlement is just a spillover into the urban areas or local neighboring trading centers. What are the forces inducing the increase of sedentarization among the pastoral communities today? Political control, benefits of modern infrastructure, socio-economic change and drought are the accelerating forces in sedentarization.

The traditional political structure of pastoral communities shows that rights and personal security were provided in a decentralized authority structure (Jacobs 1965). But the trend now is for a central government to inaugurate a bureaucratic system to handle the affairs of pastoral communities (Barth 1962). The aspiration of a modern state is to erode the value system of a nomad and replace it with the value system of the state. The Timuri of Iran are undergoing "detribalization" and "Iranization" in order to achieve an integrated, united and balanced nation (Singer 1974). After the revolution of 1917, Soviet Russia embarked on a massive sedentarization program among the Kazakhstan and Kirghizia tribe in order to "fuse the tribal loyalties into higher loyalties of the state" (UNDP 1967).

The recurrence of drought is by far the most important force leading to massive and sudden sedentarization of pastoral nomads in Africa. In Somalia, following the 1973/74 drought, 168,000 people were moved from drought-striken north regions to settlement areas, 700 miles south (Africa 1975).

The benefits of sedentarization of pastoral nomadic communities must be weighted against the problems created by the process. A strong case for settling the nomads is the fact that they have a right to partake of the benefits of a modern technology just like the other sedentary communities. Once they are settled down from their perpetual wanderings, it is argued, it becomes feasible to extend to them the important aspects of modern infrastructure like education and health institutions. Education requires buildings and a close contact between teachers and students for smooth continuity of instruction. This would certainly be cumbersome where the children have to accompany the moving herds.

Health services are conveniently located for sedentary communities. Where heavy equipment for hospitals is needed, permanent buildings are required.

Since sedentarization in most cases implies a change from pastoral nomadism to agriculture, the settled communities can then benefit from intensive agricultural production through irrigation, better seeds, and better farming techniques. With a settled population it becomes easier to develop a market system and thereby introduce a monetary economy. This trend of development finally leads to the integration of the nomads into the national economy and hopefully, too, the repercussions due to intermittend droughts will be mitigated. As balanced regional development grows, it is expected that industries will develop to offer employment for those individuals displaced from the labor-intensive traditional technology who cannot find employment in the agricultural sector.

The best example of a large scale, planned sedentarization comes from Russia (UNDP 1967). Before 1917 only a small number of Kazakhastan and Kirghizia nomads were settled. But by 1936, the process of settlement was largely completed, with 338,780 households in Kazakhastan settled and 250,000 of these in cereal farming. The average mechanization of a "collective farm" in 1967 was 106 tractors, 60 combine harvesters, and 60 lorries. People changed their eating habits from boiled meat, dried cheese and fermented milk to poultry, small animals and produce from private gardens. The rationale for transforming all forms of nomadism into sedentary lifestyle is given by the Russian historians as: "natural conditions hinder nomads from settling down and perpetuate the nomadic way of life, which itself lays a barrier across the road to further economic progress". (Novoseltsev et al 1972).

One of the primary goals of the sedentarization process is to maximize the social welfare function of a people in the long run. Barth (1962) came to the conclusion that the sedentarization of the nomads in southeastern Asia was contributing to a high mortality of livestock and people, "pauperization and protelarization of large populations", and an overall economic decline of the region. Even the modern infrastructure have their bad side effects. For example, we must guard against the quality education that stimulates false aspirations for certain kinds of jobs. The education system in most developing countries alienates the young people from their own environment.

Sedentarization often occurs on the best dry season pastures. These critical areas are transformed into arable lands and therefore are no longer available for animal use during dry season. As a result, there is an overall reduction in the carrying capacity of surrounding grazing area. So far, there is no better way of harvesting the renewable natural resources of the vacated marginal lands.

Furthermore, with sedentarization comes also a new pattern of land ownership, in which individual privatization is condoned. This leads to severe competition for any available land as more low quality land is brought into cultivation. In addition, more intensive resource use patterns lead to degradation and erosion when cultivation is attempted in marginal rain-fed areas. A case in point is the consequence of settlement of Somali communities along the Dana and Tana rivers in Kenya (Chambers 1969). The forests were being cut, and farming was being tried where the chances of any successful harvest were very slim. There was over-grazing around the settlement as the people tried to meet their customary dietary needs of milk and meat, even after adopting different resource exploitation patterns.

Although the Russians would claim a complete success in sedentarization of nomadic communities, it is important to keep in mind that there were large capital inputs, an abundant supply of skilled manpower for industrialization, plenty of water for extensive irrigation programs and a high degree of pre-planned organizational effort over a long period. The challenge of sedentarization in many parts of Africa is compounded by lack of water and impromptu massive settlement following the incidence of drought.

These problems of sedentarization emphasize that this process should be viewed in a long-range perspective. Land use conflicts among various current and potential users should be carefully assessed, especially where wholesale transformations of dry season pasture into arable areas is contemplated. Planning should also reflect not only an intensive local analysis, but also overall national needs and even sometimes international considerations.

Livestock Interventions

In light of the social-political and economic forces which have impinged upon the pastoral societies, some of the adaptive features of the traditional resource use strategy have become maladaptive. The goals and objectives of recent livestock interventions are attempts to redress the maladaptive aspects of pastoral nomadism namely low productivity of animals, environmental degradation due to large herds, and subsistence emphasis instead of economic motivations.

Horowitz (1979) has described the livestock interventions in the subsistence pastoral economy in three categories. The first category includes those interventions which are aimed at the improvement of livestock infrastructures such as veterinary services, range improvements and marketing facilities. Typical problems in this approach are establishing efficient institutions to deliver these facilities to the pastoralists.

The second category includes those interventions which attempt to duplicate the western commercial livestock production system. The main preoccupation of these interventions is how to generate production for consumption in urban and external markets.

In the last category are the interventions whose purpose is to introduce organizational systems in land use and livestock management practices. These measures seek to transplant technological discoveries from commercial sector in the developed world. The three categories of interventions are not mutually exclusive. The Kaputiei Livestock Development Project shows features of all the three types of inteventions.

Although most of the interventions are primarily intended to benefit the pastoralist and to make an economic linkage between the subsistence and monetary sectors, the repeated failures of these projects have raised great concern from agencies responsible for these interventions (Hoben 1979). To some people, these interventions have done nothing more than exacerbate the irrational motivation of pastoralists in building large herds. Other people argue that interventions are based on false assumptions about the nature of pastoral subsistence (Talbot 1968). The pastoralist are not irrational in their behavior, but they are motivated by survival needs in a precarious environment (Western 1974, Dyson-Hudson 1974). Most people agree, however, that some form of intervention in these pastoral subsistence economies are justified since the recent socio-political and economic forces are responsible for the emergent maladaptive features of traditional iivestock production system.

The best approach, from my viewpoint, is to intervene in subsistence livestock sector as learners and not as experts. The Kaputiei Livestock Development Model represents the best case study in which intervention was primarily undertaken as a learning model. The intervention was preceeded by a careful evaluation of the range resource base, livestock and people of Kaputiei. The choice of Kaputiei as my case study was motivated by a desire to study the dynamic interaction of ecological and socio-cultural changes which might provide some insights for intended similar intervention measures. Previous references to the Kaputiei project are found in Halderman 1970, 1972, Davis 1972, Davis et al 1970, Simpson 1973, Jahnke et al 1973, Livingston 1975, Kenya Development Plan 1966-1970 and 1970-74.

SUMMARY

Pastoral nomadism is a characteristic life style of people inhabiting semi-arid and arid areas. The survival factor in these precarious environments is of prime concern to the pastoral nomads. Subsisentence risk for the pastoral communities is defined as the limit of the interaction between human skills and the environment, below which the human starvation occurs (Porter 1965). The pastoral nomadic production system embodies adaptive features such as mobility, multiple use of resources, and flexibility of social organizations. These features operate to minimize the subsistence risk and thus have ensured the survival of the pastoral communities for centuries.

However, the recent socio-political and economic forces have constrained the adaptiveness of pristine pastoral nomadic resource use strategy. The modern interventions in the pastoral areas are motivated by the concern to rectify the maladaptive aspects of the traditional system, with the ultimate focus on transformation of pastoral subsistence into commercial enterprise. The history of the interventions shows little effectiveness of these measures. Kaputiei Livestock Development Model is chosen for further study, as an exceptional project, primarily designed as a learning model in pastoral areas.

Chapter 3

BACKGROUND OF THE KAPUTIEI GROUP RANCH DEVELOPMENT MODEL

HISTORICAL DEVELOPMENT IN MASAILAND

EVOLUTION OF GROUP RANCH DEVELOPMENT STRATEGY IN MASAILAND

THE KAPUTIEI GROUP RANCH MODEL

Objectives of the Model

Group Ranch Operation Environment

ADMINISTRATIVE IMPLEMENTATION CAPACITY

Internal Operational Environment

Ecternal Operational Environment

Chapter 3

BACKGROUND OF THE KAPUTIEI GROUP RANCH DEVELOPMENT MODEL

HISTORICAL DEVELOPMENT IN MASAILAND

In the early records of the English Explorer, J. Thompson (1887), the pristine interactions of the Masai and his environment were noted. The diversity and abundance of wildlife and domestic animals amazed Thompson as he crossed the Athi-Kapiti grasslands in north Kaputiei. These were the days of natural fluctuations of human and livestock/wildlife populations in response to diseases, drought and vavourable ecological periods.

From oral history of the Masai elders, Hollis (1904) reports that the coming of Masai to East Africa was a recent event. The Masai reached the height of their power and geographic control in East Africa sometime between 1830 and 1880. A rinderpest epidemic in 1890 decimated the livestock herds, and then followed a smallpox epidemic which claimed the lives of many Masai people. These two epidemics left the Masai a poor and weak community at the onset of the British rule in East Africa.

Pristine pastoral nomadism in Masailand ended very soon after the dawn of British Administration in East Africa in the late 1890's. Probably because of their war-like tendencies, the British treated the Masai differently and rather favorably from the way they did other indigenous groups. In 1904, the British Government signed a treaty with Mbatian, a Masai Laibon (leader) in which the Southern

(Kajiado and Narok) and Northern (Laikipia) reserves were set aside for the exclusive use by the Masai people (Hailey 1950).

British immigrants and veterans of World War I were allocated ranching lands along the corridor zone between Southern and Northern Masai reserves. The Masai used this corridor to migrate back and forth between wet and dry season grazing areas. This pastoral nomadic use of southern and northern reserves created friction between British settlers and the Masai. Subsequently, a second treaty was signed in 1911, which brought the evacuation of the Masai from the Laikipia area, their dry season grazing area, and enlargement of the Southern reserve in compensation for the loss of the Laikipia reserve. This process of alienation of the Masai dry season grazing areas by sedentary communities continued in other pastoral areas even after the end of British rule in Kenya in 1963.

The ecological repercussions of squeezing pastoral nomadic grazing systems into limited and low potential rangelands, accompanied by parallel changes in human and animal disease control measures, became evident early in the history of British administration in Kenya. The Masai's "...predatory habits continued to be a matter of grave concern in the early days of the colony and seemed in particular to threaten the progress of European settlements." (Hailey 1950). The problems of overgrazing associated with pastoral nomadic grazing systems were documented in the Agriculture Commission (Hall 1929), Kenya Land Commission (1933), Rennie _et al_. (1941), Governor's Advisory Committee on African Land Development

(1945), Swynnerton Plan (1955), and East African Royal Commission (1957).

The Governor's Advisory Committee of 1945 was probably the most important springboard for intervention measures into the rangelands that were attempted during the era of the British Administration. The terms of reference for the committee were to study the conservation problems in the African-inhabited areas and to recommend what measures would be appropriately implemented in order to solve these problems. According to the recommendation of this committee, the Governor was advised to attend to the degradation of rangelands with the highest priority. The Governor set aside funds for the rehabilitation of pastoral and agricultural lands and the Committee was given the authority to carry out the implementation of the recommendation under the name of the African Land Development and Reconstruction in 1946. It was during this period that various grazing control schemes were initiated in Samburu, West Pokot, Baringo, Naroko, Ilkisongo and Kaputiei (African Land Development 1962).

The Konza Grazing Scheme is an appropriate example of an intervention in a pastoral area during the era of British Administration for two reasons. Firstly, this scheme is located in Kaputiei Group Ranching Scheme which is under evaluation in this study. Secondly, because of its close supervision between 1949 and 1960, the Konza Grazing Scheme contains enough information for one to attempt an objective evaluation of its performance.

The objectives of the Konza Grazing Scheme initiated in 1947 were three-fold. The first was to demonstrate the results of proper grazing management in the improvement of the carrying capacity of the land and the productivity of cattle. The second was to improve the indigenous cattle through breeding and selection programs. The third objective was to conduct experiments in pasture improvement.

The first three years of the Scheme was preparatory. An external fence enclosing 88.7 sq. km (8907 hectares) was erected to keep out wild herbivores such as zebra and wildbeest, and to restrict illegal grazing by livestock outside the Scheme. Internal wire fences divided the Scheme into four grazing paddocks. Water supply came from three drilled boreholes and was then reticulated by pipelines to convenient parts of the Scheme. At the center of the Scheme was the settlement site for the participating families. The Scheme incurred a cost of 13,218 from 1947 to 1956.

Changing animal numbers 1949-1960 is clearly shown by Table 1. In 1951, the Scheme herd exceeded the set limit of 2000 heads and 200 heads were saïd to have been sold. It was speculated that the excess animals were simply loaned to relatives and friends residing on the periphery of the Scheme.

Between 1952 and 1955 the Masai families violated the destocking requirement again, and the number of cattle surpassed the limit of 2000 by 417 heads. After serious negotiations between the Masai families on the one hand, and the supervisory teams on the other, the number of animals in the Scheme were set at a new limit of 1700 heads. However, instead of the ten families jointly destocking their herds to the new limit, four families defected from the Scheme by night with a total of 666 animals, thus leaving behind six families with a

Table 1

The History of Cattle Number in Konza Demonstration Grazing Scheme in Kaputiei 1949-1960

Year of Development	Number of Families	Cattle per Family	Total number of Cattle	Recommended Level of Stock	Off Take
1949	10	140	1400	2000	0
1950					
1951	10	220	2200	2000	200
1952					
1953					
1954					
1955	10	242	2417	2000	0
1956	6	272	1632	2000	666
1957	6	333	2000	2000	
1958			2419		105
1959	6	403	2419	2000	400
1960	Drought - estimated over 60 percent				

total of 1632 heads. But it took less than three years, for the numbers to climb again by 419 heads, in excess of the original limit of 2000 head. So by 1959, the six families jointly disposed of 400 heads outside the scheme. Then came the drought of 1960/61 which brought the Konza Scheme to an end along with all other similar grazing schemes in the country. The Konza Scheme (1949-1960) was lauded for: (1) improving the value of the pasture through controlled grazing; (2) demonstrating the importance of regular dipping and innoculations for disease control; (3) showing the advantages of a static over nomadic lifestyle; and (4) teaching the principles of good range management.

While the Konza Scheme unmistakably depicted the potentials of range development inputs and the dangers, the Scheme never attained acceptance by the Masai families of the most critical and important innovation: control of livestock numbers. Table 1 shows that throughout the development decade the number of cattle per family participating in the Scheme more or less tripled even under supervised regular offtake rates.

The achievements outlined above by the implementing authority reveal only cultural ethnocentric bias of resource use patterns instead of a careful appraisal of the peculiar ecological circumstances in which the Masai operate their traditional livestock production system. The Masai at least responded in implementing some aspects of a static livestock production system, but there is no evidence that the implementing authorities learned anything from the traditional livestock production strategies which were already condemned before the inception of Konza Grazing Scheme. The transformation of human behavior to accommodate a new technology is neglected in most development projects probably because it is the most difficult part to implement. This inability to deal with change in human behavior is further strengthened by myths from the past which potray the advantages of a settled way of life: "Turning now to the Masai, ..., we have to deal with a Nilotic race and a more primitive culture, for they are still a nomadic pastoral people moving with their herds and flocks over a wide stretch of country as the pasturage springs in the different areas." (Hall 1936).

Undaunted by the failure of grazing schemes established during the British rule, the new Republic of Kenya proposed an ambitious and extensive development of pastoral areas. In 1963, a report to International Bank of Reconstruction and Development (IBRD) on the economic development of Kenya, commented in regard to pastoral areas that "tribal customs operate against principles of good animal husbandry and grazing management". This report made two recommendations for solving these pastoral problems. Firstly, a legislation was required to revitalize controlled grazing by districts which were started during the time of British administration. Secondly, administrative arrangements were to be established to enforce grazing regulations (IBRD Report 1963).

The basis of the master plan for extensive rangeland development for the new government hinged upon three considerations (Pratt 1968). First, four-fifths of Kenya receives less than 750 mm

(30 inches) of mean annual rainfall; so ways to intensify and transform the subsistance pastoral nomads into producing units would contribute significantly to the total national economy. Second, only with proper management could the rangeland be conserved and therefore become an asset for the whole country. Third, although the people of the pastoral areas constitute only one-tenth of the total national population, they deserve a share of the national prosperity.

Financial aid and technical assistance to carry out the rangeland development plan were sought from International Agencies such as World Bank, USAID, UNDP/FAO, and foreign governments. Kenya received $11.8 million dollars for the Livestock Development Phase 1. Sixty-two percent of this aid was to be directed to the development projects in the rangelands. The Livestock Development Phase 1 started in 1968. Its main objective was to stimulate and establish forms of ranching operations suited to different types of rangelands, taking into account their ecological potential, social feasibility, and economic viability. The group ranching scheme was selected as the most appropriate type of ranch organization in the Masailand.

EVOLUTION OF GROUP RANCH DEVELOPMENT STRATEGY IN MASAILAND

Land enclosure in Masailand started before Kenya's independence in 1963. The more progressive Masai around Kajiado town, and parts of Kaputiei started individual land enclosure without proper legal rights of ownership. Soon after independence, the Kajiado country council began granting a form of recognition of individual enclosures although the majority of Masai did not approve. Kajiado and Narok

District Development Councils were set up in 1964 to coordinate development programs and to evolve the most appropriate strategy for the development of Masailand. Each council was made up of District government officers and prominent Masai representatives.

A memorandum to the Ministry of Agriculture titled "A Plan for the Development of Kenya Masailand" was submitted jointly by the district development councils in 1965 (Lewis). In this report, the Masai representatives affirmed a growing trend among the Masai people to settle and do away with their pastoral nomadic lifestyles. However, the process of individual parcellation of land had to be discouraged both on ecological and economic grounds. The allocation of land to a group of families was the best approach to the development of Masailand (Lawrence Commission 1966).

The government accepted this trend toward a sedentary lifestyle and favored the proposed group ranch development strategy for two reasons. First, allocation of the land to groups of families reduced the "land-grab" process by the progressive Masai. Secondly, some form of private ownership of land by a corporate body like a group of families was in conformance with the evolving land tenure policy in Kenya during this period. Private rights granted to a corporate body such as a group ranch, would presumably motivate proper grazing resource management.

Meadows (1967), in his conceptual analysis of the origin and principles of the group ranch concept in relation to the problems of tenure and social customs of the Masai, commented that the translation of traditional land rights into "a tangible form of personal ownership" would would "almost inevitably add impetus to a program of development". The Lawrence Commission on Land Consolidation and Registration (1966) commended and strengthened the trend of group ranch formation in Masailand but it expressed doubt about the precondition of multiple ownership by the group ranches before any development funds could be released.

The study by Jacobs (1965) on "the traditional political organization of the pastoral Masai" sheds light on why the "group ranch" development approach found application in Masailand. The Masai people are composed of several "tribes" or sections such as the Kaputiei, Ilkisongo, Ilmatapatu, Ildalalalekutuk. An individual section normally occupies a large area within which the members of the section posesses exclusive land use rights. Each section comprises several "local groups" which live in a particular local area of the "tribal" land. Jacobs defines a local group as "an aggregate of seversl* kraal camps inhabiting a single named locality, and constitutes the smallest political community of a tribe". Such identifiable "localities" in Masailand would constitute a suitable "group entity" in a range development plan for the following three reasons.

First, the development of the whole section i.e. an aggregate of localities would not attract illegal grazers from other sections of Masai because of the traditional restrictions of grazing rights for each section.

*Kraal camp has the same meaning in this thesis as Boma or settlement site in which a number of families stay together.

Second, by recognizing customary definitions of legal boundaries by the several "local groups", emergence of group ranch entities would facilitate registration of group rights for a particular area. This process eventually may lead to better management for each group ranch.

Third, since each local area presumably accommodates both wet and dry season grazing resources, vis-a-vis smallest ecological entity, and since this entity coincides with the smallest socio-political entity, it is easier to blend existing traditional organization forms and resource use patterns on one hand, with new strategies of modern livestock production systems on the other.

The premises of building on the traditional livestock production and political systems are twofold: 1) That this will provide the least disruption of both the socio-cultural and bio-physical environments of the Masai; 2) that, developments inputs which take advantage of the existing traditional technologies will have the highest level of acceptance among the Masai people. Davis (1972) posed two fundamental questions regarding these premises. The first question is in regard to whether the group ranches constitute adequate ecological entities to provide survival grazing resources during drought; and the second question concerns the long run significance of traditional authority structures in dealing with ranch management problems at the commercial level of operation.

THE KAPUTIEI GROUP RANCH MODEL

Objectives of the Model

The first main objective of the Kaputiei Scheme was to provide a model for evaluating the effectiveness of the group ranch development approach in Masailand. The Kaputiei Masai were chosen for this experiment project because they "promised cooperation in economic and social advancement," and because the whole Kaputiei area constituted a recognizable sociological and ecological entity (Pre-Investment Survey 1969). The Kaputiei section was subdivided into fifteen "socio-ecological units" or group ranches which involved a total of about 1300 families. This approach assumed that each group ranch was a self-contained unit, and therefore, the introduction of appropriate range management practices would encourage the Masai to adopt a sedentary lifestyle instead of their seasonal migration behavior.

The second objective concerns the adaptation of appropriate range management practices. In this objective there were two basic assumptions. The first assumed that the range inputs such as water, dips, etc. would strengthen the group ranch organization. In the second assumption, the introduction of new development inputs would be followed simultaneously by adoption of a commercially oriented livestock management strategy i.e. disposal of surplus production in the market exchange system.

The key to proper range management practices hinges upon a reconciliation between forage demand by grazing animals and primary forage supply from the rangelands. The Kaputiei plan proposed the implementation of three grazing management principles to cater for the forage demand and supply. (Pre-Investment Survey 1969).

The first principle related to the control of stock numbers. It was envisaged in the plan that the best approach to achieve destocking depended upon the establishment of recognizable ranch boundaries in order to control incidence of illegal cross-boundary grazing. Furthermore each group ranch management committee would enforce regular livestock censuses and animal identification marking i.e. branding and a tag for each individual head of cattle.

The second principle in the proposed grazing management concerned the intensity of forage utilization. This principle would be implemented by constant determination of grazing capacity by means of long-term vegetation transects and observation plots. The annual grazing allotment per capita would vary according to the range condition and trend.

The final principle refers to the adoption of the most appropriate grazing system i.e. the choice between different systems like grazing deferrment, rest-rotation etc. The purpose of this principle was to allow grass to set seeds, and to produce fuel for prescribed burning which would control bush encroachment.

Other general aspects of the Kaputiei development plan included livestock production targets such as increasing calving rates, decreasing calving intervals, reduction of death losses due to diseases, improvement of rate of weight gain and yield of saleable meat, steer fattening programs and introduction of exotic bulls i.e. Sahiwal and Boran bulls. The monitoring of new resource use patterns such as off-ranch employment opportunities, and change of diet composition that includes more grain and non-livestock foods, would also provide useful information of the behavioral changes of group ranch participants.

Group Ranch Operation Environment

The boundaries were established after discussion between the Masai leaders and the Range Management extension staff. These boundaries followed natural landmarks and presumably enclosed both wet and dry season grazing for each ranch.

The weakness of the way in which these boundaries were established became apparent even before the Kaputiei Plan got off the ground, as indicated by this comment from the Pre-Investment Survey (1969) "While natural boundaries (rivers, hilltops, etc.) are easily recognizable, their use as boundaries is not always compatible with the efficient water development or grazing management. Map 1 shows the 15 group ranches which finally became operational.

With reference to the organization structure of a group ranch, the revision of the Adjudication Act (1968) paved the way for a group of families that had traditional usage of a piece of land and who agreed to form a group to be legally registered as a cooperate body. The group then selects their representatives who act as 'custodians' of the affairs of the group. After consultation with Ministry of Agriculture and settling of boundaries denoting traditional usage of their local area, the land is then adjudicated and all members registered as a corporate body with the Registrar of Group Representatives.

The members then elect a management committee that is responsible for implementing sound ranch and livestock management, oversees the proper use of loans for water and dip development, and undertakes the day to day affairs of the group ranch.

The members are expected to pay for services in proportion to their numbers of stockholding. Each member is to be allocated grazing quotas annually. The individual grazing quota depends upon current range condition and trend of the ranch. Livestock are to be owned individually but the members are expected to comply with all regulations set by their management committee in the issues of grazing management, loan repayment, proper livestock husbandary practices such as dipping, innoculations, genetic improvements, culling, and take-off requirements. (Development Plan 1966-1970).

The proposals depended on water development programs and range management practices. The actual and proposed water resources in Kaputiei ranches in 1968 are shown in Table . It was recommended that maintenance of water supplies, previously under the Kajiado Country Council, be decentralized and that each group ranch assume the responsibility of operation, fuel and maintenance. The maintenance team was to stay in Kajiado as before. The maintenance costs would come from the Kajiado Country Council or the Central Government. Each ranch should however be ready to finance the costs of one major and two minor pumps overhauls for every installation. In addition, the ranch was required to keep proper records on borehole operation hours.

The administration of the development programs was shared by four agencies and a few other ancilliary bodies: Range Management

Division, Agricultural Finance Corporation (AFC), Water Development Division, and Registrar of Group Ranch Representatives.

The Range Management Division, within the Ministry of Agriculture assumed the heaviest responsibilities. The Division was to supply extension staff at district and group ranch level to work with the group ranches. The extension staff provided knowledge on new livestock management practices such as the appropriate grazing systems, herd management practices, livestock improvements through planned breeding programs, dip management and destocking requirements. The grazing quotas were assigned on the basis of the assessed carrying capacity of each ranch every year. Annual livestock censuses were made and submitted to the AFC. Finally, the extension staff advised the ranches on keeping good records.

The AFC was a parastatal body in charge of administering the loans for development programs. The AFC established a Ranch Section and appointed a Ranch Technical Officer (RTO). The RTO participated in the development projects, ascertaining that the loan requirements were fulfilled. The AFC was entrusted by the Government and the World Bank to recover the development loans from the ranch members. Each member was assigned to portions of the ranch loan on the proportional basis of the individual stockholding.

The Water Development Division (later known as the Ministry of Water Development) played a major part in the scheme. Water sources were strategically developed to enhance the total carrying capacity of each ranch. Water development expenditures constituted 57 percent of the total proposed development inputs in Kaputiei.

The Registrar of Group Representatives, appointed under the Land Adjudication Act of 1968, acted in the capacity of a legal adviser to the group ranches. He was also in charge of keeping an updated list of registered members of each group ranch. The process of incorporating new groups of families as legal entities under this Act (1968) was an important responsibility in the rapid evolution of many group ranches.

The significance and crucial role of the group ranch committee in interacting with the above agencies became manifest during implementation of the development programs. Other agencies providing ancillary services in the course of development included the veterinary Department, Livestock Marketing Division, and the central District Administration under the District Commissioner in Kajiado.

ADMINISTRATIVE IMPLEMENTATION CAPACITY

Internal Operation Environment

Some group ranches had strong internal leadership. In particular Ilmamen, Kiboko, Mbilin, and Olkarkar group ranches fall in this category. By 1972, Kiboko and Olkarkar ranches had finalised the first phase of development which involved water and dip constructions. In a joint meeting between these two ranches in July 1973, the items on the agenda included more advanced aspects of ranch development proposals such as breeding and steer fattening programs; and ways to implement destocking measures.

However, not all ranches were endowed with good leadership. Nkama for example, had very weak internal leadership and disharmony among the members themselves. This problem could have been precipitated by the extensive area of the ranch. After attending a general meeting in January 1972, the Provincial Range Officer (PRO), informed the AFC officials that Nkama members had resolved to reject loan money partly because of leadership problems.

The Nkama members contended that the elected management committee members, who would be in charge of loan funds, had never called a general meeting to explain the nature of the government's development proposal. In addition, these committee members did not command the respect of the majority because of their alleged previous misappropriation of funds. The attendance at general meetings continued to drop and in 1974, only 10 percent of the total ranch membership of 322 attended.

The exercise of allocating grazing quotas was not welcomed. In 1974, the Ilmamen members complained that grazing quotas could not work because some members had double registration under different names. Mbilin members refused any discussions in 1975, of grazing qutoas, as long as illegal grazers occupied parts of their ranch. An attempt to issue legal eviction notices to nonmembers incited acts of vandalism in which one borehole was destroyed, and the ranch store was ransacked.

The rate of water development in Kaputiei ranches is a good indicator of the strength of group ranch leadership. For example in 1970, Ilmamen leaders were already active, pressing for an implementation of a water development program. The Embolioi ranch, probably because leadership problems, only managed to complete the first step of incorporation as a group ranch in 1973.

The procedures of unleashing the development funds from AFC was not an easy task for many uneducated group ranch leaders. For example, in 1973, Imaroro/Mashuru leaders faced problems with legal procedures of obtaining and filing the application forms for development loans; and then the subsequent submission of security documents with proper signatures. Olkinos and Empuyankat reported siting of borehole and earthdam, but these constructions were not carried out even as late as 1974. The above beaurocratic channels delayed the pace of implementation.

The repair and maintenance of water installations show a poor record. Kiboko and Olkarkar installations had to cater for influx of outside animals in 1974. Ilmamen borehole had a very low discharge, while the Mashuru borehole was drilled and stayed without pump installation. Problems of repair and maintenance of Nkama water boreholes aroused official concern from the Range Management Division.

The severity of drought precipitated a temporary breakdown of the group ranch governments. However, after the drought in 1977, most of the group ranches started functioning again. For example, Kiboko members held a general meeting in 1977, in which legal action was sought against group ranch members who had misappropriated loan steers from AFC during the drought crisis. In September 1977, Ilmamen members had already re-established their leadership and therefore, upon their request, 600 AFC steers were advanced to the ranch as a part of the steer fattening program of the livestock development project.

External Operational Environment

The Kaputiei group ranch proposals received a development loan in 1968. However, the conditions for releasing the loans to the group ranches proved to be a hindrance (Simpson 1973). Each group ranch had to undergo the incorporation process with the Registrar of Group Representatives in order to acquire a group-title deed, a security condition before borrowing development loans from AFC. The greatest delay in the incorporation stage stemmed from undue emphasis on egalitarian considerations geared toward avoiding the emergence of landless Masai. Wales (1977) calculated that out of the total $1.8 million of development loan approved in 1968 for Kaputiei Group ranches, only $0.9 million had been disbursed by 1974.

The external environment in which the group ranch governments operated failed to provide protection for the fragile institutions in two important areas. In the first area, the issue of group ranch territorial integrity was outside the enforcement domain of an individual ranch to avoid the possibilities of inter-group skirmishes. In 1971, the Nkama members held a meeting with the Kajiado District Commissioner to resolve the question of non-Kaputiei illegal grazers from adjacent less developed Ilkisongo section. However, proper machinery to deal with illegal grazers was never established.

In 1975., the District Officer, unable to help Mbilin members to deal with illegal grazers advised the members to use the court procedure. The outcome of this advice led to increased vandalism in Mbilin by outsiders. The unresolved issue of illegal grazers was to undermine the most important aspect of the Kaputiei Livestock Development Project. Using the problem of illegal grazers, many members refused to consider any kind of destocking measures.

The second area in which the external operational environment of Kaputiei group ranches failed was its inflexibility. After attending a general meeting in Nkama in 1972, the PRO noted the need to bend the condition of a two-thirds majority. The Registrar of Group Representatives, however, insisted on this condition before resolutions could receive official endorsement. The meetings held in Nkama never fulfilled this requirement. The low attendance in general meetings was a good signal that all was not well with the day to day operation of group ranch leadership. However, there appears to have been no immediate attempts to rectify faulty leadership in the ranches, probably because this problem was never anticipated in the early development proposals.

This brief review of implementation and operation of the group ranch institutions in Kaputiei deserve greater analysis than the one attempted in this section. It appears that too much responsibility was delegated to the group ranch management committees, who had no special skills for the work. The extent to which the local leadership should be sought without spelling great risks in the operations of the development projects would be an interesting area to explore. Unlike many other development projects, the Kaputiei project leaned quite heavily on building upon the existing traditional institutions. This is a step in the right direction except that the group ranch leadership roles were new innovations which therefore needed monitoring to alter stringent legal procedures where necessary, in order to enhance effective performance.

The continuation of group ranch institutions after the 1975-77 drought is a positive indicator that the new institutions are taking root and being adapted by the Masai to fit the changing socio-cultural environment. But the extent to which the external operational environments of these institutions are also changing to accommodate new forms of group ranches in an interesting subject that is beyond the scope of my thesis.

CHAPTER 4

THE KAPUTIEI ENVIRONMENT

CHAPTER 4

THE KAPUTIEI ENVIRONMENT

INTRODUCTION

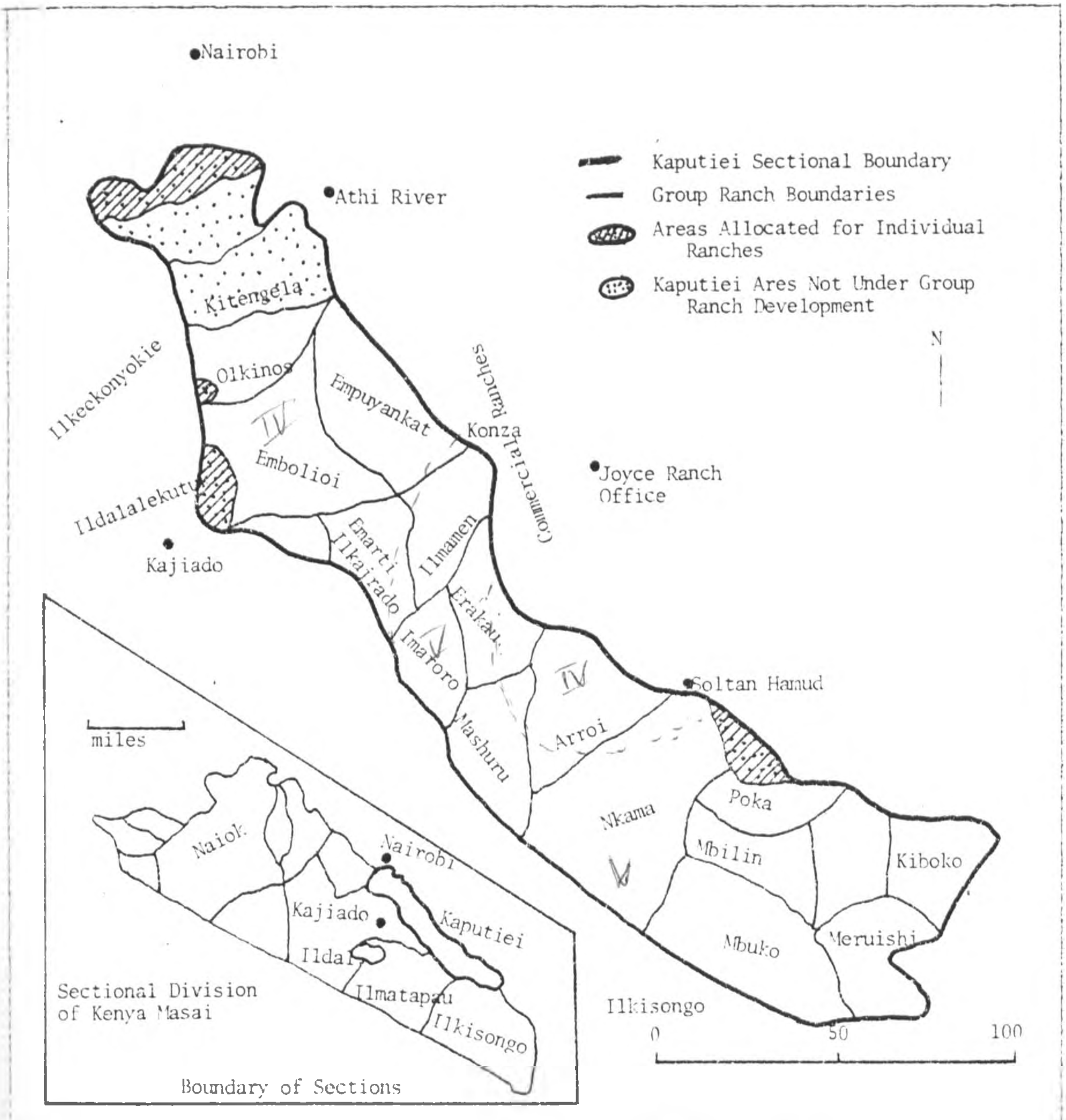
This chapter describes the Kaputiei environment and the recognized units within the areas, emphasizing ranch sites. The vegetation fauna and human components of the Kaputiei ecosystems will be covered in the succeeding chapters.

Kaputiei section lies between latitudes 1° 15' and 2° 30' south and longitudes 36° 45' and 37° 45' east. Kaputiei, administered as a division of Kajiado District in Kenya, is a rectangular strip of land, 145 km long (90 miles) and 24 km (15 miles) wide, covering an area of about 376,136 hectares (827,500 acres). This area includes Kitengela conservation unit with an area of 53,182 hectares. The present group ranch program constitutes 273,000 hectares (675,000 acres) or 73 percent of the total Kaputiei section. Figure 1 shows the 15 Kaputiei group ranches and parts of Kaputiei under different ownership. To the north of Kaputiei group ranches is the Kitengela Game Conservation and some individual ranches. To the west of Kaputiei are other sections of Masai i.e. Ilkeekonyokie, Ildalalekutak, and Ilmatapatu. Ilkisongo section lies in south west of Selengei river which is the natural boundary dividing Kaputiei Masai from other sections of Masai in the west.

The Mombasa - Nairobi railway line is the eastern boundary stretching from Athi River to Kiboko Railway Station. Commercial ranches separate Kaputiei Masai from the Kamba people. The southern

Figure I

The Kaputiei Group Ranching Scheme



boundary of Kaputiei section is the Kiboko river, while the northern limit of the group ranches is the Kajiado-Athi-River road.

BIOPHYSICAL ENVIRONMENT

Physical Geography

The geology of Kaputiei has been described by the works of Matheson (1964), Baker (1954), Searle (1954) and Saggerson (1959). The area is in three distinct physiographic categories; the Athi-Kapiti Plains, the Central Uplands and the Southern lowlands (Figure 2).

The Athi-Kapiti Plain, with a relief of 1585 m to 1828 m (5200 ft. to 6000 ft.) is referred to as "stepped geologic peneplain", and consists of a submiocene peneplain upon which tertiary volcanic rocks have been extruded. The Kapiti phonolite, the oldest of these tertiary rocks is the most extensive and has protected the peneplain from extensive geologic erosion. The topography is also flat to gently undulating with less than 2 percent slope.

South of the peneplain lies the Central Uplands consisting of basement system rocks. The central upland plateau with a general relief of 2 - 8 percent consists of undulating land forms which are heavily dissected by Selengei tributaries. These central uplands extend southwards, and terminate in Emali basement hills which have a relief of 8 - 16 percent. The elevation of central uplands varies from 1220 m - 1585 m (4000 ft to 5200 ft.). Some hills such as Soysambu (5679 ft.) and Olmuntus (5953 ft.) rise above 1585 m.

The southern lowlands are of two types: geologic erosional plains and pleistoceine volcanic types. The relief is fairly uniform lying between 1128 - 1220 m. (3700 - 4000 ft.), with occasional volcanic hills.

The Kaputiei drainage systems are characterized by seasonal streams and rivers. The drainage systems follow the physiographic features described above (Preinvestment Study Report 1969). The Athi-Kapiti drainage system runs from north to south-easterly direction. This area is poorly drained by streams which join Stony Athi river, the tributary of Athi river.

The central upland drainage system is characterized by many streams which drain in a west-southern direction into Selengei river. The Selengei river continues into southern lowlands, where it bifurcates into several channels which disappear in large flat areas of black cotton soil (vertisols). To the south of Kaputiei is Kiboko river which drains in easterly direction.

Eco-climatic Zones

According to the classification of East African Rangeland by Pratt et al (1968), Kaputiei section falls under ecological zones III, IV and V (Fig 2). This classification is based on the climatic factors and land use potentials on the one hand, and the physiognomic characteristic on the other. The description and extent of physiognomic classes in Kaputiei ranches are summarized on Table 2 .

The climate is categorized according to the Thornwaite Moisture Index factor which is defined according to the ralationship between

Figure 2

Classification of Kaputiei Rangeland into Ecological Zones and Landscape Types
(Source-Preinvestment Study Report 1969)

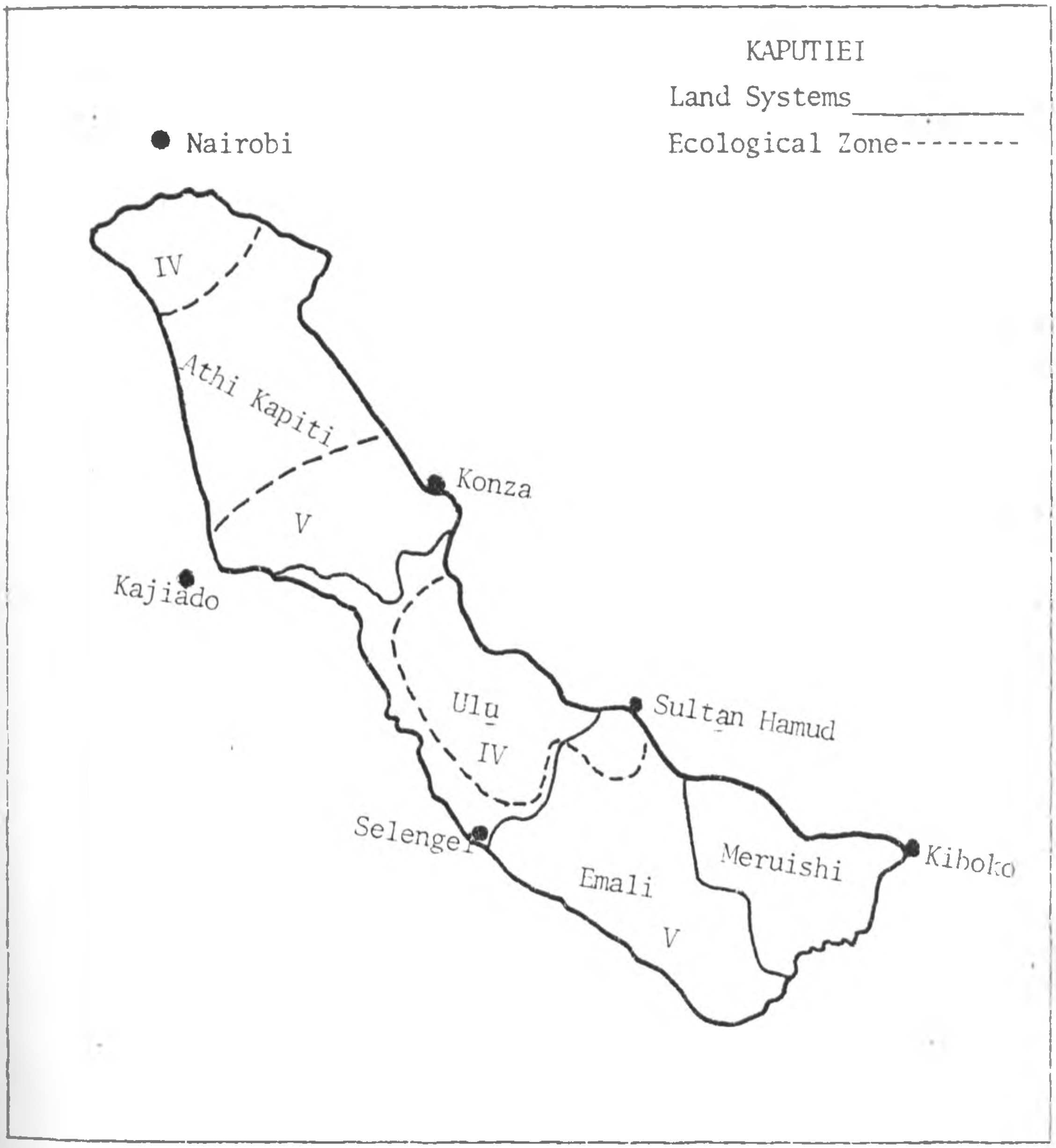


Table 2

Physiognomic Types in Kaputiei Group Ranches

Ranches	Physiognomic Types[1]					Total	Dominant Physiognomic Type
	W[2]	WG[3]	B[4]	BG[5]	G[6]		
North Kaputiei							
Embolioi					62200	62200	100 G
Empuyankat		1240		7350	41910	50500	83% G
Olkinos							
Central Kaputiei							
Emarti			2100	2710	6430	11240	57% G
Ilmamen			21610	5370	2960	29940	72% BG
Erankau		190	22100	4490	3770	30550	72% B
Arroi		990	23390	9880	15010	48270	46% B
Nkama	4290	16810	35800	20210	25570	102680	35% B
Imaroro/Mashuru							
Mashuru	2720	5990	4470	5490	16060	34730	
Imaroro	620	680	17980	6730		26010	
South Kaputiei							
Poka	1090	2390	720	5370	19030	28600	67%B
Mbilini		430	6850	11600	19190	38070	50% G
Mbuko			39590	21620	8530	69740	57% B
Meruishi		3030	2650	9650	15590	30920	50% G
Kiboko		60	4750	9760	21400	35970	60% G
Total	8726	3891	199160	129500	284630	660860	

[1] Definition of physiognomic types (Pratt et al 1968), Source: Pre-Investment Study Report 1969)

[2] W - Woodland - (over 20% tree cover)

[3] WG - Wooded grassland - (under 20% tree cover)

[4] B - Bushland - (over 20% bush cover)

[5] BG - Bushed grassland - (under 20% bush cover)

[6] G - Grassland - (under 2% tree or bush cover)

the evaporation potential and the annual precipitation.
Ecological zone III has a moisture index of -10 to -30 and has dry sub-humid to semi-arid climate. This zone is suitable for crop production as well as intensive livestock production. The zone has a grazing potential of 2 hectare per stock unit.*

Ecological zone IV with a moisture index of -30 to -40, has a semi-arid climate which is marginal for rain-fed agriculture. The potential grazing capacity is estimated at 4 hectares per S.U.

Ecological zone V covers extensive area in South Kaputiei. This is the driest climate in Kaputiei with a moisture index of -40 to -50. The zone is suitable for extensive livestock production and has a grazing potential of more than 4 hectares per S.U.

The definition of Kaputiei ecosystem into these three broad ecological zones (III, IV and V) puts Kaputiei rangelands in context of the other ecological zones in East Africa, but it does not provide a detailed description for the analysis of ecological changes due to management and climatic factors.

Since climate is such an important determinant of the performance of Kaputiei Livestock Development Model, Kaputiei climatic features deserves special emphasis beyond the broad ecological classification discussed above. Kaputiei has a uniform temperature which ranges from 31°c to 41°C (56°F to 73°F), with a mean monthly daily variation of 3.5°C, and a diurnal range of 12°C (Preinvestment Study 1969). The relative humidity averages 60 percent.

*One stock unit is equivalent to a 450 kg steer.

Precipitation regime constitutes probably the greatest source of risk and uncertainty in planning and managing the rangeland ecosystems. The time of fall, variability and total amount or rainfall in East Africa are governed by the Inter-Tropical Covergence Zone (ITCZ) which moves between latitudes 15°S and 15°N in response to the apparent movement of the sun across the Equator twice a year. Winds from northern and southern hemispheres coverge and as a result of ascending air masses, the ITCZ is characterized by a belt of rains (Griffiths 1958). The movements of ITCZ determine the bimodal rainfall pattern in Kaputiei. The two rainy seasons come between March and May and between November and December.

The seasonal variations of bimodal rainfall in Kaputiei are depicted by Ngong Station in ecological zone III and Makindu Station in ecological zone V. (Table 3 and Figure 3 & 4). In ecological zone III, the March to May rainy season is more important than the November to December season, accounting for about 52 percent of the total annual rainfall. However, in the more arid ecological zone V, the November to December rainy season is more important than March to May season constituting about 48 percent of the total annual rainfall.

The monthly rainfall distribution is better and more reliable in wetter areas of north Kaputiei than in south Kaputiei (Table 3 , Figure 3). For example, in the north, only four months show a coefficient of variation (CV)* $\geq$ 100 percent compared to nine months

*CV calculated as percentage of standard deviation of the mean

Table 3

Mean Monthly Rainfall Distribution in North (Ngong) and South (Makindu) Kaputiei (From 1967 to 1977)

Month	North Kaputiei Ngong Station			South Kaputiei Makindu Station		
	Mean	SD	CV	Mean	SD	CV
January	47.1 ±	60.7	129%	33.1 ±	38.0	115%
February	43.2 ±	40.0	93%	34.2 ±	40.7	119%
March	90.2 ±	115.4	125%	60.1 ±	71.9	120%
April	182.5 ±	121.2	66%	136.4 ±	98.6	72%
May	163.6 ±	91.0	56%	24.4 ±	28.6	117%
June	49.5 ±	39.4	80%	2.5 ±	4.4	176%
July	21.1 ±	31.2	148%	0.9 ±	1.9	211%
August	16.0 ±	17.8	111%	2.9 ±	6.8	234%
September	26.0 ±	24.2	93%	5.9 ±	10.1	171%
October	35.7 ±	31.6	89%	17.0 ±	27.7	163%
November	89.1 ±	63.4	71%	214.2 ±	106.7	50%
December	51.4 ±	39.4	71%	73.3 ±	54.1	74%

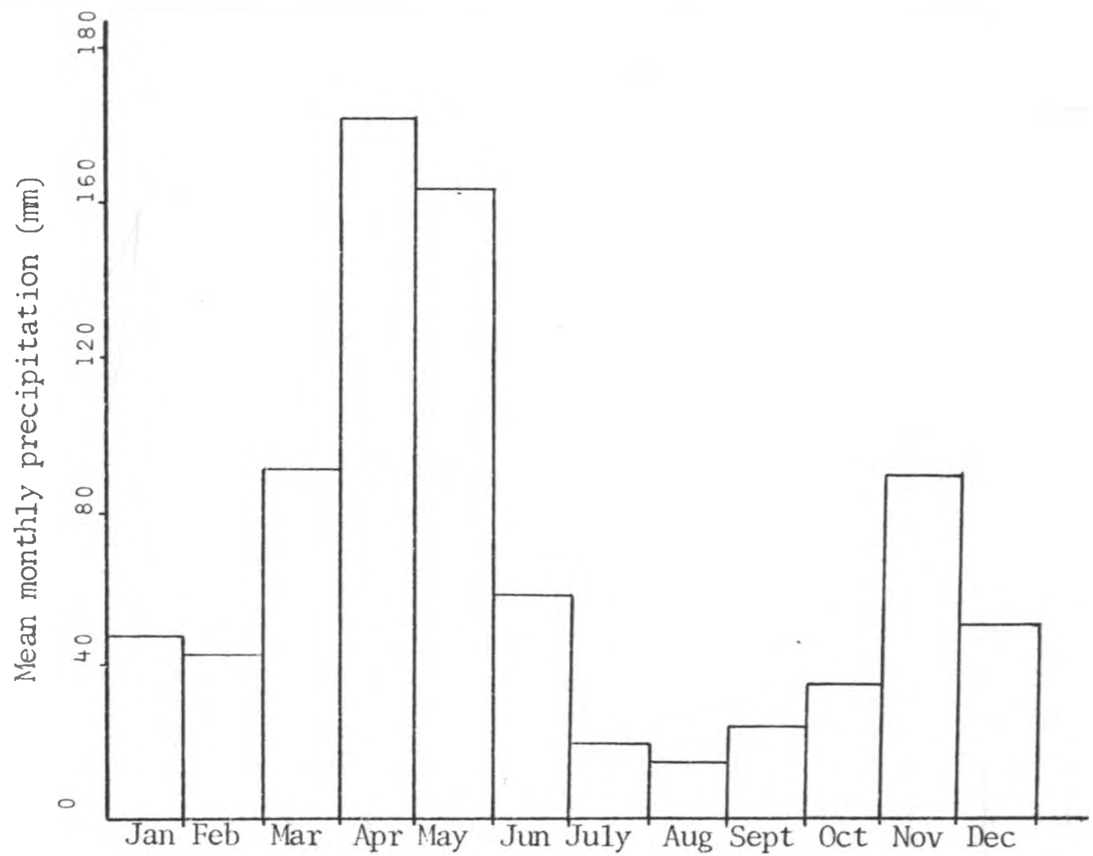


Figure 3

Mean Monthly Rainfall (mm) Station North Kaputiei
(Records for 12 years, 1966-1977)

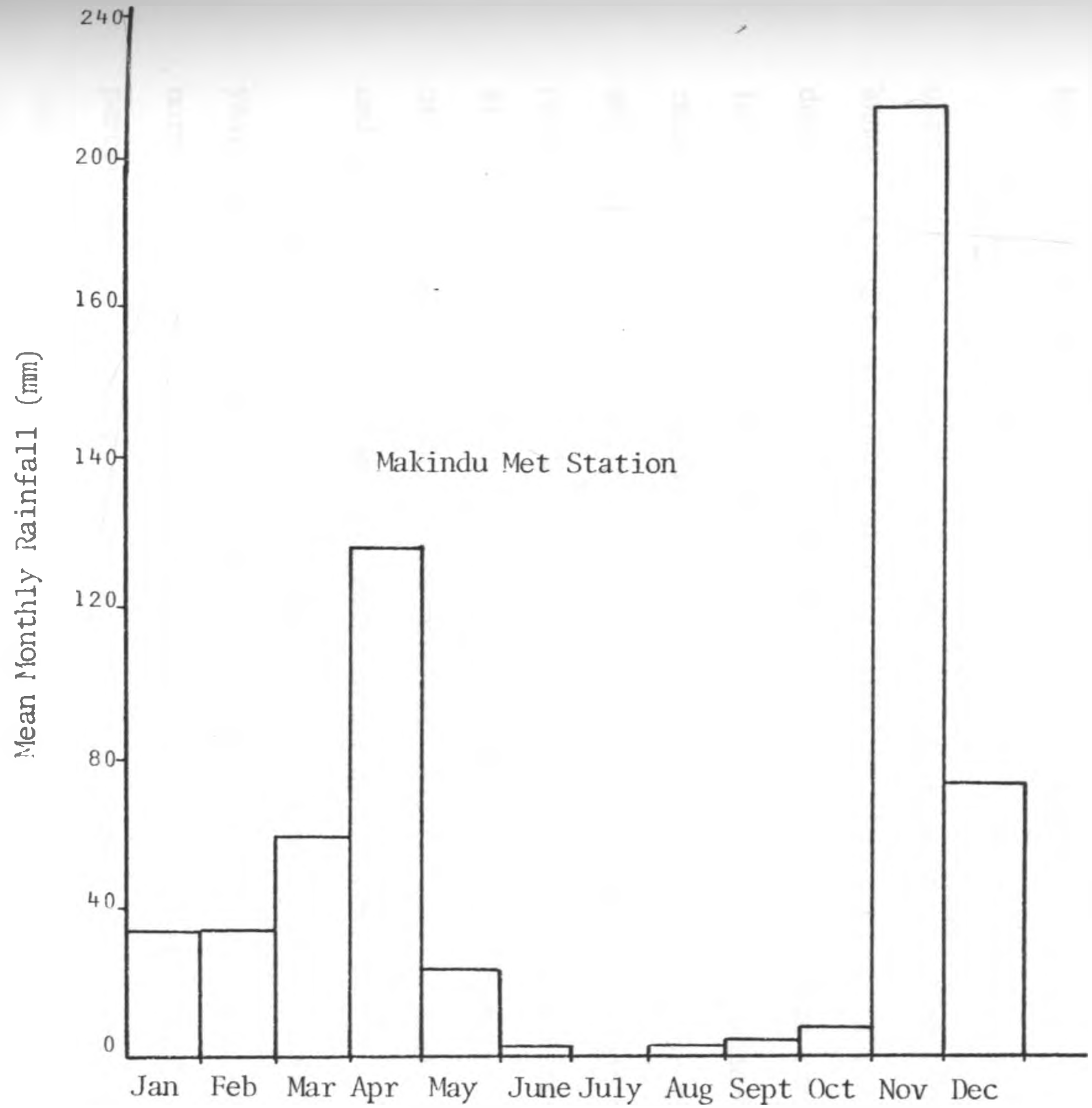


Figure 4

Mean Monthly Rainfall for the Period 1967-1977 under the same category in the south. The higher the CV, the more unreliable the rainfall for that month.

The spatial variability of total annual rainfall in Kaputiei is indicated in Table 4. In general locations east of Kaputiei section receive higher precipitation as the easterly winds drop the moisture before descending to the lowlands west of Kaputiei.

The annual variation of total rainfall seems to follow unpredictable periodical cycles of dryness and wetness. The total annual rainfall in Makindu station indicates that the rainfall has decreased steadily since 1968 until 1977 (Figure 5). Joyce ranch is located on the eastern side of central Kaputiei area near Konza-ulu railway line. The rainfall records at this ranch are used for the analysis of temporal rainfall patterns with the assumption that these patterns can be extrapolated to Kaputiei areas. The rainfall records at Joyce ranch between 1914 and 1977 depict the approximate patterns of wet and dry cycles which have profound implications in designing and evaluating development projects in the rangelands.

The masai people remember that 1960, 1973 and 1976 were very dry years in which the annual rainfall was inadequate to sustain their normal resource use patterns. These years received less than 70 percent of the mean annual rainfall at Joyce ranch. Using this information regarding the amount of reduction in rainfall which interrupts the normal resource use patterns, a dry year is characterized by an annual precipitation of $\leq$ 70 percent of the mean annual precipitation. A wet year, by contrast, is therefore defined as a

Table 4

Total Annual Rainfall as Percentage of the Mean Annual Rainfall Inside or Near Kaputiei Section (From 1966-1977)

	Station						
	Ngong	Isinya	Joyce Ranch Office	Kajiado	Kibini	Simba	Makindu
	Location						
Year	Inside North	Inside North	Near Outside Central	Outside West	Inside Central	Inside South	Outside South
1966	94%	79%	113%			147%	82%
1967	128%	106%	113%	97%	128%	158%	138%
1968	109%	111%	185%		157%	163%	211%
1969	72%	86%	92%	108%	77%	54%	93%
1970	90%	102%	94%	136%	87%	50%	111%
1971	87%	93%	86%	108%	85%	70%	100%
1972	177%	85%	91%	94%	81%	27%	71%
1973	68%	59%	68%	93%	71%		69%
1974	99%	122%	89%	126%	70%		68%
1975	82%	71%	67%	105%		41%	73%
1976	60%	55%	44%	32%	47%	68%	61%
1977	135%	171%	117%		114%	122%	122%
Mean Annual Rain in mm	845.4	592.5	648	472.6	602.5	650.7	604
SD	921	186		118	172		262
N	12	16	63	12	15	18	11

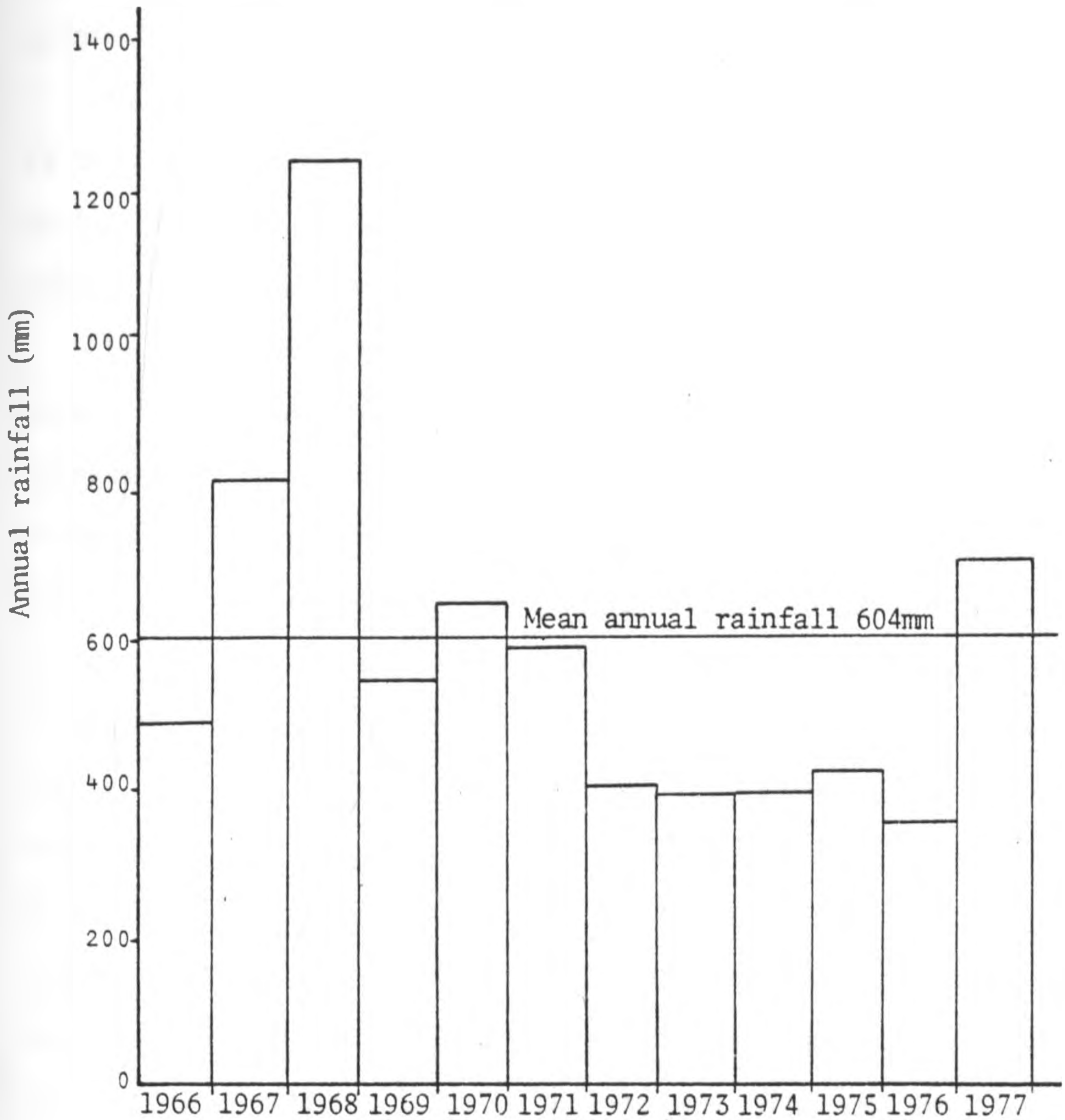


Figure 5

Makindu Met Station: Variation of the Total Annual Rainfall From 1966 to 1977 year which receives $\geq$ 30 percent rainfall above the mean annual rainfall.

Between 1914 and 1977, Joyce commercial ranch recorded a total of 14 dry years and 10 wet years. (Table 5). This approximates that 1 out of 4.5 years will be a dry year, while 1 out of every 6.3 years will be a wet year.

In many cases, the most severe conditions which interrupt the normal resource use patterns occur during a period of at least two consecutive years of inadequate annual precipitation. A drought is defined in this case as a period of two consecutive years which jointly average less than 75 percent of the mean annual percipitation for that period. Using the above definition, Joyce ranch experienced 8 droughts or a total of 16 "drought years" in a period of 63 years (Table 6). This implies that the chances of experiencing drought conditions are 1 out of 4. The 1975/76 drought averaged 55.5 percent of the mean annual precipitation and was therefore the most acute drought ever recorded in Joyce ranch. The following conclusions can be drawn from the precipitation patterns in Kaputiei area.

(1) Kaputiei section originally included the Ngong area which receives more mean annual rainfall than other parts of Kaputiei. Most of the wetter parts of north Kaputiei regions are not included in the group ranching program. Hence the proper utilization of south Kaputiei area with poor rainfall reliability and a strong seasonality factor depended on the dry season grazing in wet areas in the north and central Kaputiei area.

Table 5

Joyce Rainfall Records 1914-1917

Decades	Number of years (N)	Mean Annual Precipitation	*Percentage of Mean Annual Precipitation	Number of Dry Years**	Number of Wet Years***
1914-1919	6	24.48 ± 6.41	94%	1	0
1920-1929	10	22.26 ± 7.07	86%	3	1
1930-1939	10	26.18 ± 8.00	101%	1	2
1940-1949	10	23.22 ± 6.69	90%	3	1
1950-1959	10	27.35 ± 12.6	106%	2	2
1960-1969	10	29.86 ± 13.30	115%	1	2
1970-1977	8	21.07 ± 5.63	81%	3	0
Total	63	25.92"	100%	14	10

*Mean annual precipitation (1914-1977) 25.92" (648 mm).

**Dry year defined as a year receiving ≤ 70% of mean annual rainfall.

***Wet year - receives ≥ 30 percent of mean annual rainfall.

Table 6

Recurrence of Droughts in Joyce Ranch Between 1914-1977

Drought[1]	Year (Two Consecutive Years)	Absolute Precipitation in Inches	[4] Percentage of Mean Annual Rainfall	[2] Drought Score	[3] Drought Index
1	1921 1922	13.32 22.09	51% 85%	136	68%
2	1924 1925	15.24 20.15	59% 78%	137	68.5%
3	1933 1934	19.91 24.67	77% 57%	134	67.0%
4	1943 1944	13.64 23.63	53% 91%	144	72%
5	1945 1946	18.74 18.08	72% 70%	142	71%
6	1949 1950	15.08 15.02	58% 58%	116	58%
7	1959 1960	18.05 17.76	70% 69%	139	69.5%
8	1975 1976	17.36 11.32	67% 44%	111	55.5%

1. Drought defined as two consecutive years with less than a sum of 150 for the two percentage of means i.e. for drought 1, 51+85=136
2. Drought Score: The sum of percentages for two consecutive drought years
3. Drought Index + (Drought Score /200) X 100
4. Mean annual precipitation

(2) Dry and wet weather cycles in Kaputiei constitute the greatest source of rainfall variability which ultimately influences the primary forage production for livestock. Hence range development programs must incorporate strategies to deal with drought which seem to recur one out of four years.

(3) Kaputiei range resources were surveyed between 1966 and 1967; group ranch proposals were formulated in 1968, but implementation of these proposals was not undertaken until 1970. According to the weather patterns at Joyce ranch, the development proposals were conceived in the wettest decade since 1920, but unfortunately, the implementation phase coincided with the worst dry spell in Kaputiei since 1914. (Table 5).

MANAGEMENT UNITS

It is important to keep in mind that there were two sets of management oriented definitions of Kaputiei ecosystem units. The first set involved the establishment of the 15 group ranches on the basis of socio-political units which had traditional usage of the land (refer to Chapter 3). The assumption in the definition of these group ranch management units is that each socio-political unit occupied an ecological unit in which the grazing resources were sufficient to sedentarize the participants throughout the year provided appropriate range management practices were applied.

The second definition of management units in Kaputiei were based on ecological characteristics. For example, Kaputiei was divided into four landscape units based on the geologic boundaries. Each landscape unit has similar geologic features. The four landscape units include: Athi-Kapiti, Ulu, Emali and Meruishi (Figure 2). The geologic features under each landscape type have been introduced above. Athi Kapiti landscape occupies intermediate volcanic rocks; Ulu landscape is an old deeply dissected peneplain of basement complex rocks; Emali landscape covers the Basement Hills around Sultan Hamud i.e. Soysambu Hills and also the extensive erosional plains in Mbuko and Mbilin ranches. The Meruishi landscape occupies pleistoceine volcanic system.

The above landscape units, however, did not constitute suitable ecological units for livestock management proposals in 1968. Kaputiei ecosystem was therefore subdivided into smaller ecosystem units called "Ecological land units". These ecological units were delineated for two purposes: (1) to facilitate an evaluation of each ecological land unit in terms of its potential for livestock production; (2) to prescribe management practices for each ecological land unit in order to enhance optimum sustained offtake of surplus livestock (Preinvestment Report 1969). Nine ecological land units were recognized as shown on Fig. 6a and Table 2 .

The ecological land units can be grouped into four major range site types in this study. A range site type consists of land units with similar climate, slopes, soils, vegetation and fauna and which respond similarly to management treatments. The four major range site types in Kaputiei include (1) Athi-Kapiti, (2) Central uplands,

(3) Erosional plains, (4) Recent volcanic range sites. These four range sites account for about 86 percent of Kaputiei rangeland.

The Athi-Kapiti range site coincides with the Athi-Kapiti landscape type. The type includes ecological land units 6, 7, 8 in Athi-Kapiti plains. (Figure 6b, Table 7). The soils were developed from intermediate volcanic and pyroclastic rocks, and they range from moderately well drained to imperfectly drained dark grey to black firm clays, classified as various forms of Vertisols and Planosols. The soils show large cracks during dry seasons. (Figure 7). The Athi-Kapiti range site type is nearly flat, with a relief of < 2 percent. (Touber 1977).

The vegetation type is a grassland. On poorly drained sites, Acacia drepanolobium and Ischaemum afrum are the characteristic species. In most of the areas, Pennisetum mezianum and Themeda triandra form extensive grass cover. Under Ecological Zone III, the Athi-Kapiti range site is characterized by Hyparrhenia sp. and Setaria sp. The riverine vegetation carries Acacia xanthophloea, a tall yellow tree.

The Athi-Kapiti range site type constitutes about 20 percent of the total Kaputiei ecosystem. Embolioi, Olkinos, Empuyankat and parts of Ilmamen and Emarti group ranches are included in this range site type (Table 7).

The Central Uplands range site type covers the Ulu landscape type and the hilly parts of the Emali landscape type. It is characterized by a general relief ranging between 2 - 16 percent,

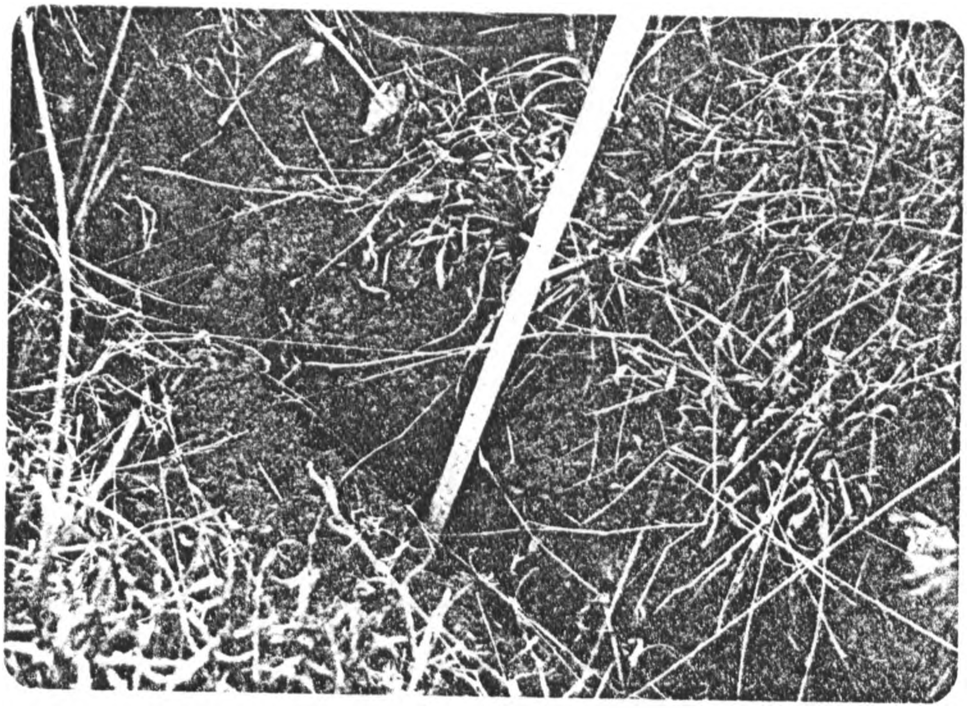


Figure 7 - October 1977 - The black cotton soils characteristic of the Athi Kapiti grasslands, show huge cracks during dry seasons.

Table 7

Grassland Type Acreages for Each of the Sixteen Group Ranches, Kaputiei Section[1]

[2]Grassland Types	1	2	3	4	5	6	7	8	9	
Acres per S.U.	11-30	10-20	8-15	10-50	10-20	10-15	10-15	10-15	8-12	Total
North										
Empuyankat						17350	27340	5810		50500
Embolioi						13460	35710	13030		62200
Central										
Nkama	28650	37010	8370	8670	16000			950	3030	102680
Arroi	7440	26740	3950	3460	1670			5010		48270
Masharu	220	15470	770	350	10610			4840	2470	34730
Erankau	190	27160	420		2780					30550
Imaroro		24280	1110						620	26010
Ilmamen		25810				2280	1850			29940
Emarti		4070				2350	4140	680		11240
South										
Kiboko	930	26680	740	4550	1850			60	1160	35970
Olkarkar	1300	6110	620	13650	7410			930		30020
Poka	4300	4420	1910	4770	4150			9050		28600
Mbilin	430	15000	4810	6970	5430			5430		38070
Mbuko	250	59710	8600	310				120	750	69740
Meruishi	1360	8950	1050	13500	2170			860	3030	30920
[3]Olkajiado	1540	16550				6240	5180	1910		31420
Total	46610	297960	32350	56230	52070	41680	74220	48680	11060	660860

[1]Ranch boundaries may not have been followed. (Source: Pre-Investment Report 1969).

[2]The grassland types are described on page

[3]Olkajiado ranch proposal was not implemented.

Footnotes

*Ranch boundaries may not have been followed

[1]Basement complex hills and pediments (Acacia brevispica).

[2]Red sand plateau (Commiphora Africana-Chloris roxburghiana)

[3]Sandy alvial depressions (Acacia seyal - Sporobolus pellucidus)

[4]Cinder cones and lava flows (Acacia thomsonii-sehima nervosun)

[5]Volcanic loam plateau (Sporobolus fimbriatus-Themeda triandra)

[6]Athi-plain hilltops (Themeda triandra-harpachne schimperii)

[7]Athi-plain plateau (Pennisetum mezianum-Themeda triandra)

[8]Black cotton valleys (Acacia drepanolobium-Ischaemum branchytherum)

[9]Riverine complexes (Acacia tortilis-cynodon dactylon)

with a topography range from 1220 - 1585 m (4000 - 5200 ft.), the exceptions being basement complex hills such as Soysabu.. Ecological land unit 2 in central Kaputiei and within elevation of 1220 meters is discussed together with unit 1, 3 under this category of central upland range type (Fig. 6a, Table 7).

The Central Upland area lying between 8 - 16 percent (Ecological land unit 1) consists of Basement Complex hills. The soils in this area are characterized by pediments, and gullies, they are well drained, red, shallow to deep Regosals. The vegetation type is a complex of woodland and wooded grassland. This grassland type is characterized by Eragrostis superba, Panicum maximum and Heteropogon contortus. Bush enchroachment and steep slopes present forage utilization problems.

The range in central uplands with a slope of 2 - 8 percent consists of undulating upland plateau. The soils are well drained, deep to shallow. These soils are classified as various forms of Ferralsols and Luvisols developed on basement system rocks.

The vegetation type in the central upland plateau range site varies from shrubland to woodland (Fig.6a), dominated by Commiphora schimperi, Acacia mellifera, Acacia brevispica. The grassland type is characterized by Cymbopogon pospochilli and Digitaria macroblephara. The area of each ranch under this central upland range type is shown on Table 7 .

The ecological land units 3, 8 and 9 in central upland range type are as described on Fig. 6 and Table 7 . (Preinvestment Survey Report, 1969).

The Erosional plains lie between 1128 m and 1219 m (3700 - 4000 ft.) above sea-level and geologically lie in Emali landscape type. They are nearly flat with a slope of $\leq$ 2 percent. This range type has been described in ecological unit 2, in the Preinvestment Study Report (1969) but because of elevation differences, precipitation and vegetation characteristics, the erosional plains constitutes a large range site type and peculiar vegetation characteristics deserving a separate category in the present study.

The soils are "well drained, very deep, dark reddish brown to dark brown, friable to firm, sandy clay to clay" classified by Touber (1977) as various forms of Ferralsols and Luvisols. These soils become sealed on the surface after being denuded.

The vegetation type is a bushland characterized by shrubs such as Commiphora africana, Commiphora campestris; and broad leaved weeds such as Astripomea sp. Indigofera spinosa and Disperma sp. The grassland type in this range site is composed of Chloris roxburghiana, Chrysopogon aucheri and Digitaria macroblephara.

The recent volcanic range types cover the Meruishi landscape type. There are two main types described under ecological land units 4 and 5. The range site coinciding with the ecological land unit 4 has a relief of 5 - 16 percent. The soil developed on Pleistocene volcanic rocks. These soils are somewhat excessively drained, shallow, dark, reddish brown, boulderly gravelly, clay loams. Touber (1977) classified the soils in this range type as some form of Cambisols.

The vegetation type is grassland to bushed grassland. Digitaria macroblephara, Chrysopogon aucheri and Aristida sp. are the dominant grasses. This range site is usually unsuitable for grazing and is estimated to have a carrying capacity of 4 - 20 hectares (10 - 50 acres) per stock unit.

Ecological land unit 5 constitutes an upland volcanic plateau range site, with soils developed on olivine basalt rocks. The soils are well drained, very deep, dark red and friable, stony and bouldery clay. The vegetation type is a grassland dominated by *Sporobolus fimbriatus* and *Digitaria macroblephara*.

The proportions of each ranch under each range site type are summarized on Table 7 and Fig. 6a. The Kaputiei ranches can be classified into three main categories: (1) North Kaputiei ranches lying on Athi-Kapiti range site type: The ranches under this category are Embolio; Olkinos, Empuyankat. (2) Central Kaputiei ranches, lying in central upland range sites include: Ilmamen, Emarti, Erankau, Arroi, Nkama and Mashuru. (3) South Kaputiei ranches cover the Erosional Plains and recent volcanic range sites: These ranches include Mbilin, Poka, Mbuko, Kiboko, Meruishi and Olkarkar.

Chapter 5

RANGE CONDITION AND RANGE TREND ANALYSIS IN KAPUTIEI GROUP RANCHES

INTRODUCTION

PERMANENT VEGETATIONAL TRANSECTS IN KAPUTIEI

Introduction

Methods

Range Condition and Trend Analysis

RANGE CONDITION RATING SCHEME

Methods

Plant Successional Patterns

Overview of Range Condition Status in Kaputiei Ranches in 1978

FACTORS INFLUENCING VEGETATIONAL CHANGES IN KAPUTIEI

Seasonal and Climate Patterns

Soil Factor

The Grazing Factors

Chapter 5

RANGE CONDITION AND RANGE TREND ANALYSIS IN KAPUTIEI GROUP RANCHES

INTRODUCTION

Vegetation and soil resources constitute the primary resource base within which the development targets are constrained. Thus, range development planning must include a survey of the current and productive potential of range resources such as vegetation, soils, water, livestock and wildlife.

The concept of carrying capacity in a rangeland ecosystem embodies the condition of range resource base and its potential for improvement on the one hand, and the anticipated management objectives on the other. Carrying capacity has been defined as the maximum stocking rate possible without inducing damage to vegetation or related resources (Glossary RM 1974). This definition emphasizes livestock production as the major management objective. The concept of carrying capacity must also be extended, in practice, to other land use options such as wildlife management and human settlements on the rangelands.

Effective rangeland development maintains or improves the carrying capacity of the rangeland by safeguarding the status of the primary resource base. There are three stragegies within a rangeland development project that deal with this objective. The first employs suitable range management practices i.e. grazing systems, destocking programs, etc., under the prevailing ecological constraints. The second strategy introduces intervention measures to alleviate ecological limitations such as lack of water, diseases, unsuitable vegetation types, etc. The third strategy combines the first and second options to achieve the highest possible carrying capacity of the rangelands without undermining the primary resource base of vegetation and soil conditions. It is important to appreciate that the level of development inputs, and therefore capital expenditure, in rangeland development projects is largely determined by the projected flow of benefits from a sustained productive potential of the rangeland ecosystem, usually expressed in terms of the carrying capacity for the preferred set of range products.

It is, therefore, imperative that one of the performance criteria of Kaputiei group ranch development model should incorporate an analysis of the changes in the biophysical resource base. The assessment of the range condition and range trend in Kaputiei characterizes the current status of primary resources--vegetation and soil, which ultimately determine the changes in the carrying capacity of the rangelands. If the range condition and range trend in Kaputiei ranches have improved after ten years of operation, the Kaputiei development model has succeeded in this aspect and the carrying capacity has improved; but if there are indications of extensive range deterioration in the last ten years, the project has failed in two ways. First, the carrying capacity of the rangeland has declined; and second, future development inputs in this area will be relatively more expensive because of declining range productivity and high costs of range rehabilitation. It is therefore not surprising that prescribed management practices in the Kaputiei development model focus on the need to maintain and improve the range condition and range trend as already discussed in Chapter 3.

The concepts of range condition and range trend are easily misunderstood because of their many shades of meaning among different people; but they are nonetheless useful in describing changes in the rangeland. Range condition has been defined as "the present state of health of the range in relation to what it could be with a given set of environmental and managerial factors." (Heady 1975). The main range condition classes usually recongnized include excellent, good, fair and poor conditions. Once the ideal health of the range is defined in terms of the range-site potential for stated management objectives, this constitutes the excellent range condition class. The other classes are set on the basis of certain criteria which indicate the departure from the excellent condition. To facilitate accurate assessment of range condition classes, the rangeland ecosystem is usually divided into different types of land unit on the basis of vegetation criteria (i.e. physiognomic and floristic characteristics), physiographic and climatic factors. Land units with similar bio-physical environments (vegetation, physiography and climate) are then classified under the same range site type as already discussed in Chapter 3. The important feature of range condition concept in this regard, is that different range sites at their best ecological conditions do not possess the same forage production capacity. For example, a range site in poor condition in ecological zone III, may produce more forage than a range site in excellent condition in ecological zone V. An evaluation of range condition of a range site is related to the potential of the site under excellent condition, or to other similar undisturbed areas.

The interpretation of range condition classes requires explicit management objectives. If the management objective includes, for example, a common use by both livestock and wildlife species, the ideal excellent range condition becomes difficult to define. The habitat requirements of different species occupying the same site may be antagnostic to the optimum range condition of individual species. Excellent range condition for giraffes, gerenuk and impala includes predominantly browse forage from brushlands and woodland vegetation types. However, in these vegetation types, maximum grass forage production constitutes excellent range condition for cattle, zebras and wildebeest. In order to improve the carrying capacity for grass-grazing animals, it may be necessary to selectively control bush and woody species i.e. to increase grass production at the expense of reduced browse production. For multiple use of rangelands therefore, the range condition classes for livestock may not represent the best approach for evaluating changes in the rangelands. Because of the complexity of these changes the present analysis of range condition emphasizes livestock production in the mix of multiple uses.

Another problem in the use of range condition concept lies in the confusion between production oriented and ecologically oriented range condition classification. In rangelands where the final successional stage coincides with the definition of excellent range condition for management objectives, this confusion is minimum. But in areas where the climax state is for example a bushland vegetation type, this does not express the excellent range condition for grazing animals. The current evaluation of range condition status in Kaputiei ranches combines the ecological approach and forage production potential for livestock production.

Range trend is defined as a direction of change in range condition. The application of range trend hinges on the separation of different vegetational changes, some due to uncontrollable factors, and others due to management inputs. If the range trend is downward, repeated measurements over time show increasing disappearance of desirable species and eventual deterioration of soil surface condition. Desirable species are those species which contribute to the management objectives--in this case palatable, perennial grasses for livestock production. By contrast, the range has an upward trend when the desirable plants increase in abundance and health, and the soil surface features improve with repeated measurements over a period of time.

The assessment of range condition and range trend uses relicts of undistributed aress if available. But in areas with extensive range deterioration, the projection of excellent range condition for each range site raises arguments about assumptions made about the processes of vegetational changes in the rangelands.

Vegetational changes are crucial in the analysis of changes in range condition and range trend. It is therefore important to discuss some of these vegetational changes briefly to avoid confusion in the interpretation of vegetation measurements used in this study. There are two sets of vegetational changes in the rangelands: Vegetational changes which are uncontrollable by man; and vegetational changes controllable by man to some extent (Heady 1975). The first set of uncontrollable vegetational changes include climatic drifts, evolutionary changes, seasonal and drought changes. In the first set, the first two types of change take place over many hundreds of years (in a geological time scale) and are therefore unlikely to have any significant effects on the vegetational measurements in this study. The last two changes in the first set are always occurring in the rangelands and, therefore, require some clear understanding of their role in contributing toward changes in range condition. Such range trend measurements are given later in this chapter.

The second set of vegetational changes include plant succession, immigration and introduction of species, and mechanical and chemical vegetational manipulations. The plant successional changes are the most reliable indicators of changes in range condition and range trend resulting from management inputs. Plant succession processes involve a replacement of plant species in a directional change toward an asymptotic steady state or "climax." As conventionally described, toward a steady state; the diversity and structural complexity of species increases; the total biomass production approaches a maximum for the area; and there is a trend toward community stability (i.e. reduction of frequency fluctuation of species and increase in independence from environmental changes). The final successional stage or climax conforms to the general physiognomic type of the area as determined by the edaphic and climatic factors of the local area (Margalef 1968).

The successional changes toward or from the ecological steady state or climax can be harnessed to the advantage of man. If the plant community at climax state does not provide excellent range condition, the knowledge of successional patterns in conjunction with appropriate management techniques may be used to maintain a more productive, but lower successional stage from climax. This successional stage becomes the excellent range condition for particular management objectives.

The utilization of successional changes in the management of grazing lands has a long history in U.S. (Sampson 1919, Clements 1928, Weaver and Clements 1929, Dyksterhuis 1949, Parker 1952, Deming 1954, Humphrey 1965, and Heady 1975). In general, the attempt has been to correlate successional stages to range condition classes. The higher the successional stage towards climax state, the higher the range condition class, and therefore the better the land management practices.

Dyksterhuis' quantitative climax approach in range condition and trend analysis was based on the degree of departure of botanical composition of a range site from its climax potential of species composition (Dyksterhuis 1949). The approach emphasized ecological principles rather than productive capacity of a range site. Higher successional stages are not necessarily the most favorable stages for various grazing animals. Dyksterhuis' categories of range plants as decreasers, increasers and invaders are widely used in the description of range condition and trend.

The need for the assessment of range condition and trend in East Africa was underscored by Heady (1960). He applied the successional concept in his description of East African grasslands. In one detailed study, Heady (1966) proposed the possible retrogressive stages due to grazing in *Themeda triandra* grassland. Other studies that show botanical composition changes emphasized the importance of understanding the successional processes in the management of East African grassland (Langat 1970, Skovlin 1971, Pase *et al.* 1975). The urgency of developing methods to describe and characterize range condition changes in East Africa was stressed by Naveh (1965, 1966) and the work of the East African Rangeland Committee (Pratt, *et al.* 1966).

Two types of vegetational studies were conducted in Kaputiei during the assessment of range condition and trend. The first study was an intensive measurement of permanent vegetation transects which were established before the operation of group ranch organization in Kaputiei in 1968. The second study was an extensive survey of Kaputiei group ranches using a range condition rating scheme described later in this chapter.

PERMANENT VEGETATIONAL TRANSECTS IN KAPUTIEI

Introduction

Permanent vegetational transects are a popular method of evaluating range condition and range trend in the United States. By 1967, more than 16,500 permanent transects had been established in six western regions of U.S. (i.e. Rocky Mountains, Pacific North-west, Pacific South West, Inter Mountain, California and Alaska regions) (Reppert and Francis 1973). Similar types of permanent transect were located in the Kaputiei region in 1967 by Casebeer and Isavuwa to serve as permanent plots for measuring changes in range condition and range trend. These Kaputiei permanent transects, like those in the western regions of the U.S.A. were established and monitored using Parker's 3-step method (1951).

In step one, clusters of transects, usually consisting of three or more, are permanently located in selected sites. Sites selected should be grazed and respond to management treatment; and be suitably located away from water sources, roads or areas where livestock would normally congregate.

In the second step, vegetation and soil data are collected and summarized in the field, and the current range condition and range trend are evaluated. In the final step, pictorial records of vegetation and soil condition are taken. Trend is then determined by a comparison of records obtained periodically within an interval of about five years. A trend is considered significant only if repeat measurements show changes greater than one-fourth of the original measurements.

The most important measurements in the permenent transect are the frequency of occurrence of individual species, basal cover, and forage production. The frequency of a species is defined as the chance of finding a plant species within a sampling unit in any single trial (Greig-Smith 1964). This frequency is usually expressed as a ratio between the number of trials in which a species occurs and the total of trials. The frequency of a species in this study refers only to the presence of a species in a sampling unit and not to the number of individual plants of this species.

The change of frequency of a species has important biological and management implications and is easy to measure. A change of frequency of a species from the original level of distribution in the vegetation community indicates that live plants of this species have increased or decreased over time.

The basal cover refers to the percentage of ground covered by stems of perennial grasses. Shrub cover or forb cover refers to the vertical projection of crown or foliage on the ground. Forage production is the weight of forage that is produced within a certain period on a unit area. Forage measurements in this study are restricted to grazeable grass biomass.

Methods

The original data files containing site descriptions and 1967/69 vegetational measurements of the permanent transects were found at the Kiboko Range Research Station. Luke Isavuwa, who participated in the initial establishing and monitoring the vegetation transects, assisted in the relocation of these transects early in 1977. Most of the original transect markers such as piles of stones, trees, distant hills etc. still existed after ten years (Figure 8). In all, 24 of the original 29 transects were studied during 1977/78 (Table 8, Figure 6a).

November 1969

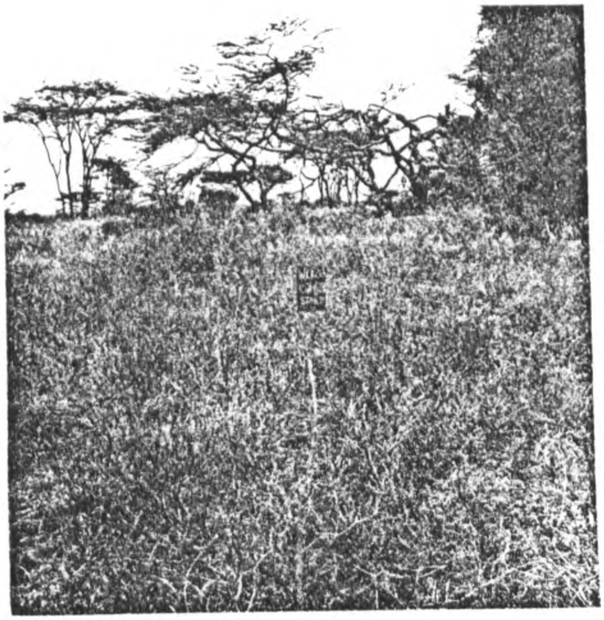
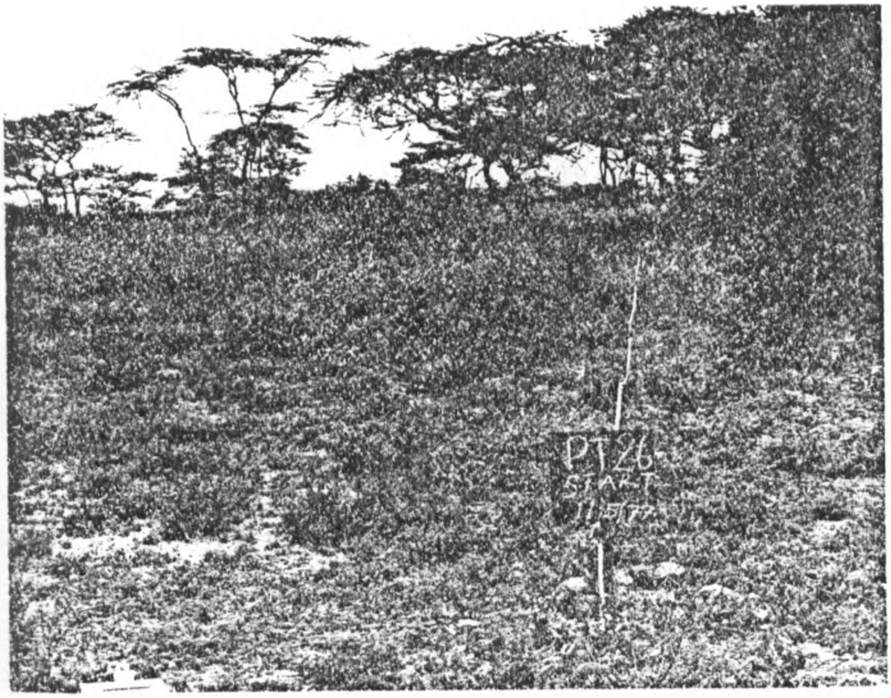


Figure 8 - Transect 26: Relocation of permanent transects was made possible by transect markers such as trees and heaps of stones at the starting point. The bearing was determined with a compass before laying down the transect line with a tape measure.



May
1977

Table 8

Important Site Features of the Kaputiei Permanent Transects

Geographical Regions	Transect Number	Elevation in Feet	Soils	Micro-Relief	Ecological Zone	Vegetation Type	Utilization
North Kaputiei							
	5		Black	Slightly undulating	IV	Grassland	Moderate
	6	5000 to 6000	Black	Flat depression	IV	Grassland	Slight
	7		Black	Flat	IV	Grassland	Slight
	8		Black	Flat well drained	IV	Grassland	Slight
	9		Black	Flat depression	IV	Grassland	Slight
	17		Red	Slightly undulating	IV	Bush Grassland	Heavy
	21		Grey	Flat	IV	Grassland	Heavy
	22		Grey	Flat	IV	Grassland	Heavy
Central Kaputiei							
	16		Volcanic	Undulating	V	Grassland	Heavy
	23		Red	Slightly undulating	IV	Bush Grassland	Heavy
	24	4000 to 5000	Red	Slightly undulating	IV	Bush Grassland	Heavy
	25		Grey	Undulating	IV	Bush Grassland	Moderate
	26		Grey/Red	Flat	IV	Bush Grassland	Heavy
	27		Red	Rolling undulating	IV	Bush Grassland	Heavy
	28		Grey	Flat	IV	Bush Grassland	Heavy
	29		Red	Rolling undulating	IV	Bush Grassland	Heavy
South Kaputiei							
	1		Red	Flat	V	Bushland	Heavy
	2		Red	Flat	V	Grassland	Heavy
	3	3700 to 4000	Red	Flat	V	Bush Grassland	Heavy
	4		Black	Depression	IV	Grassland	None
	12		Red	Flat	V	Bush Grassland	Heavy
	13		Volcanic	Flat	IV	Grassland	Moderate
	14		Red	Flat	V	Bush Grassland	Heavy
	15		Volcanic	Undulating flat	V	Bush Grassland	Heavy

The Kiserian transects 10 and 11, and Mbirikani transects 18, 19, and 20 were rediscovered but not measured in 1977 because of shortage of time and their location outside the group ranches.

From the starting point of each transect, the compass bearing of the transect was taken. Using a 0.089 square meter (0.96 ft.^{2}) circular frame, one hundred plots, at approximately 0.92 meter intervals (3-yard intervals) were laid along each 308 meter (1,000 feet) transect line (Figure 9). Measured vegetational parameters included species frequency, basal grass cover, shrub cover, and forage production. Species frequency was measured in all plots. The basal cover and forage production estimates were taken at every fifth plot. The intercepted bush species were categorized into height classes. Forage production was estimated by the double sampling method in which some plots were clipped, the herbage separated by species and weighted, while in other plots, only ocular estimates of production by species were made. Photographs were taken at the start and end of each transect. Sampling periods during 1967/69 and 1977/78 were at similar dates and coincided either with wet seasons in May or dry seasons in September to October. The methods for vegetation measurements used in the permanent transects in 1967/69 were repeated as closely as possible during 1977/78.

Range Condition and Range Trend Analysis

Range plants are classified into two use categories: desirable and undesirable. Desirable plants include both decreasers and increasers as defined by Dyskerhuis (1949). Decreasers are the species

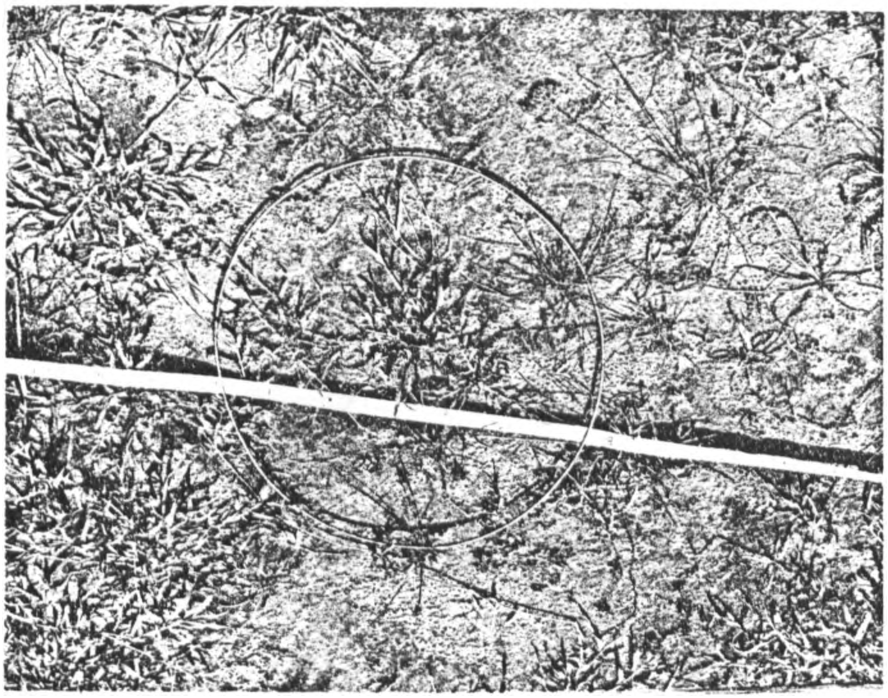


Figure 9 - A circular plot 0.96 ft^2 ($0.089m^2$) was laid at 3 meter intervals along transect line. The presence of species was recorded in every one of the 100 plots for each 30 meters transect line. Basal cover was estimated as the proportion of the plot (in percentage) covered by the stems of perennial grasses.

in the range pastures which are the first ones to disappear with overuse. Examples of the palatable, perennial grass decreaser species are Themeda triandra and Chrysopogon aucheri. Increasers are those species which tend to increase with moderate grazing, at least for a short period before decreasing under continued overuse. Examples in this category include Digitaria macroblephara, Cynodon dactylon and Chloris roxburghiana. The desirable plants are the key species whose frequency of occurrence serves as an indicator of changes in range condition and range trend resulting from management inputs.

The undesirable species are defined as those plants which do not contribute toward the management objectives vis-a-viz excellent range condition for livestock production. They are characterized by either ephemeral life cycle or unpalatable qualities for livestock. In this category are all ephemeral grasses such as Eragrostis spp. Sporobolus spp. and Aristida spp.; and also perennial unpalatable grasses such as Pennisetum mezianum and P. stramineum. The physiognomic dominance of forbs such as Ipomoea spathula, Astripomea spp., and shrub species such as Acacia mellifera and A. brevispica, which indicate serious site disturbance and in most cases, a reduction of grass forage production. Appendix 1 lists the common grasses in Kaputiei with their rating of desirable and undesirable.

The analysis and determination of range condition and range trend from Kaputiei permanent transect data depend on two factors. First, vegetation changes must be interpretated in light of the original pre-development range condition of the different range site types. In this regard the premanent vegetation transects describe changes in four range sites: Athi-Kapiti, Central uplands, South Kaputiei Erosional plains and South Kaputiei Volcanic range sites.

The second factor is the relatively weighting of the measured or estimated vegetation parameters upon which the determination of range conditions and trends are based. These parameters include the frequency of species, basal cover estimate, forage production estimates and finally, the photographic records. The changes in frequency of species is the strongest and most objective evidence of changes in range condition and range trends. Basal cover changes usually collaborate the changes in frequency measurements, but these measurements are subjective and less accurate. Forage production estimates in permanent transects suffer from two major problems. First, this parameter is very sensitive to seasonal and annual fluctuations of rainfall; and second, these estimates were done on open grazing areas and therefore they are subject to indeterminate grazing intensities. The forage production estimates are therefore the weakest evidence of range condition and trend changes from Kaputiei transect data.

The photographic evidence of changes in range condition and trend is determined by the visual comparison of the photographic records at different dates. For example, Figure 10 shows the appalling downward trend of range condition between 1969 and 1977 in transect 1 located in South Kaputiei Erosional plains. The photographic evidence of changes in range condition and trend is very accurate and easy to

1967

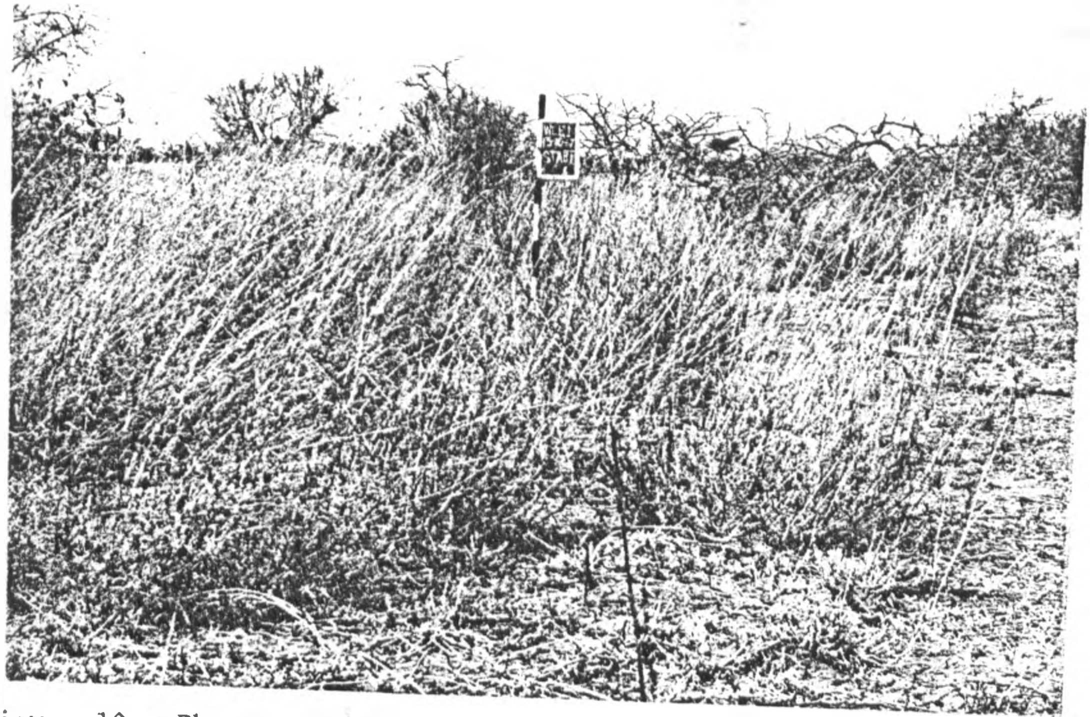


Figure 10 - Photographic evidence of range condition and trend changes between 1967 and 1977 in Kaputiei Permanent Vegetation Transect 1.

1977

show with drastic vegetation changes like in Figure 10. The stastical evidence (frequency, basal cover and forage production measurements) and photographic records must be used together to document vegetation changes between 1967 and 1977, the period in which the Kaputiei group ranch model was implemented and operated. Appendix 1, , Table 9 and 10 summarize the changes in range condition and trend in Kaputiei grasslands.

Changes in Athi-Kapiti grasslands are shown by transects 5, 6, 7, 8, 9, 17, and 22 (Tables 9, 10, Fig. 6a).) In Athi-Kapiti grasslands the frequency of desirable grasses in permanent transect decreased moderately from 1381 in 1969 to 1052 in 1977, a decrease of 24 percent. The frequency of one major undesirable perennial grass, Pennisetum mezianum increased slightly from 286 in 1969 to 311 in 1977, an increase of only 9 percent.

By combining evidences from statistical measurements and photographic records (Table 9 , 10), it can safely be concluded that the range condition and range trend in Athi-Kapiti range grasslands has not changed significantly between 1969 and 1977.

The central upland range site is mainly in ecological zone IV, like the large section of the Athi-Kapiti area. However, the soil and vegetation types in this central Kaputiei area are different, as discussed in Chapter 4. Transect 23, 24, 25, 26, 27, 28 and 29 are located in central uplands (Figure 6a). The total frequency of desirable plants decreased from 1068 in 1969 to 515 in 1977, thus representing a downward trend of 52 percent. The basal cover also

Table 9

Statistical and Photographic Evidence of Changes in Range Condition and Trend in Kaputiei Permanent Vegetation Transects

Permanent Transects	Eco-Zone	Frequency of Species: Desirable 1969 (May)	Desirable 1977 (May)	Undesirable 1969 (May)	Undesirable 1977 (May)	Basal Cover[1] Percentages 1967	1969	1977	Forage Production, KG/HECT Dry Weight 1967	May 1969	Dry 1969	1977	1978	Photographic Records[2] Range Condition Classes 1967	1968	1969	1977
Athi-Kapiti																	
5	IV	205	117	158	298	M 22.5	M 19.3	M 21.0	A 263	Jn 880	D 975	D 2360				Good	Good
6	IV	156	147	44	120	A 46.5	M 5.8	M 16.3	A 1391	Jn 583	D 366						
7	IV	238	243	28	213	A 67.0	M 8.5	M 25.5	A 1838	Jn 803	D 566	Oct 2600	M 4020			Good	Good
8	IV	173	131	88	261	A 56.3	M 24.3	M 32.5	A 1527	Jn1129	D 490	M 2200	M 1380		Gd/Exc[2]	[2]Exc	Exc
9	IV	158	109	36	116	A 57.5	M 15.5	M 19.0	A 1488	Jn 803	D 446	Oct 1360				Exc	Exc
17	V	209	100	73	242	N 57.3	M 16.3	M 27.3	N 581	M 871	D 452	Oct 720		Fr/Gd		Good	Fair
21	V	112	86	158	260	N 59.0	M 15.5	M 10.8	N 581	M 317	D 211		Jn 840	Fair		Fair	Fair
22	V	130	119	126	209	N 64.3	M 13.8	M 16.0	N 494	M 338	D 737	Oct 440			Good		Fair
Total		1381	1052	711	1719		14.9±5.8	21.1±7.0									
Central Uplands																	
23	IV	115	63	92	125	N 59.0	M 12.3	M 29.5	N 726	M 580	N 45				Good	Fair	Good
24	IV	111	25	141	157	N 52.0	M 9.0	M 7.3	N 468	M 209	N 159				Good	Gd/Fr	Fair
25	IV	152	39	111	202	M 55.5	M 15.2	M 26.5	N 481	M 829	N 195	M 500		Good		Good	Fair
26	IV	148	46	113	153	M 55.5	M 16.8	M 6.0	N 481	M 799	N 101			Fair	Fair	Fair	Fair
27	IV	187	108	34	97	M 46.3	M 10.8	M 5.5	N 578	M 460	D 278	Oct 440		Good	Good	Good	Fair
28	IV	172	143	90	155	M 48.8	M 9.3	M 6.5	N 384	M 299	D 329				Good	Good	Fair
29	IV	183	91	113	196	M 45.8	M 9.3	M 2.5	N 435	M 345	D 326	Oct 304			Good	Good	Fair
Total		542	342	694	1085	51.8±5.1	11.8±3.1	12.0±11.1									
South Kaputiei Erosional Plains																	
1	V	149	22	55	92	M 17.0	M 17.3	M 1.8	M 1104	M 1083	N 255			Good	Good	Gd/Fr	V/Poor
2	V	151	32	29	129	M 20.3	M 28.8	M 4.3	Jn1206	M 1440	N 815			Exc	Exc	Exc	Poor
3	V	110	46	82	77	M 17.0	M 10.5	M 1.5	Jn 458	M 567	N 473				Fr/Gd	Good	Poor
12	V	166	91	13	9	S 52.0	M 18.8	M 4.0	S 2026	M 1350	N 686	D 360	Jn 450	Gd/Exc	Good	Gd/Exc	V/Poor
14	V	150	4	83	86	S 31.8	M 14.0	M 0.5	S 1224	M 4385	N 115	M 0		Fr/Pr	Good	Fair	V/Poor
15	V	73	1	156	57	S 24.8	N 7.0	M 1.0	S 302	965	N 41	M 0		Fr/Pr	Fr/Pr	Fair	V/Poor
Total		799	196	418	450		16.1±7.6	2.2±1.6		± 470							
Volcanic Lava Flows																	
13	IV	188	115	33	68	M 52.0	M 15.5	M 12.0	M 844	M 803	N 446			Good	Good	Good	Fair
16	V	166	51	89	163	? 42.8	N 6.0	M 5.8	M 486		N 921			Fr/Gd	Good	Fair	Fair
Bottomland																	
4	IV	111	153	68	76	M 22.5	M 11.5	M 22.8	Jn 623	M 1273	N 311			Exc	Exc	Good	Exc/Gd
Kaputiei Average		155	87	84	148	51.5	13.8	12.2									
	$\bar{X}$	8	12	9	15												

[1]Symbols: M=May, Jn=June, A=August, S=September, Oct=October, N=November D=December

[2]Gd-Good, Exc-Excellent, Fr-Fair

Table 12

A Summary of Range Trends of Kaputiei Permanent Transects from 1967 to 1977

Transect Location	Eco Zone	Frequency 1969-1977		Basal Cover		Forage Production		Pictorial Evidence	
		Desir.	Undes.	967-1969	1969-1977	1967-1969	1969-1977	1967-1977	1969-1977
Athi-Kaputiei Site									
5	IV	-	+	0	0	+	+	0	0
6	IV	0	+	-	+	-			
7	IV	0	+	-	+	-	+	0	0
8	IV	0	+	-	+	0	0	0	0
9	IV	-	+	-	0	-	0	0	0
17	V	-	+	-	+	0	0	0	-
21	V/IV	-	+	-	-	0	0	0	I
22	V/IV	0	+	-	0	0	0		I
Average		0/-	+	-	0/+	0	0	0	0
Central Upland Range Site									
23	IV	-	+	-	+	-		0	0/1
24	IV	-	0	-	0	-		0	-
25	IV	-	+	-	+	-	0	0	1/0
26	IV	-	+	-	-	-		0	-/0
27	IV/V	-	+	-	-	0	0	0	-
28	IV/V	0	+	-	-	0		0	0
29	IV/V	-	+	-	-	0	0	0	-
Average		-	+	-	-	0/-	0	0	-/0
Erosional Plains South Kaputiei									
1	V	-	+	0		0		0	-
2	V	-	+	0	-	0		0	-
3	V	-	0	-	+	0		0	-
12	V	-	0	-	-	-		0	-
14	V	-	0	-	-	-		0	-
15	V	-	-	-	-	-		0	-
Average		-	0	-	-	0/-		0	-
Volcanic Range Sites									
13	IV	-	+	-	0	0		0	-
16	V/IV	-	+	-	0			0	-
Average		-	+	-	0			0	-
Bottomland									
4	IV	+	0	-	+	+	0	0	0

decreased during the same period. Evidence of range condition changes from forage production is rather sketchy. Photographic records show a moderate downward trend from good range condition in 1969 to fair range condition in 1977.

The following conclusions can be drawn from Table 10 regarding the changes in range condition and trend in central uplands. (1) Downward range trend is stronger on transects located on red soils or basement complex soils (TR 24, 27 and 29) than on transitional soils between red and black soils (TR 23, 25, 26 and 28). (2) Range trend assumed a downward trend between 1969 and 1977. (3) The range condition of central Kaputiei grassland is currently in fair condition.

Changes in range condition and trend in south Kaputiei grasslands are shown by Transects 1, 2, 3, 12, 14 and 15 on erosional plains range site and transects 13 and 16 on recent volcanic soil sites (Figure 6 and Tables 9 & 10). The frequency measurements on transects located on erosional plains show a marked downward range trend. The desirable grasses decreased by 75 percent between 1969 and 1977. The basal cover also decreased from 16.1 percent in 1969 to 4.7 percent in 1977. Pictorial evidence (Figures 10 and 11) show, that a dramatic decline in range productivity between 1969 and 1977. Of all the Kaputiei grassland types, the range condition and trend changes in erosional plains are most drastic.

The statistical and pictoral evidence of changes on volcanic range sites (TR 13 and 16) show a downward range trend which is not as marked as the one observed on erosional plains.

September 1967

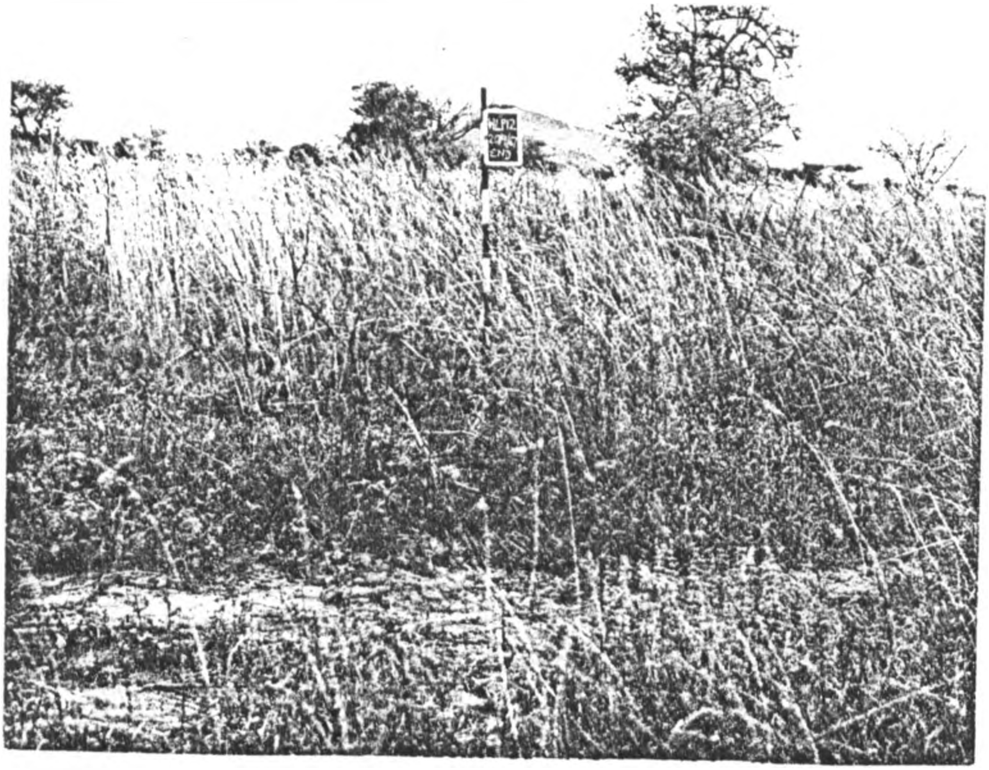
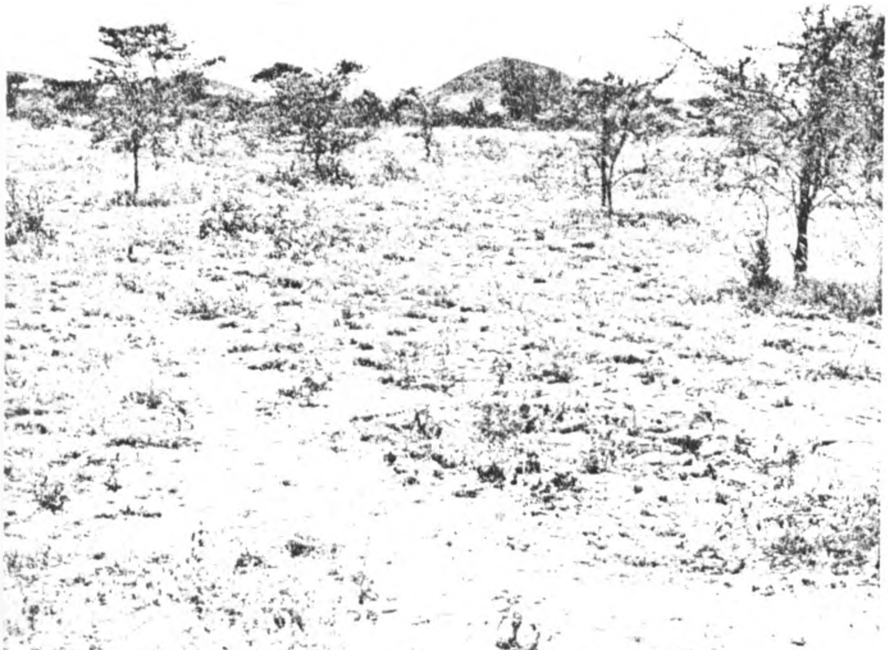


Figure 11 - Range condition and range trend changes in South Kaputiei Permanent Vegetation TR 12 in Kiboko group ranch. The range changed from good to poor condition between 1967 and 1977.



May 1977

According to the data analysis the 24 permanent vegetation transects in Kaputiei, Athi-Kapiti grasslands sustained the least damage during the implementation and operation of Kaputiei group ranch development model (1968-1977). South Kaputiei grasslands on red soils (erosional plains) sustained the most severe damages in range productivity between 1969 and 1977.

RANGE CONDITION RATING SCHEME

The original 24 permanent transects in Kaputiei were not sufficient to describe the current status and trend of most of Kaputiei rangelands for two reasons: First, these transects represent an intensive study of vegetation changes on a small scale and therefore the results may not be extrapolated to other areas of Kaputiei. Second, some of the locations of the original transects were sited in areas which were susceptible to unusual over-use by livestock such as near water (TR 14) and settlement area (TR 15). Reconnaissance methods were therefore employed to complement the permanent vegetation transects. A range condition rating scheme was designed. It employed transects located in relict sites and estimates of primary forage production from exclosure and calf paddocks as well as studies of broad areas. In general these methods suffer from subjective judgments, but they also enable coverage of large areas. The Kaputiei region, for example, ccvers 273,000 hectares, hence the need for broad coverage as well as detailed transect data.

The range condition rating scheme involved separate scoring scales of three important parameters of a range site: (1) the status of desirable plants, (2) the status of undesirable plants, and (3) soil condition. (Table 11).

The desirable plants were scored from 0 to 5, corresponding to lowest and highest level of potential abundance in each site. The desirable plants received the highest rating scale in order to give the grazeable resources more weight in the overall range condition score compared to either undesirable grasses, or soil condition scoring. A desirable plant had any two of the following characteristics: perennial life cycle; high palatability for livestock, particularly cattle; and high successional status in that site. Most desirable plants were grass species.

The undesirable plants were scored on a scale of 3 to 0 from highest to lowest. The absence of undesirable plants carried a higher positive score that would favor the overall condition status of the site. An undesirable plant showed the following characteristics: (1) ephemeral life cycle, (2) perennal but unpalatable qualities for livestock grazing, (3) low successional stage in the site. The ephemeral quality of a species indicates unstable supply of forage from wet to dry season. The successional status of a species is indicated by its level of abundance in relation to expected abundance in the range site. For example, Pennisetum mezianum is generally a common perennial and unpalatable species on black soils. Its presence as pure stands on black soils indicate heavy selective grazing, which has favored higher than expected composition status of this species. Hence it is assigned a low score, when it is abundant on black soils.

Table 11

Description of Score Assignments in Kaputiei Range Condition Rating Scheme

Scale	Desirable Plants	Undesirable Plants	Soil Surface Conditions
Maximum Score	5	3	3
0	Rare or absent through site degradation	Dominant, forms pure stands	Severe sheet and gulley erosion no protective soil cover, slope >8 percent
1	Rare	Very common	Active surface erosion, little soil cover slope 3-8 percent
2	Uncommon but noticeable	Common but not dominant	Slight surface erosion, poor soil cover slope <2 percent
3	Common and widely scattered	Absent or present in normal proportions	No erosion, good soil cover
4	Very common		
5	Potential grass composition attained with proper grazing management		

The soil condition score scale ranged from 0 to 3 depending on the degree of soil surface degradation. The lowest score was assigned to denuded soil surface with little or no vegetation cover; the highest score represented good soil cover and little or no soil surface disturbance. This range condition class for each sampling point was then the basis of total independent scores of desirable and undesirable plants, and the soil surface condition. The discription of the range condition classes are shown on Table 12.

The range condition rating was done along prescribed routes which covered different range sites. (Figure 6a). At the end of every kilometer along the routes, independent scoring of desirable and undesirable plants, soil condition, and ocular estimates of cover were made (Appendix 2).

A more intensive sampling approach consisted of locating transects in selected areas usually with the highest proportion of pristine grass composition, for example, areas inaccessible for grazing due to lack of water, predation damages, or tse tse fly infestations. The calf paddocks also represented relict grass cover in heavy overgrazed sites. These new transects along the routes followed are shown on Figure 6b.

Table 12

Range Condition Class Assignment and Description

Aggregate Score From Table	Range Condition Class	Class Description
0-1	Very Poor	Desirable grasses are absent, undesirable plants are dominant, soil surface shows serious surface disturbance through erosion
2-4	Poor	Desirable plants rare to uncommon, undesirable plants are dominant, soil condition shows active sheet erosion.
5-7	Fair	Desirable plants are common, undesirable plants are common, soil surface with good cover except in isolated patches
8-11	Good	Desirable plants very common, undesirable plants if present at normal expected level, soil surface intact with good cover

Botanical composition, basal cover, and production estimates were measured in $1/4^2$ plots in the new transects. The intensity of sampling depended on the uniformity of the vegetation. In an experiment conducted in different sites to determine the most efficient sampling unit for grass composition study in poor, fair, and good range condition classes, the one-quarter meter square frame was the most efficient and convenient sampling unit. Others tested were frames of 0.089 m^2 (0.96 ft.^{2}), 1/2 m^2 rectangular, and 1 m^2 in size. In poor sites the largest frame was the best sampling unit. A sample size of 15 plots with 1/4 m^2 frame was in most cases characterized by the botanical composition of the grass cover. In fairly uniform and undisturbed relict sites, fewer than 15 plots were adequate in characterizing the grass composition. The new transects averaged 300 m (1000 ft.) in length. In addition to forage production estimates in ungrazed areas, five exclosures were built in April 1977. Three of these exclosures were located on black cotton soils in Athi-Kapiti grassland, two of which were at Isinya Massion Station near an old permanent exclosure; and the third exclosure in Agricultural Development Corporation Commercial ranch near Konza. The Isinya exclosures are in ecological zone IV, while the Konza exclosure is in ecological zone V.

The fourth exclosure was sited in Imamen group ranch at Silangini area near the location of the ranch borehole. This exclosure represents the central upland vegetation types.

The fifth exclosure was located in Mbuko group ranch near Sara about 3-4 kilometers towards Kibini bearing from the Range Management Office. This exclosure was chosen to represent the Erosional Plains range site which characterizes Mbuko group ranch. The locations of the five exclosures are shown on Figure 6b.

Plant Successional Patterns

The potential grass cover in the Athi-Kapiti plains consists of a tall grassland dominated by Themeda triandra and Pennisetum mezianum. The tall grass species characterize a fairly stable grass cover which undergoes seasonal and yearly changes without change of the physiognomic characteristic. (Figure 12). Potential forage production in this grassland type is represented by forage measurements at Isinya and Konza exclosure (Table 13).

The retrogressive change from this tall grass cover proceeds through two distinct stages. In the first stage, the tall grassland becomes a short-grassland dominated by Digitaria macroblephara and Cynodon dactylon. These are stoloiferuos perennial and palatable grasses which increase under heavy utilization. They are also grasses resistant to heavy utilization, and therefore they tend to characterize the Athi-Kapiti rangeland under heavy utilization without giving way substantially to the second stage of retrogression. Embolioi, Empuyankat, parts of Emarti and Ilmamen are under this stage of retrogression (Figure 13). The forage production potential is not seriously affected because the short-grassland type provides high quality forage for livestock. In poorly drained or low lying areas,

Figure 12 - March 1978 - The potential grass cover on Athi-Kapiti plains - Olkinos group ranches: Themeda triandra-Pennisetum mezianum grassland type.

Figure 13 - July 1968 - Athi Kapiti grassland in fair range condition (Empuyankat group ranch). Bare spots and broad leaved weeds such as *ipomea* sp. in the foreground indicate the first retrogressive stage of this grassland.

Table 13

Grass Forage Production Measurement in Kaputiei
Kg/hectare, Dry Weight ($\bar{X} \pm$ SD)

	Exclosure		Undistributed Open Sites
	Inside	Outside	
Thi-Kapiti			
Black cotton soils Isinya Exclosure poorly drained	1530 ± 420	2160 ± 380	
Isinya Exclosure well drained	1230 ± 740	1490 ± 840	
Konza ADC Ranch.	1023 ± 870	1340 ± 1230	
Central Uplands Red Soils Aug. 1977			
Ilmamen	930 ± 329	300	
Arroi Bottomland			1620 (1978)
Ilmamen, calf paddock			1220 kg/hec
Erosional Plains Red soils Aug. 1977			
Woodland Exclosure Isara	385	147	
Kiboko Research Station - Block A Premanent Exclosure June 1977	1190 ± 950	170 ± 60	
Mbuko X_3, Mar '78			1840 ± 1040
Mbilin X_7, Mar '78			1720 ± 970
Recent Volcanic Range Sites			
Kiboko X_3 Feb. '78			1640 ± 480
Olkarkar X_2 Feb. '78			2480 ± 800
Olkarkar X_1 Feb. '78			2600 ± 800

[1] $\bar{X} \pm$ SD: refers to the mean and standard deviation. These new Transects do not correspond with the onese in Figure 6b.

the first stage is characterized by pure stands of unpalatable tall species such as Pennisetum mezianum and P. stramineum.

The second stage of retrogression from the potential tall grassland type is represented by ephemeral grasses and forbs. The characteristic ephemeral grasses include Microchloa kunthii, Aristida spp., Eragrostis spp. Indigofera spp., Commelina spp., Heliotropium spp. and sedges are the common forbs in this stage. Bare ground areas in Athi-Kapiti are limited to small patches around termite activity areas.

The central upland grasslands are more heterogeneous than the Athi-Kapiti or southern grasslands. The potential grass cover varies from site to site and includes a wide spectrum of tall perennial grasses such as Panicum maximum, Eragrostis superba, Eragrostis heterora Eragrostis caepitosa, Heteropogon controtus, Enteropogon macrostachyus, Chloris roxburghiana, Chrysopogon aucheri, Sporobolus fimbriatus, Cenchrus ciliaris, Pennisetum mezianum, Pennisetum stramineum.

Panicum maximum, Eragrostic heterora, Eragrostis superba, Heteropogon contortus, and Enteropogon macrostachyus favor rocky and heavily wooded areas, while Chrysopogon aucheri, Chloris roxburghiana, Sporobolus fimbriatus, and Cenchrus ciliaris prefer the red soils and open sites.

Transects X_1, X_2, and X_3 represent typical range site types in the central woodlands (Table 14). The potential forage production in the central uplands potential grass cover was estimated in ungrazed areas (Table 13). In a calf paddock located in Ilmamen group ranch,

Table 14

Potential Grass Composition in Central Woodlands of Kaputiei

Potential Grasses	Transect X_1 (Nkama) Red Soil	Transect X_2 (Arroi) Red Soil	Transect X_3 (Mashuru) Grey Soil
Chloris roxburghiana	35	-	-
Chrysopogon aucheri	-	60	2
Cymbopogon pospochilli	55	-	20
Cynodon dactylon	-	-	26
Dicanthium insculpta	-	-	26
Digitaria macroblephara	50	87	26
Eustachyus paspaloides	25	27	10
Panicum maximum	45	-	-
Pennisetum mezianum	-	13	32
Eragrostis superba	80	-	-
Eragrostis heteromera	30	-	-
Themeda triandra	10	40	30
Basal Cover	46.1 ± 19.0	25.4 ± 15.6	26.5 ± 11.6

near the exclosure, the forage production averaged 1220 kg per hectare in June 1978. This paddock is typical of red soil areas. In Arroi bottomland with heavy black soil, the forage production was measured at 1620 kg per hectare in March 1978. This shows that the forage production measurements of 930 kg per hectare inside the Ilmamen exclosure does not represent the potential production level. The exclosure was located in a disturbed site.

The indicator species of the first retrogressive stage from the potential grass cover include Cynodon dactylon, Digitaria macroblephara, in more open areas, and Cymbopogon pospochilli in the woodland and bush areas; and Pennisetum mezianum in the bottomlands. High densities of bush species such as Acacia mellifera, A. brevispica indicate distrubed areas.

The second stage characteristic of the vegetational changes in the central uplands include broad leaved weeds such as Ipomoea spathula Sida ovata, Indigofera spp., Tribulus terrestris, Solanum spp., and ephemeral grasses such as Eragrostis cilianensis and E. aethiopica.

Southern grasslands include the grassland on the basement complex soils on the erosional plains and volcanic soil grasslands.

The potential grass cover on the basement complex soils consists of the following perennial bunch grasses; Chrysopogon aucheri, Chloris roxburghiana, and Pennisetum massaicum. The relict of this grassland is rare to find due to extensive vegetational changes in this grassland.

The calf grazing area in Nkama depicts the physiognomic characteristics of this grassland (Figure 14).

The first of intermediate retrogressive stages in this grassland is characterized by the dominance of Digitaria macroblephara, Aristida adoensis and other ephemeral grasses (Table 15).

In the second stage of retrogression, the grassland changes into pure stands of weeds, particularly dominated by forbs like Astripomea spp., Zyllea spp., Tribulus terrestris and Ocimum spp., and Ipomoea spathulata.

The grasslands on recent volcanic soils are characterized by Chrysopogon aucheri, Aristida keniensis on the steep volcanic hills, and Sporobolus fimbriatus and Chloris roxburghiana on the volcanic plateau. The volcanic hills, usually found in excellent condition during the 1977 survey, are dominated by Chrysopogon aucheri and Aristida keniensis. A paced transect from the base to the top of a volcanic hill in Mbilin showed frequencies of 87, 60 and 33 percent for Chrysopogon aucheri, Aristida keniensis and Heteropogon contortus, respectively. Enneapogon, Eragrostis heterora, and Cenchrus ciliaris were also fairly common on the volcanic hills. The potential grass cover on these hills has not changed because the grazing animals neglect steep slopes for grazing. However, at the base of volcanic hills we

Figure 14 - May 1978 - Relict site in calf grazing area in Nkama group ranch near Kibini. The tall foxtail perennial grass is chloris roxburghiana an indicator of good range condition in South Kaputiei grasslands on red soils (erosional plain range site).

Table 15

Retrogression Stages on Red Soils as Indicated by Species Frequencies in Percentages

	TR. 1		TR. 14	
	1969 (May)	1977 (May)	1969 (May)	1977 (May)
Climax or Stable Stage				
Chloris roxburghiana	18	6	32	1
Chrysopogon aucheri	8	2	26	0
Pennisetum mezianum	5	2		
Pennisetum massaicum	22	4		
Themedatr andra	4	0	6	0
Intermediate Stage				
Digitaria macroblephera	95	10	55	0
Aristida adoensis	35	0	29	0
Microchloa abyssinica	16	1	20	0
Eragrastis tenuifolia	3	13	0	0
E. althiopida	0	13	0	12
Eragrostis cilianesis	0	31	0	24
Sporobolus pellicides	0	24	0	5
Chloris virgata	0	0	0	12
Weed Stage				
Tribulus terrestris		29		
Ipomea spathula		42		
Astripomea				
Zyllea		13		
Ocimum				

find pure stands of Pennisetum mezianum, and farther down, into the black soils of volcanic origin, only broad leaved forbs dominate (Figure 15). These forbs include Abutilon spp., Melhania spp., Hibiscus spp., Commelina spp., Aspilia spp., and Leonotis spp.

On the weathered red volcanic plateau soils in Mashuru, Poka and parts of Mbilin, Olkarkar and Kiboko, the potential grass cover consists of tall-tufted species such as Sporobolus fimbriatus and Pennisetum mezianum as dominants, and also Chrysopogon aucheri and Chloris roxburghiana (Figure 16).

The southern Kaputiei production levels from ungrazed sites show comparable standing biomass with north and central Kaputiei (Table 13). While the north and central Kaputiei forage may contain as much as 1/3 of unpalatable species, the standing biomass in the south contains proprotionately fewer undesirable species. Where the higher level of production is maintained in the south, the pastures are more palatable and this compensates to some extent for the low rainfall in this ecological zone V.

The intermediate or first stage retrogression is sometimes represented by pure stands of Pennisetum mezianum particularly around human settlements. Digitaria macroblephara is probably the best indicator of the intermediate stage. Cynodon plectostachyus is an increaser in the intermediate stage.

The weed stage consists of ephemeral grasses and forbs. These include Aristida spp., Chloris virgata, Sporobolus spp., Microchloa kuthnii, Eragrostis spp., Tragus spp., for grasses; and Zyllea

March
1978

Figure 16 - Potential grass cover on recent volcanic range site in South Kaputiei grasslands. The hills in the background are volcanic. The grassland type on this loam soil is dominated by sporobolus fimbriatus.

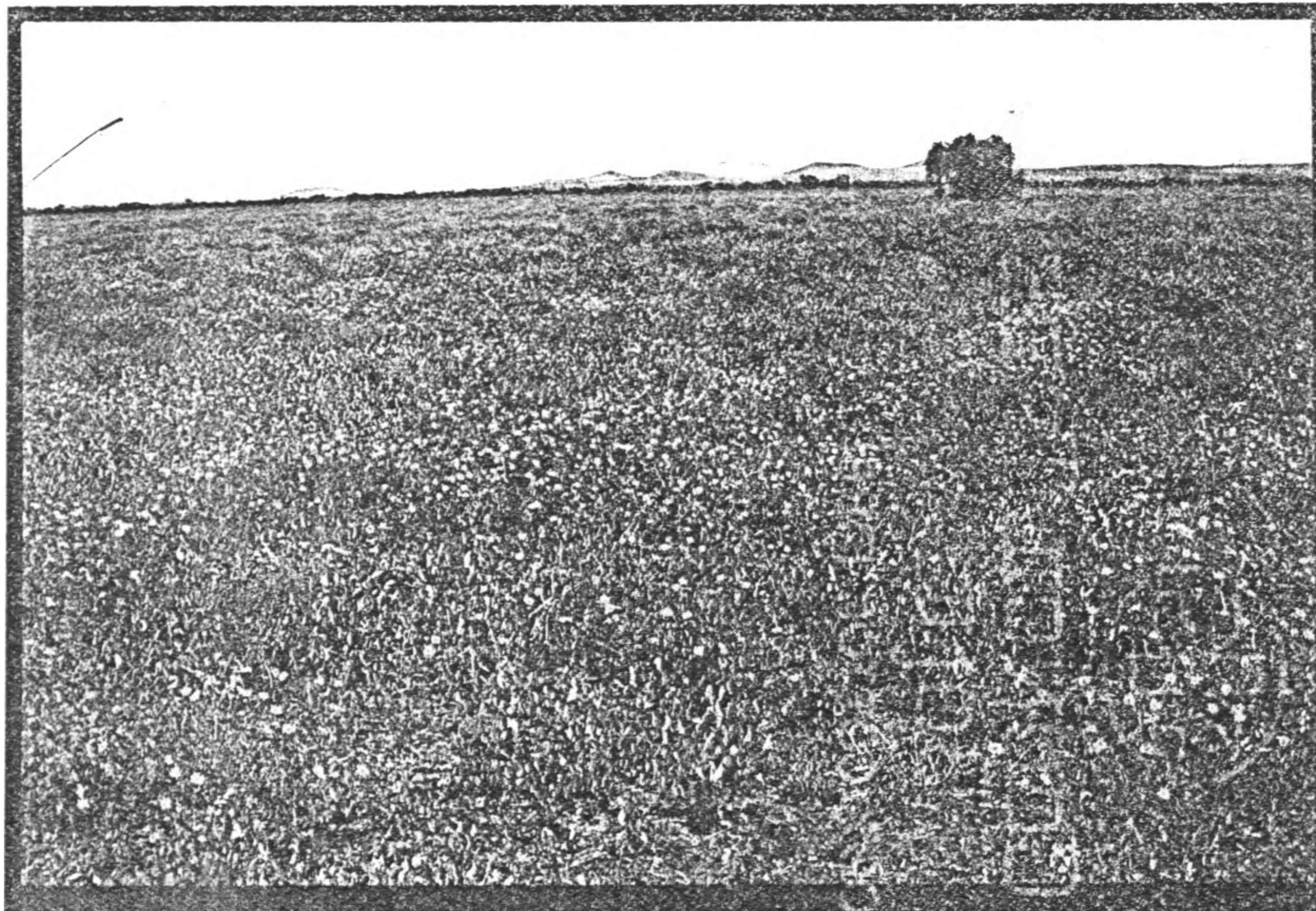


Figure 15 - May 1978 - The extensive bottomland sites in South Kaputiei are devoid of any perennial grasses. Seasonal broad-leaved weeds in the photograph disappear as soon as the dry seasons come. It is uncertain whether the low range productivity in this site is caused by grazing animals. Soil salinity of black cotton soils and prolonged dry season in South Kaputiei could be a possible causal factor (Tober 1977).

protandra, Tribulus terrestris, Indigofera spp., Ipomoea spathulata, Polygonum spp. and sedges for forbs.

Overview of Range Condition Status of Kaputiei Ranches in 1978

The results of the Range Condition Scoring Scheme, which covered nearly 300 sampling points at one kilometer interval, are summarized in Table 16.

The range condition of ranches on the Athi-Kapiti black soils reveals an average of 93 percent areal cover and an average soil condition rating score of 94 percent of perfect score Figure 16). These data support the field observation of little or no soil disturbance in Athi-Kapiti plains. The mean total score of combined score of vegetation and soil in the northern grassland ranged from 5.81 scores in Embolioi ranch to 9.36 scores in Olkinos ranch. The abundance desirable and undesirable plants in the pasture averaged respectively 52 and 26 percent of the potential abundance in the black soils. The frequency distribution of the sampling points into the range condition classes shows 66 percent good, 27 percent fair and only 7 percent in poor condition (Table 16.)

The rangeland in fair condition was characterized by heavy utilization of desirable plants. Cynodon dactylon an increaser becomes an important forage species of a fair range condition. Pennisetum mezianum and P. stramineum, though constituents of non-grazed black cotton soils, show increase in abundance in fair condition rangeland. The fair condition rangeland covers most flat well drained areas of Empuyankat, Embolioi and Emarti group ranches.

Table 16

The Summary of Range Condition Rating Scheme of Kaputiei Group Ranches in 1978

Group Ranch	Site Description	Desirable[1] out spp of 5	[2]Undesirable spp 3-0	[3]Soil Cond. 3-0	[4]Combined Score	[5]Range Cond. (Mean)	Range Cond. Classes: Very Poor 0-1.9	Poor 2-4.9	Fair 5-7.9	Good 8-11	Distance Sample KM (N)	Soil Aerial Cover Percent
Athi-Kapiti												
Olkinos	Athi-Kapiti plains	3.50	2.86	3.00	9.36	G	0	0	0	18	18	95%
Embolioi	"	1.84	1.39	2.58	5.81	F	0	5	13	19	37	90%
Empuyankat	"	1.91	2.18	2.86	6.95	F	0	0	8	14	22	93%
North Kaputiei							0	7%	27%	66%	77%	
Central Upland												
Red soils												
[7]Erankau	Bush Grassland	3.20	1.90	2.60	7.70	F	-	-	-	-	10	95%
Arroi (1)	"	3.53	2.67	2.60	8.80	G	0	0	5	10	15	86%
Arroi (2)	"	3.53	2.26	2.79	8.58	G	0	1	4	14	19	91%
Woodland												
Nkama (1)	Uplands in Basement hills etc.	3.25	1.56	2.44	7.25	F	0	2	7	7	16	88%
Nkama (2)		2.30	1.40	1.70	5.40	F	1	4	3	2	10	82%
Ilmamen	Bush&Grassland	2.58	2.00	2.08	6.66	F	0	6	3	3	12	80%
Mashuru	Riverine Sandy P.	1.21	2.50	2.46	6.17	F	0	4	16	8	28	74%
Central Kaputiei							1%	17%	38%	44%	100%	
Erosional Plains												
Mbuko	Bush Grassland	0.34	1.41	1.39	3.14	P	0	28	10	3	41	46%
Nkama	Red Sandy Soils	1.60	1.40	2.80	5.80	F	0	3	7	0	10	90%
Other South Kaputiei Ranches												
Kiboko	Volcanic/soils	2.88	1.41	2.16	6.45	F	5	7	11	10	33	75%
Olkarkar	Basement cond.	1.13	0.56	2.00	3.69	P	1	7	6	2	16	61%
Poka	Volcanic plateau	3.42	2.67	2.75	8.84	G	0	0	3	9	12	93%
Kaputiei							7	67	96	119	289	82.6+13.9
[8]Summary							6%	40%	33%	21%	112%	

Footnotes

[1]Desirable spp. - scored from 0 to 5 in increasing frequency of occurence of desirable grasses.

[2]Undesirable spp. - scored from 3 to 0 in order of increasing abundance of undesirable plants. The absence of undesirable plants thus gets the highest score of 3.

[3]Soil condition: The characteristics of soil surface - evidence of erosion, lack of protective vegetal cover.

[4]Combined score: the sum of desirable and undesirable plants, and the soil condition.

[5]Range condition - the range condition class assigned on the basis of combined score.

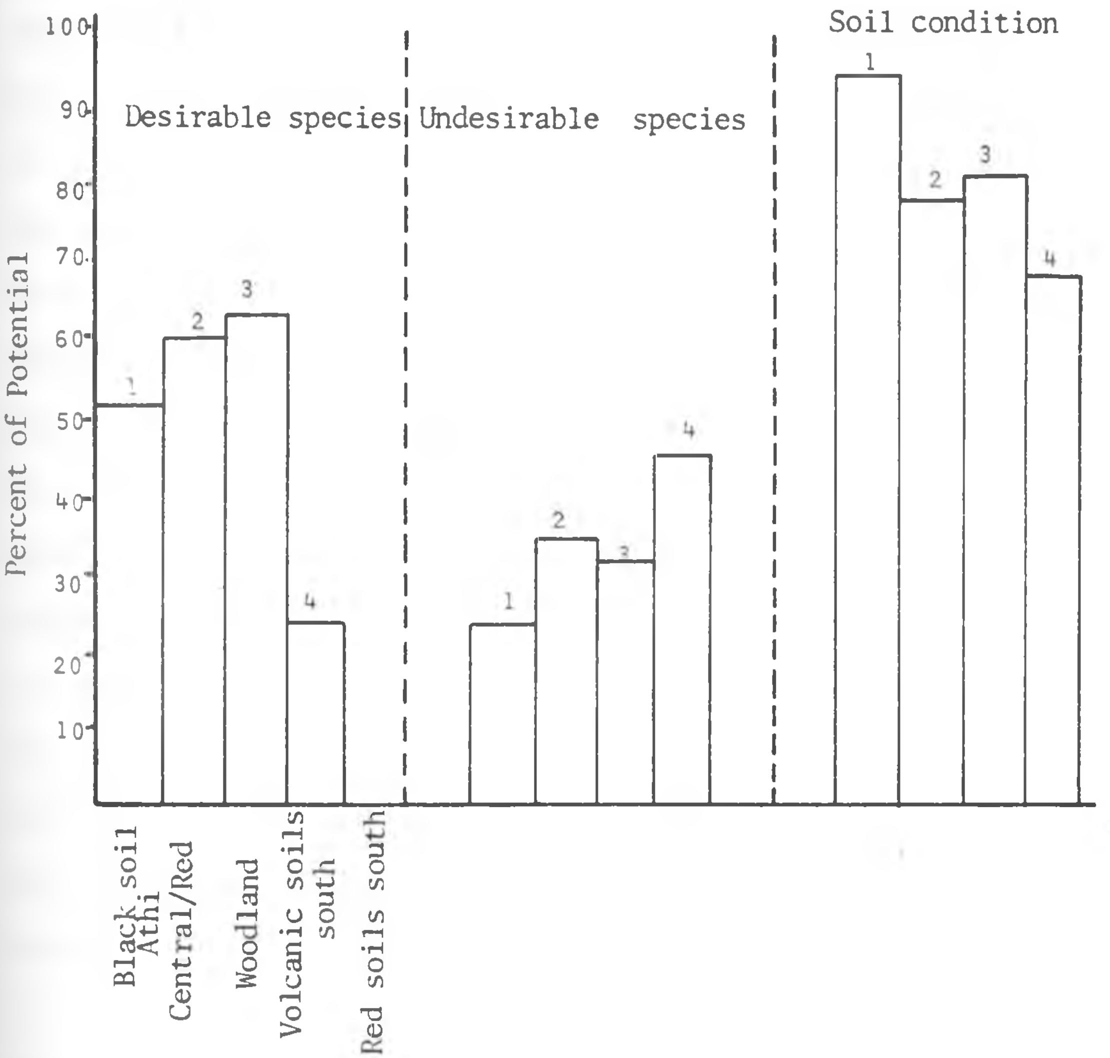
[6]North Kaputiei Range condition status.

[7]Erankau excluded from the computation of range condition classes.

[8]Summary of Kaputiei group ranches range condition classes based on the range condition rating scheme as developed in the above section.

Figure 16

The Status of Desirable, Undesirable Plants and Soil Condition in Kaputiei Range Site Types



[1]Athi-Kaputiei range site

[2]Central Uplands range site

[3]South Kaputiei - Volcanic range site

[4]South Kaputiei - Erosional plains

The differences in range condition status among north Kaputiei ranches come from the differences in status of vegetation and not from the soil condition factor. Embolioi and Empuyankat rangelands have been heavily utilized by grazing animals and therefore the proportion of desirable grasses in this range site i.e. Themeda triandra, Digitaria macroblephara have decreased significantly from the potential score of 3.00 (Table 16). In Olkinos rangeland, however, these desirable grasses are in a relatively higher proportion of the potential and the range is therefore in good condition. There are three possible reasons which may explain why Olkinos ranch is in better condition. First, Olkinos ranch is separated from Embolioi and Empuyankat ranches by a deep river valley. During the wet season, the Isenya river is flooded and this keeps off the movements of cattle from other group ranches into Olkinos. The second reason may be the individual ranches bordering the north of Olkinos ranch. These individual ranches prevent the influx of cattle from the north side. The third reason concerns differences in ecological potential among the northern Kaputiei ranches. Olkinos lies totally in better ecological zone IV, while Embolioi and Empuyankat ranches encompass both ecological zone IV and V. In general, the poorer ecological zone V is more susceptible to mismanagement.

The results of range condition scoring scheme support the conclusions drawn from the permanent vegetation transects in this area. Permanent transects in ecological zone IV (i.e. Transects 5, 6, 7, 8, 9) and Olkinos range reconnaissance survey confirm that the rangeland is in good condition. In contrast, permanent transects in ecological zone V support the reconnaissance evidence of rangeland in fair condition as shown by Embolioiand Empuyankat ranches (Table 16). Hence we can safely conclude from evidence drawn from range condition and range trend studies in Athi-Kapiti range site, that this rangeland has always been heavily grazed and range development inputs have not significantly caused degradation of the rangeland since 1969.

In the central uplands the condition status of the range is not uniform in this area because of heterogeneity of land forms and vegetation types. Erankau, Arroi, Nkama and parts of Ilmamen group ranches characterize the range condition status under bushed grassland in central uplands (Table 16). Arroi group ranch is in good range condition probably because of heavy natural bush, high danger of livestock predation in bushland, in addition to low level of water development inputs. In general, the proportion of desirable grasses in central uplands is ralatively higher than in either north or south of Kapitiei areas. This difference may be due to the undulating steep land forms in the central uplands, usually covered by impenetrable bush and woodlands. Dense bush protects relicts of desirable plants from overgrazing and therefore the replenishment of desirable plants is always ensured.

In woodlands and wooded grassland in Nkama, the natural dense vegetal cover does not provide an ideal habitat for livestock. Hence the ralatively higher undesirable bush plants have contributed to the low rating of the range condition in this area (Table 16). An improvement of range condition in central uplands must incorporate bush control measures in establishment of good range condition for livestock.

The summary of range condition status of the central uplands shows, that 44 percent of the range was in good condition, 38 percent in fair condition adn 18 percent in poor condition. Evidence from the permanent transects in this area (transects 23, 24, 25, 26, 27, 28, and 29) reveals that the range trend has been downward between 1969 and 1977. It is probable therefore that the range under fair and poor condition shown by the range reconnaissance survey in this area, is the result of range degradation between 1969 and 1977, the period of group ranch development program. The relatively high proportion of rangeland in good condition is indicative of frontier rangelands in the central uplands which have not been opened up for heavy grazing due to bush, predation and water problems.

Mbilin Mbuko, Kiboko, Meruishi, Olkarkar, and Poka ranches constitute the south Kaputiei rangelands. The range condition of Mbuko ranch is typical of other rangeland on red basement complex soils in Nkama, Meruishi, and Mbilin ranches (Table 16). The desirable plants in Mbuko have decreased to about 7 percent of site potential. This proportion of desirable plants is probably inadequate to allow a natural recovery of this rangeland even if grazing is completely excluded from this area. Poka, Kiboko and Olkarkar rangelands are largely on recent volcanic soils: Olkarkar ranch is in poor condition because of the permanent water source in Simba springs which draws livestock from as far as Ilkisongo Section (Halderman 1971). Poka ranch lies in ecological zone IV unlike other south Kaputiei ranches in ecological zone V. The ranch is in fair to good range condition.

The results of range condition status from permanent transects in south Kaputiei corraborate the evidence drawn from this Range Condition Scoring Scheme in this area. We may therefore conclude that the extensive degradation of rangeland in south Kaputiei occurred between 1969 and 1977.

A general classification of range condition rangeland shows that 6 percent of the range is in very poor condition, 40 percent in poor, 33 percent in fair while only 21 percent of the rangeland is in good condition (Figure 17).

FACTORS INFLUENCING VEGETATIONAL CHANGES IN KAPUTIEI

Since vegetational changes may result from a myriad of factors, the task of separating the ralative contribution of the various relevant factors in the range condition and range trend analysis without prior experimental design becomes almost impossible due to confounding and complementary relationship among these factors. If, for example, the frequency of a species drops from 90 percent to 10 percent after ten years, a glaring change of status of this species in the plant community, it is difficult to assign the casual factor without additional frequency measurements of this species in the intervening years. Such a drastic change may be due to drought,

Figure 17

Summary of Range Condition Status in Kaputiei Range Sites in 1978

(a) South Kaputiei Range Sites
Sample size 112 km
Red and volcanic soils

(b) Athi-Kapiti Range Site
Sample size 77 km
Black cotton soils

(c) Central Uplands Range Site
sample size 100 km
Red soils

seasonal or yearly changes, or grazing pressure. An attempt to substitute space for time introduces range site differences. An intuitive data analysis of Kaputiei vegetation measurements will approximate the relative importance of the crucial factors which contribute to the overall status of the range condition and range trend.

Seasonal and Climatic Patterns

Frequency, basal cover and forage production parameters are measured in order to characterize the long term trends of vegetational changes due to managerial factors. However, these parameters are subject to the influence of seasonal and climatic patterns which are beyond the control of man. A qualitative evaluation of the effects of the seasonal and yearly changes in vegetational measurements will lead to a better understanding of the relative importance of controllable and uncontrollable factors which cause changes in range condition and range trend. (Table 17).

The frequency of perennial grasses increased by 17.5 percent from wet to dry season in 1977. This increase is also partly due to reduction of grazing pressure following the livestock mortality in 1976 and the recovery of perennial grasses from drought conditions. The ephemeral grasses, by contrast show strong seasonal influence. The total frequency of ephemeral grasses decreased by 81.5 percent from the wet to the dry season in 1977 (Table 17).

Table 17

Seasonal Changes in Vegetation Measurements of Kaputiei Permanent Transects

Parameter	Permanent Transects	Number of Transects	Year	Wet (May) $\bar{X} \pm$ CI[1]	Dry (Oct.) X $\pm$ CI
1 (a) Frequency of perennial grasses	1, 4, 7, 9, 15, 17, 22, 27	8	1977	108 $\pm$ 56	127 CI 68
2 (b) Ephemeral Grasses Frequencies	"	8	1977	157 $\pm$ 65	29 $\pm$ 25
3. Basal Cover		14	1969	15.3 $\pm$ 8.4	10.1 $\pm$ 9.0
4. Forage Production kg/hec	1, 4, 8, 12	4	1969	1209	436

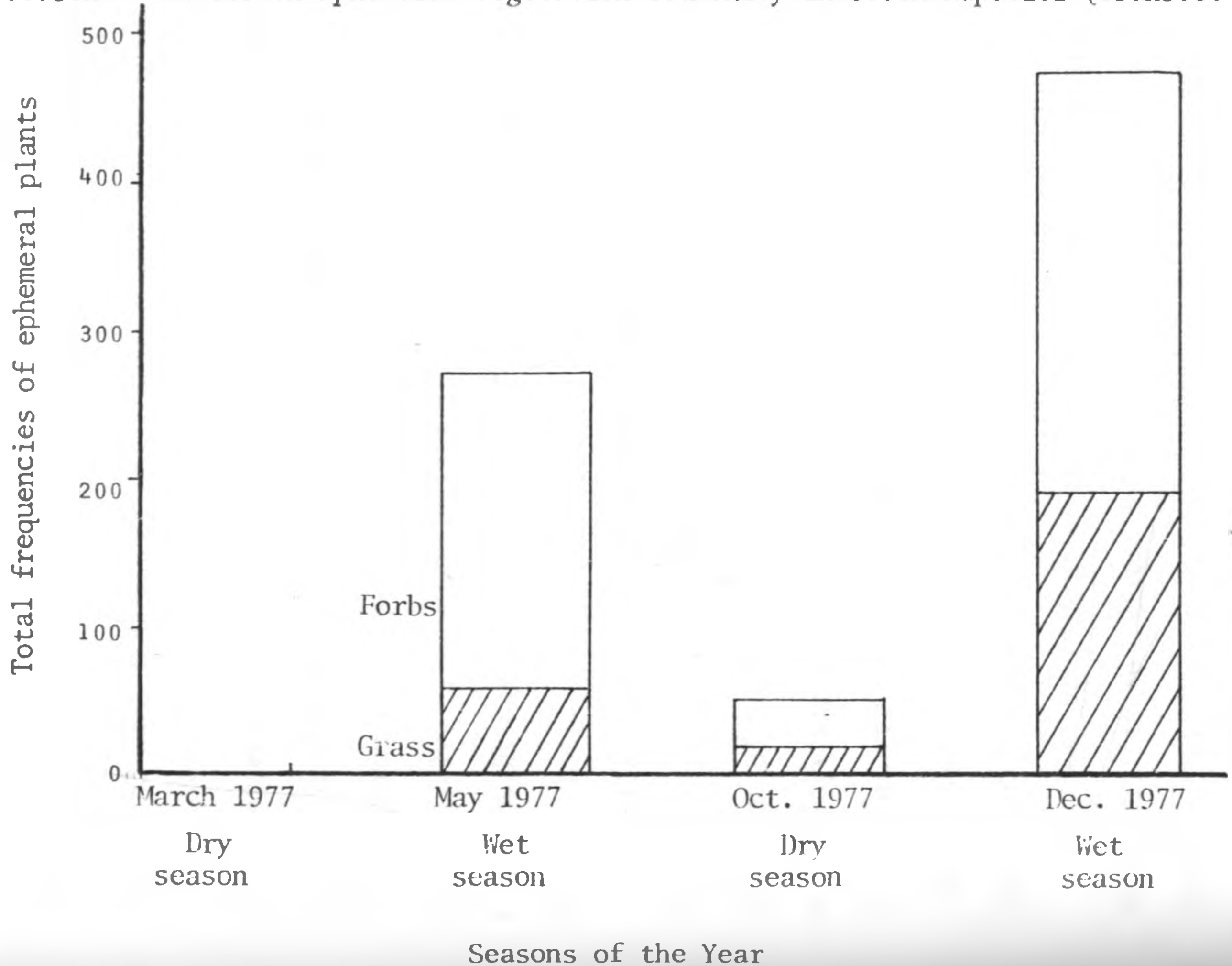
[1] $\bar{X} \pm$ CI: 95 percent confidence interval of Mean used.

The rangelands in poor condition suffer from a strong seasonality factor as depicted by Merushi permanent transect 15 in Figure 18. The frequencies of ephemeral grasses and forbs show peaks of abundance during the wet seasons in the year (April/May, and November/December). In the dry seasons, most of the ephemerals only exist as seeds for the next growing season; consequently the frequency measurements are extremely low during January to March and June to October, the dry seasons in this area.

The rangelands in good condition, i.e. with a fair proportion of desirable grasses, do not suffer from such strong seasonal changes in frequency of species (Table 17). The variations of basal cover and forage production measurements between wet and dry seasons are well documented in the 1969 measurements (Table 17). The basal cover and forage production measurements decreased by 34 percent and 64 percent respectively between wet and dry seasons. However, the reduction in these parameters is confounded by the seasonal variation of grazing pressure as well as superimposed effects of yearly rainfall patterns. Basal cover changes of perennial grasses when accompanied by significant frequency changes are complementary evidence of a downward range trend. The vegetational changes due to the seasonal influence can be controlled if measurements are made at the same phenological stage of the vegetation each time. This approach was adopted in the study of the Kaputiei vegetational transects. However, the vegetational changes due to unpredictable patterns of wet and dry periods are not easy to isolate.

Figure 18

Seasonal Effects on Ephemeral Vegetation Community in South Kaputiei (Transect 15)



Drought effects in the U.S. grasslands have been documented by several workers (Weaver et al. 1935, 1936, 1939, 1943, 1944; Ellison, et al. 1937, Pechanec, et al. 1937, Julander 1945, Coupland 1958 and Chamrad et al. 1965).

Weaver (1936) reported a frequency reduction of perennial grasses by 20 percent after the 1934 drought in the Prairie of Nebraska. He also indicated a decrease of basal cover by 50 percnet, 54 percent and 91 percent in grazed, moderately grazed, and heavily grazed sites respectively. The annual rainfall in the sites studies during the 1934 drought was only 69 percent of the annual average of 560 mm (22.4 inches).

Similar weather changes occur in Kaputiei at least once every decade as shown on Table 6 in Chapter 4). The effects of the variation of annual rainfall from good to bad years, and vice-versa, on the vegetation changes in Kaputiei grassland have not been documented, and therefore, it becomes rather difficult to show the ralative significance of weather fluctuations and grazing intensities on vegetation changes.

The best approximation of the drought effects on grass composition in Kaputiei is to compare measurements from undisturbed sites before and after the drought in 1976. This case more or less exists in some parmanent transects in Athi-Kapiti grassland.

Transect 7, located near Stony Athi Railway Station has remained ungrazed for various reasons. The railway workers nearby do not keep any livestock. A commercial ranch borders the Empuyankat ranch to the East. The Nairobi-Mombasa railway is an effective barrier in restricting grazing on Transect 7 from the commercial ranch. The Masai avoid grazing their animals in this area mainly because of disease hazards from resident wildbeest herds. The frequent day and night trains keep the wildbeest herds from visiting the Transect 7 area.

The frequency of important perennial grasses (i.e. Cynodon dactylon, Digitaria macroblephara, Pennisetum mezianum, P. stramineum and Themeda triandra) did not change before and after the drought in Transect 7 (Table 18). However, the basal cover increased moderately from 8.5 percent in 1969 to 25.5 percent in 1977.

These frequency and basal cover data suggest that if there were any significant vegetation changes in Athi-Kapiti grassland from 1969 to 1977, they are most likely due to other factors such as grazing intensities, and not the recent drought.

The drought impacts in the southern grassland are difficult to demonstrate along the same line of argument presented for the Athi-Kapiti grassland. As a result of serious vegetation disturbances in all permanent transects in the red soils in south Kaputiei, the best approach to the isolation of possible drought impacts is to subsitute space for time.

Transect 1 and a new transect X_5 in Mbilin are located within 4 kilometers of each other and in the same climate, vegetation and soil types. Transect X_5 is located in an area with little grazing pressure due to tse tse infestation and lack of water. This area too is under

Table 18

The Relative Significance of Drought and Grazing Intensities in Vegetation Changes in Kapiti Permanent Transects Using Frequency and Basal Cover Measurement

	Athi Kapiti Black soils		Red Soil Area			Volcanic Soil Areas		
	TR 7		TR 1		Mbilin X^5	TR 13		Poka X^1
SPECIES FREQUENCIES PERCENTAGES	1969 (May)	1977 (May)	1969	1977	Feb. 1978	May 1969	May 1977	Feb. 1978
Chloris roxburghiana			18	6	10			
Chrysopogon aucheri			-	-	60			
Cynodon dactylon	26	26	-	-	-			
Digitaria macroblephara	56	45	95	10	100	80	54	87
Pennisetum mezianum	17	24						
P. stramineum	50	53						
Sporobolus fimbriatus	-	-				50	39	60
Themeda triandra	49	53						
Total frequency	198	201	113	16	170	130	93	147
Basal cover in percentages	8.5	25.5	17.3	1.8	19.3 $\pm$ 9.8	15.5	12.0	37.5 $\pm$18.5

N.B. Transect Mbilin X_5 and Poka X_1 - Frequency measurements were taken with 1/4 m^2 square qradrat n=15. Other measurements (1969 and 1977) were taken with 0.96 ft^2 circular quadrant n=100. These new Transects do not correspond with the ones in Figure 6b.

rest from any grazing by consent of the members of the group ranch. Permanent transect 1 has been under heavy grazing and is also within the range of the Sultan-Loitokitok water pipeline.

The frequency of Digitaria macroblephara in Transect X_5 is very similar to the frequency of this species in south Kaputiei Transect 1 in 1969 (Table 18). Chrysopogon aucheri, a very palatable species, had already been selectively grazed from Transect 1 by 1969 but in Transect 2, just less than 2 kilometers away from Transect X_5, Chrysopogon aucheri decreased from 34 percent in 1969 to zero percent in 1977. The frequency of Chrysopogon aucheri (60 percent) in Transect X_5 after the drought suggests that it is grazing pressure that has reduced the abundance of this species in Transects 1 and 2.

The basal cover in Transect X_5 compares reasonably well with the 1969 basal cover in Transect 1; hence the reduction of basal cover in Transect 1 from 17.3 percent in 1969 to 1.8 percent in 1977 must be accounted for by other factors other than drought effects on the southern red soils.

Vegetation changes on volcanic lava flow soils in the south and central Kaputiei before and after the 1976 drought are illustrated by data from permanent Transect 13 and a control transect, Poka X_1, located in a calf-paddock, one kilometer away from Transect 13. The grass composition in Transect 13 during 1969 compares fairly well with the grass composition in a moderately grazed area in Poka X_1 (Table 18) The moderate reduction of the frequencies of Digitaria macroblephara and Sporobolus fimbriatus from 1969 to 1977 represent grazing effects, since the status of these two species in Transect 13 during 1969 is similar to the control in Poka XI. Hence frequency changes in volcanic sites are likely to be attributed to other factors, and not totally due to the recent 1976 drought.

The climatic effects on changes in forage production is shown by the Athi-Kapiti measurements. The standing crop in August 1967 for Athi-Kapiti permanent transect (7, 8, 9) averaged 1617 kg per hectare.

In 1969, the average standing crop for these transects was 912 kg per hectare during the wet season in April/May, and only 501 kg per hectare at the end of the dry season in early November. One explanation of this difference is forage production in 1967 and 1969 is related to the low rainfall during 1969. The total annual rainfall for 1967 and 1969 was 106 percent and 86 percent respectively of the mean annual rainfall at Isinya Station (Figure 19(i)).

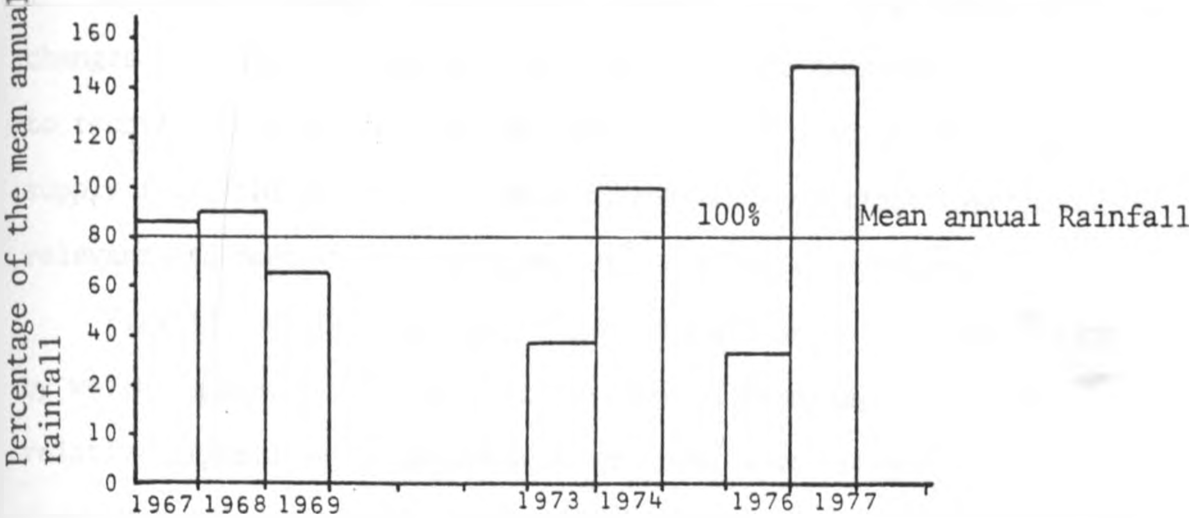
The forage production measurements at Isenya exclosure after the 1973 drought show the greatest fluctuation of forage supply due to seasonal rainfall. During 1974 the standing crop increased from 180 kg/hectare in February to 4298 kg/hectare in December. The same pattern was observed in 1977, in transect 7, as the standing crop increased from 150 kg/hectare (due to 1976 drought) in March to 4020 kg in May 1978. The peaks of high standing crop coincide with the rainfall peaks (Figure 19(ii)).

The relative composition by weight of the major species in Athi-Kapiti standing crop does not show any prolonged significant trend. However, temporary relative compositional changes can result from

Figure 19

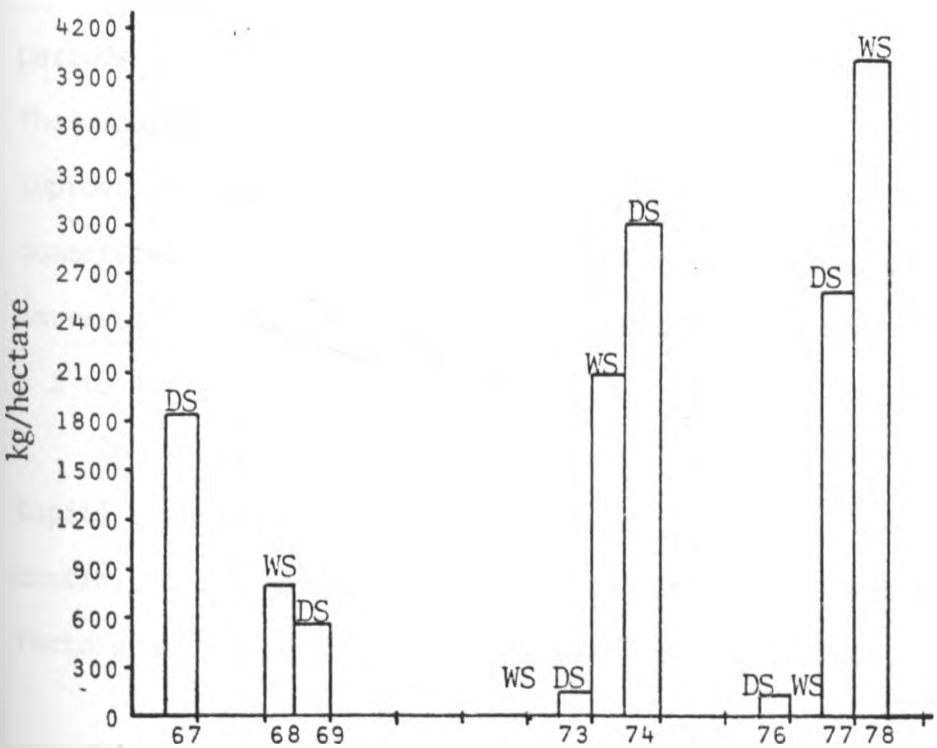
The Effect of Total Annual Rainfall on Forage Production on Athi Kapiti Grassland

(i) Mean annual rainfall as percentage of the average (1962-1977) at Isinya Station



(kg/hectare dry weight)

(ii) Forage production WS = Wet Season, DS = Dry Season



alternating good and bad years. Figure 20 shows the relative composition of major grass species in Athi-Kapiti soils from 1967 to 1978. In well managed areas, there seems to be no long term significant changes in forage composition by weight, except temporary changes due to recovery from wet and dry periods. This phenomenon in forage supply from Athi-Kapiti grassland suggests two important hypotheses of relevance to management practices in the black soil types.

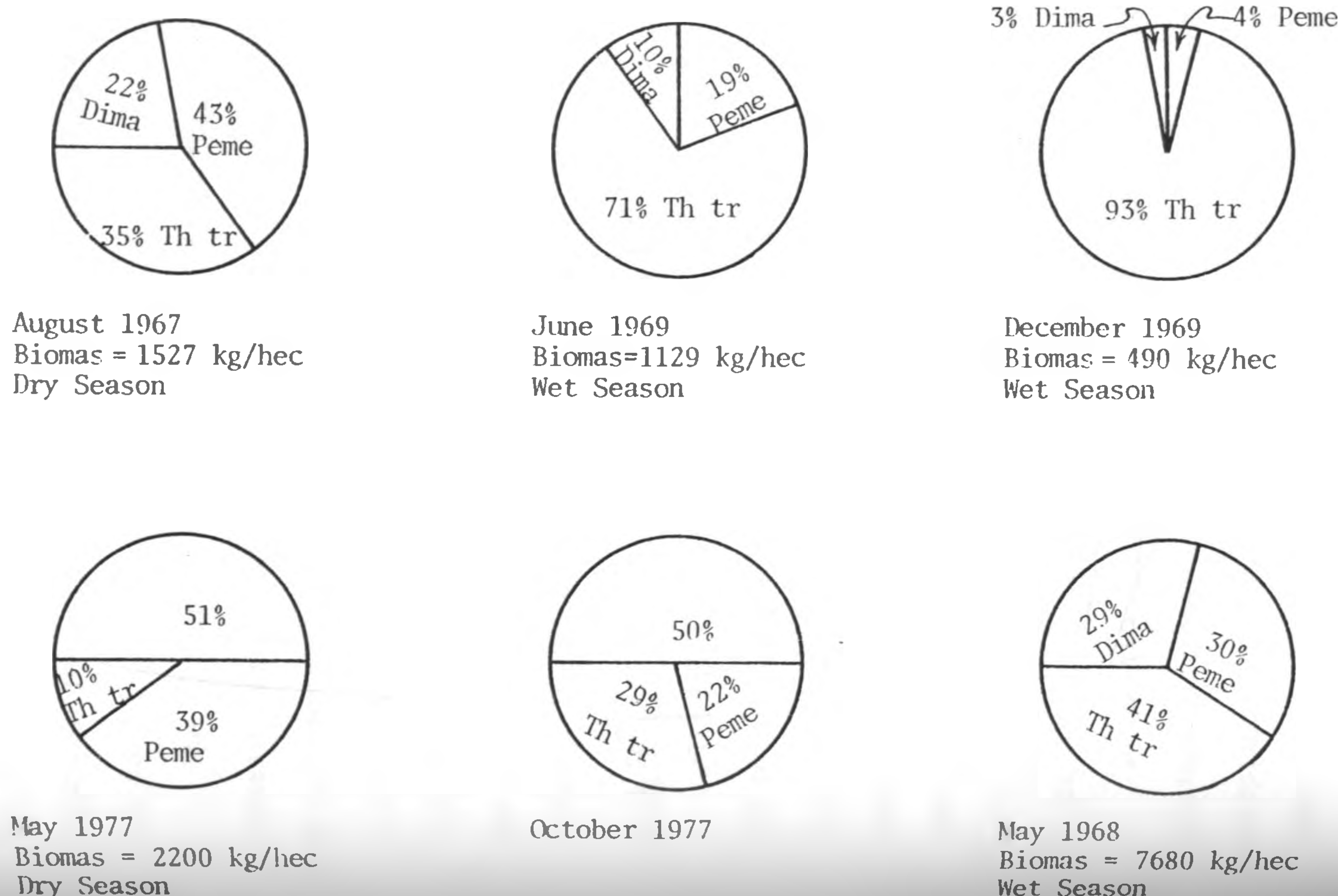
Firstly, seasonal and periodical changes in forage composition by weight enhance resilience in the face of mismanagement. The relative importance of undesirable grasses, like Pennisetum mezianum from wet to dry seasons protects the desirable species such as Themeda triandra. Digitaria macroblephara is a lower successional desirable grass which also shows seasonal increase and decrease from one year to the next.

Secondly, the usual peaks of forage production after severe dry periods function in a similar manner to those following fire treatment. The drought probably rejuvenates the pastures just like forage improvement after fire treatment to remove ungrazed stems. One commercial rancher has recognized this periodical supply of forage, by harvesting early 3 or 4 years. The drought frequency seems to follow a 3 to 4 year cycle.

In conclusion, the fluctuations of forage production in Athi-Kapiti grassland clearly shows that the amount of precipitation controls the primary production to a large degree even where other factors are controlled. This is particularly useful to keep in mind

Figure 20

Relative Change in Species Composition by Weight of the Athi-Kapiti Standing Crop in TR 8 (1967-1978)



Dima: Digitaria macrodephara, Peme: Penisetum mezianum, Th tr: *Themeda triandra* when range condition and range trend assessment are carried out during either too wet or too dry periods. The assessment of range condition in a dry period tends to shift the blame for the apparent low forage production on livestock.

The effects of seasonal and climatic factors are not the major causes which account for the changes in frequency and basal cover measurements of perannial grasses between 1969 and 1977. Comparative evidence from relict sites near the permanent vegetational transects show that the frequency and basal cover measurements in these areas are similar to the 1969 measurements of the respective permanent transect in Kaputiei.

Soil Factor

Although the botanical composition changes on both black and on red soil sites can be attributed to differences in precipitation, the soil seems to be an equal if not more crucial factor. According to results of a controlled experiment conducted between 1958 and 1967 at Katumani Research Station, not far from central Kaputiei, similar grazing treatments showed significant differences between the red and black soil properties (Langat 1970).

In the red soils, the bulk density during the first year of treatment increased by 17 percent, while the pore space and rainfall acceptance decreased by 40 percent and 50 percent respectively. These effects on soil properties lasted even after enght years of no grazing treatment.

In the black soils, however, no significant changes in the bulk density, pore space and rainfall acceptance were recorded in the plots grazed for one year, but plots grazed for six years and nine years showed a progressive reduction of rainfall acceptance of 14 percent and 40 percent, respectively (Langat 1970).

In this experiment, the black soils sustained less damage to their physical properties, while the red soils were highly susceptible to long-lasting detrimental changes with only one year of intensive grazing. It was also documented in tha above experiment that the black soil provided a total of 1874 grazing days in nine years, while the red soil could only carry 854 grazing days before animals started to lose condition through starvation. The red soils therefore, had 58 percent of the grazing potential of the black soils.

Since Katumani is located in proximity to central and north Kaputiei, the differences between black and red soil under similar grazing treatments can be safely extrapolated for Kaputiei grasslands. An important conclusion which can be drawn from this controlled experiment at Katumani, is that some soil type differences predispose some sites to greater risk for mismanagement than others. In this respect, it is likely that part of the widespread degradation of south Kaputiei rangeland is accelerated by qualities of the basement complex red soils, while the resistance of the Athi-Kapiti grassland to mismanagement may be associated with some good characteristics of the black cotton soils. Range condition and range trend assessments therefore are more accurate where the site potential differences are recognized.

The Grazing Factors

The above analysis of the effects of seasonal and climatic patterns, and soil factors on the vegetational changes in Kaputiei has shown that this set of uncontrollable factors is not largely responsible for the differences in vegetational measurements in 1969 and 1977. Hence our attention is now focussed on the set of management-related causes which are most probably responsible for these vegetational changes.

In Kaputiei group ranches, the grazing factors constitute the most important category of management factors. Those grazing factors which directly or indirectly lead to vegetational changes in Kaputiei include various aspects of forage consumption by livestock and wildlife, human settlement patterns which have been influenced by development inputs such as the intensity of water development and trends toward sedentarization. These factors will be eleaborated in the subsequent chapters. However, a brief analysis of the effects of selective grazing and water development on the vegetational changes highlights the significance of the grazing factors as the most plausible explanation of changes in range condition and range trend between 1969 and 1977. The impacts of grazing animals in the Athi-Kapiti grassland are usually masked by the proportion and dominance of unpalatable grasses such as Pennisetum mezianum and P. stramineum. Selective grazing is clearly demonstrated by the contrast of Themeda triandra, a desirable grass and Pennisetum mezianum, an undesirable grass in permanent transects with and without grazing pressure.

Transect 5 and 8 represent locations with moderate grazing, while transects 6 and 7 have had only slight grazing between 1969 and 1977.

Figure 21 shows the frequency changes of Themeda triandra and Pennisetum mezianum in 1969 and 1977. The proportion of Themeda triandra in the grazed transects 5 and 8 decreased in 1977 to 47 percent and 48 percent of the 1969 frequency levels respectively. There were no substantial frequency changes in the slightly grazed transects 6 and 7 during the same interval of time.

Pennisetum mezianum, however, indicates slightly higher frequencies in both the ungrazed and grazed transects after the drought. In addition, Pennisetum mezianum increased proportionately more in grazed transect 5 than in ungrazed transect 7. The slight increase in undesirable species like Pennisetum mezianum, may be as a result of the decrease of desirable species due to grazing. Inter-species competition is more likely to favor the undesirable species. Selective defoliation of desirable grasses reduces their carbohydrate reserves which are needed to start regrowth in the next wet season. The relatively higher carbohydrate reserve in undefoliated, unpalatable species give greater regrowth and therefore better inter-specific competitive ability of undesirable plants against the desirable plants.

Selective grazing implies that a grezing animal takes time to select palatable plants from among the unpalatable plants. The unpalatable plants, therefore, protect to some extent the desirable grasses from indiscriminate grazing. Rangelands with a mixture of undesirable and desireble perennial grasses sustain higher grazing

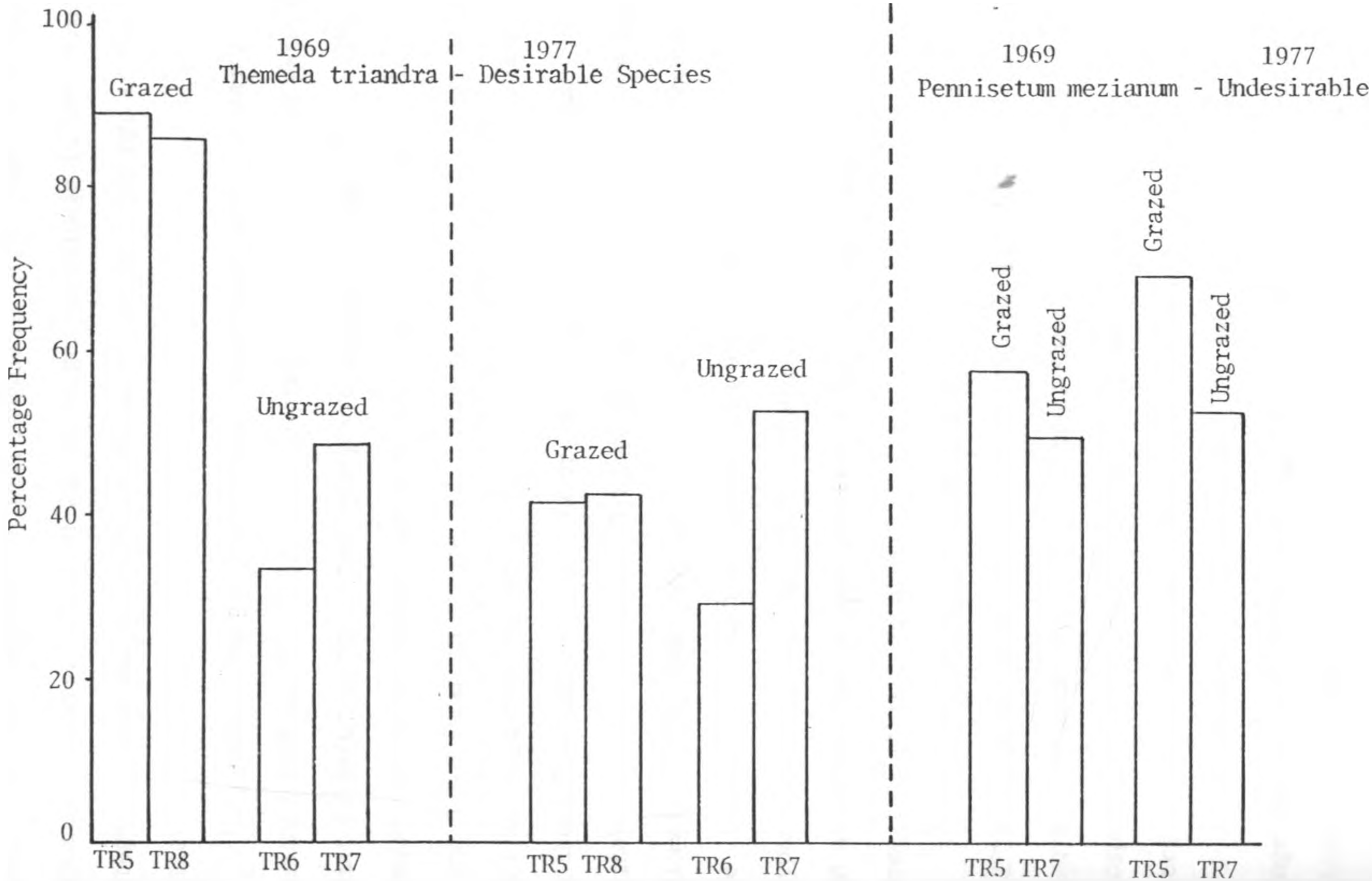


Figure 21

Effects of Selective Grazing and Vegetation Changes in Kaputiei Permanent Transects pressure without degradation than rangelands with scanty undesirable perennial grasses. The Athi-Kapiti rangeland belongs to the former category, while the southern rangeland on red soil belongs to the latter.

In general, the grazing pressure decreases with increasing distance from water. This trend of grazing pressure around watering point is referred to as the "piosphere effect" (Lange 1969). The frequencies of desirable plants in south Kaputiei transects 14, 1, 2 and 3 are shown in Figure 22. Transect 14 is located very near (1/2 km) to a borehole which was constructed after 1969. Transect 1 is about 3 kilometer from a water-connection from the Sultan-Loitokitok water pipeline. Transects 2 and 3 are located more than 8 kilometers from water and were inaccessible prior to 1969 because of tse tse flies. With the introduction of prophylactic drugs against trypanosomiasis, such as Berenil, the grazing pressure has increased and also the animals have penetrated further into the hinterland into formerly inaccessible areas.

The total frequencies of desirable grasses in transects 1, 2, 3 and 14 decreased drastically between 1969 and 1977 (Figure 22). However, the decrease of these grasses show a gradient around water piosphere. The desirable plants disappeared in Transect 14 due to overgrazing and trampling effects around the water poing.

A similar trend in grazing pressure was observed during the range condition scoring investigation. A transect was taken from Kiboko river into the hinterland of Kiboko group ranch and even

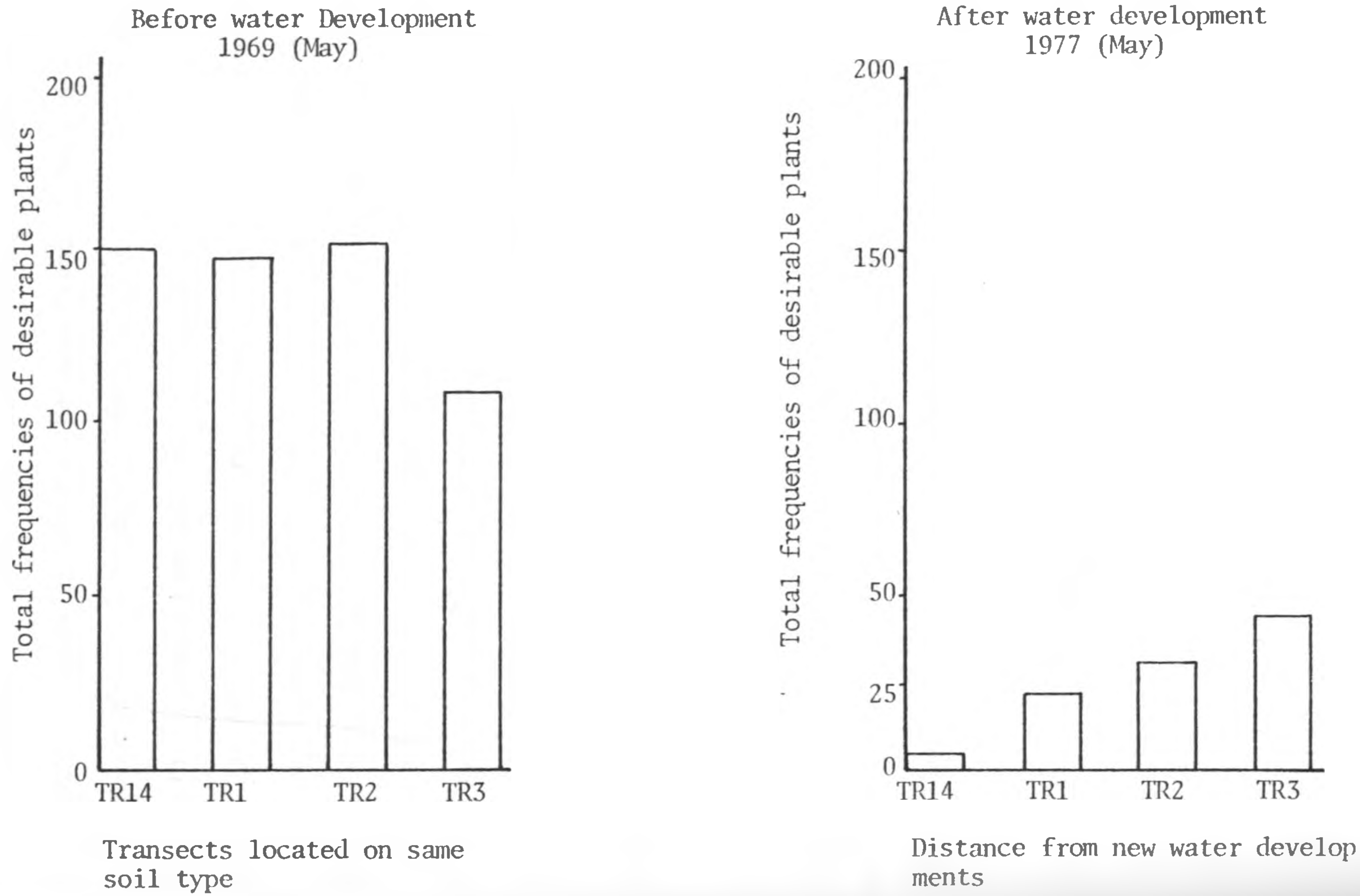


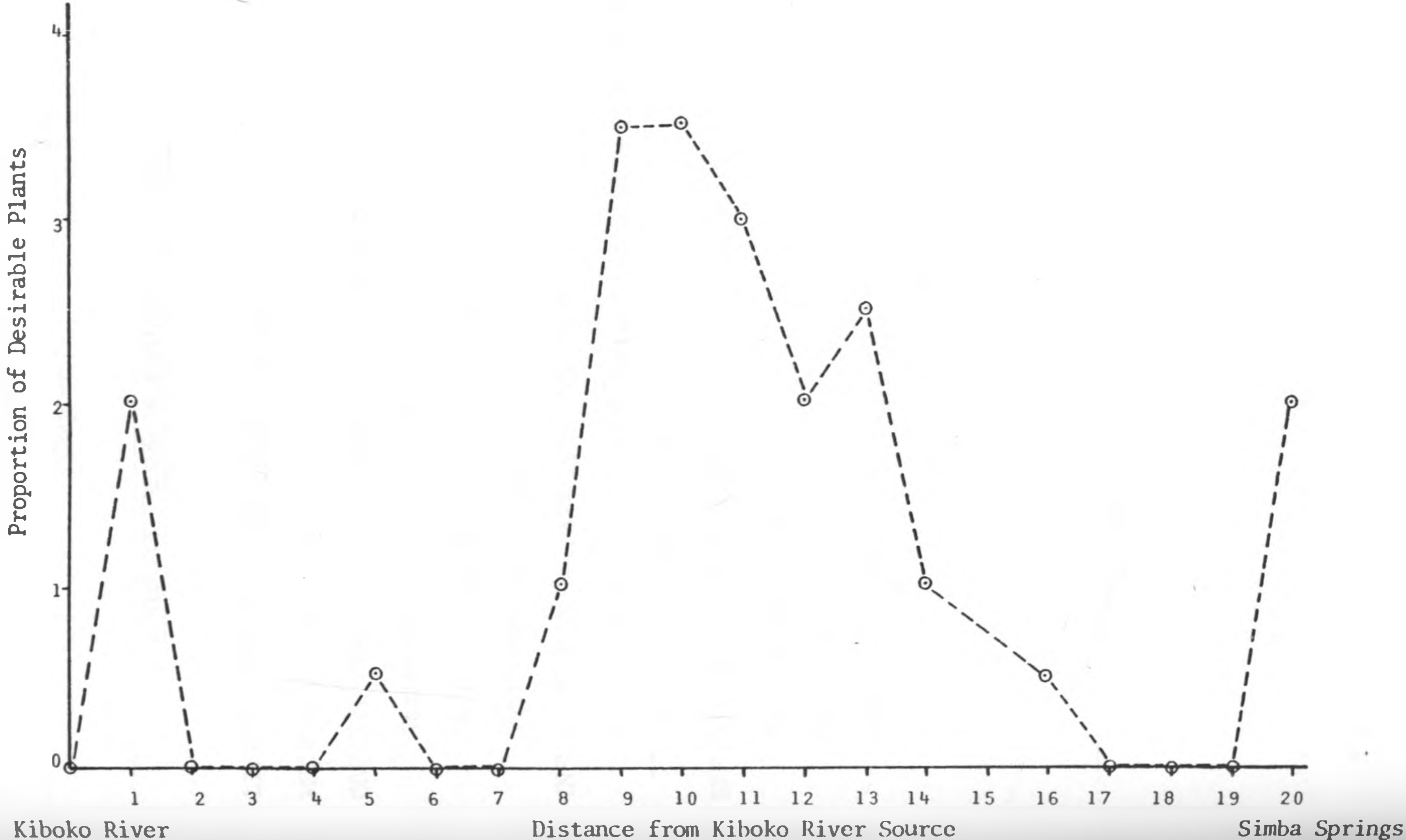
Figure 22

The Impact of Water Development on the Botanical Composition of Desirable Plants *in Kaputiei Transects* farther toward Simba Springs (Fig. 6b). The desirable species were scored together on a scale of 0 to 5 according to their degree of abundance. Figure 23 reveals the same trend of desirable plants that was observed in permanent transect above. The high proportion of desirable plants near the river (Figure 23) is due to the established reserve grazing for calves near human settlements. The impact of a permanent water source like the Kiboko river is reflected by the heavy grazing pressure within an 8 kilometer radius, in which the desirable plants have almost disappeared from the rangeland. From 9 to 11 kilometers from the Kiboko river, the rangeland was in excellent condition, but from 12 kilometers and farther toward Simba Springs, the desirable plants decreased steeply due to the effects of the next permanent water source at Simba Springs.

We can conclude that if grazing regulations cannot be enforced in south Kaputiei area, the destruction of the areas surrounding water sources extends over nearly 30 square kilometers. The rehibilitation of such an area would cost more than the total cost of providing the water plus any of the benefits from unregulated livestock production.

Figure 23

The Effect of Permanent Water Source on the Abundance of Desirable Plants in Kiboko Ranch



Chapter 6

LIVESTOCK TRENDS IN KAPUTIEI (1968-1977)

Chapter 6

LIVESTOCK TRENDS IN KAPUTIEI (1968-1977)

LIVESTOCK TRENDS AS PERFORMANCE CRITERIA

In the previous chapter on the vegetation trends in Kaputiei, livestock grazing was introduced as an important cause of vegetational changes. In this chapter, livestock trends are examined in detail. The changes in livestock populations over the development decade reflect both the prevailing ecological conditions at the time of livestock censuses and the livestock management standards. For example, the pattern of precipitation, disease control measures, and range condition and trend have significant effects not only in the changes of livestock populations for each species, but also in the relative mix of the various livestock species. Livestock trends, therefore are one set of performance criteria of livestock development intervention among pastoral nomadic societies. These trends are indicators of the outcome of the mutual adaptation process between socio-cultural changes of the people and their altered biophysical environment.

METHODS AND RELIABILITY OF LIVESTOCK CENSUSES

The 1967 baseline livestock census covered fifteen proposed group ranches over the whole of Kaputiei (Pre-Investments Survey 1969). Livestock holdings for each head of family in a group ranch were counted by the Range Management extension staff. Cattle were classed into three groups: female, males and castrates. Each group was then subjectively divided into three age classes: birth to one year, immature and mature. Sheep, goats and donkeys, were not divided into sex or age categories.

During the implementation and operation of the Kaputiei Group Ranches, Range Management extension staff in the Ministry of Agriculture continued frequent livestock censuses. The pattern of a complete livestock census for every member of a group ranch was maintained. However, the planned annual livestock censuses for all group ranches never materialized, partly because of slow progress for three or four years in implementing the group ranch proposals. In some ranches the members became uncooperative and during years of inadequate rainfall the semi-nomadic movements made livestock census impossible.

However, some ranches such as Ilmamen and Mbilin had strong leadership and the group ranch leaders asked for frequent livestock censuses themselves, so that the AFC would release development loans for their respective ranches. Table 19 shows the frequency of livestock censuses done by Range Management staff in Kaputiei group ranches between 1968 and 1977.

A complete livestock censuses was done in this study in 1977/78 for three objectives. The first objective was to make an independent and complete inventory to be used for comparision with another inventory made by the Range Management Division in the Ministry of Agriculture. Phase I Group Ranches were to be replanned. The

Table 19

Ranches and Year of Livestock Census in Kaputiei

Ranches	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	Total per Ranch
Arroi	X		X							X	3
Embolioi	X				X			X		X	4
Emarti	X				X					X	3
Empuyank	X				X	X	X			X	5
Erankau	X				X					X	3
Ilmamen	X		X	X	X	X	X	X		X	8
Kiboko	X			X	X		X			X	5
Mashuru	X				X					X	3
Mbilin	X		X			X	X	X	X	X	7
Mbuko	X			X						X	3
Meruishi	X				X					X	3
Nkama	X			X		X			X	X	4
Olkarkar	X		X	X			X			X	5
Olkinos	X				X					X	3
Poka	X	X	X							X	4
Number of Ranches Sampled	15	1	5	5	9	4	5	3	1	15	63

second objective was to estimate the livestock losses sustained by each stockholder during the 1976 drought. An evaluation of the extent and possible significance of livestock reciprocity ties among the members of Kaputiei group ranches was the third objective.

Two teams under the author's supervision with three enumerators per team carried out the survey. One team started with North Kaputiei ranches in October 1977 while a second team worked on the South Kaputiei ranches in November 1977. Of the six enumerators, five were Masai young men from either Kaputiei group ranches, or surrounding Masai country. One enumerator, of Somali origin, was born and raised in Kajiado area and had a good command of the Masai language and customs. All the enumerators had a minimum of 12 years of basic education.

The survey lasted for three months (mid-October 1977 to mid-January 1978). The camping sites for the working teams were located near settlements. Each team visited all bomas* near the camping site before moving to another site within the ranch to work on other herds. The group ranch committee requested their members to welcome the enumerators and there were very few incidences of lack of cooperation.

The censuses were carried out between 6-9 a.m. before the animals left for grazing and 5-6:30 p.m. after the animals

*Boma - a collection of families staying together, same as kraal camp or settlement site.

returned from grazing. In most instances, the chairman or one of his representatives from the group ranch committee would accompany the enumerators during the morning and evening censuses. Each boma was located on a 1: 50,000 map of the local area. The work of the enumerators was supervised at every stage and any problems arising in the course of the census were settled on the spot. (Figure 24).

The data collected during the survey included the number of livestock counted for each head of family, animals counted for each head which belonged to persons outside the family, animals supposed to be in the herd but given on loan to other members, and an estimate from each family of livestock losses due to the 1976 drought. Most of the pastorialists were very willing to reveal drought losses although with some bitter memories of drought experiences.

Variations and accuracy of livestock data deserve mention for two reasons. First, the Kaputiei livestock trends in this chapter are based on livestock censuses done by various persons over an 11 year period. It is, therefore, important to show the degree of reliability of these data.

Secondly, a brief evaluation of the possible sources of variation and the level of accuracy of the data may provide hepful insights into the development of future information gathering for similiar development projects.

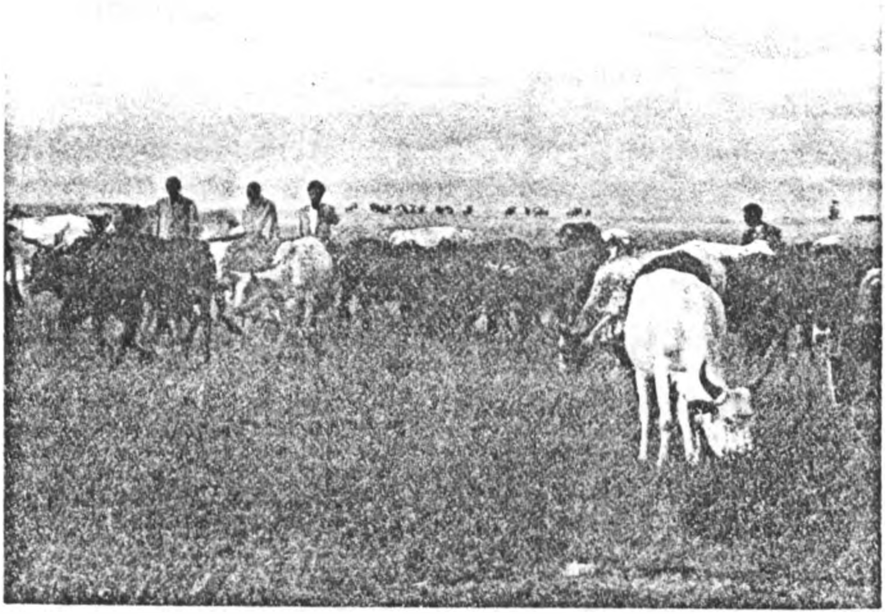


Figure 24 - Livestock census in Olkinos group ranch. The coopera-
tion of group ranch committee members made possible
the identification of herd and flock breakdown according
to their owners

Analysis of the Government livestock census in 1977 (hereafter, referred to as the first census) and my livestock census about six months later in 1977 (hereafter, referred to as the second census) reveal close agreement in most ranches. (Table 20).

One major factor accounting for the discrepancies on some ranches between first and second censuses is the semi-nomadic behavior among the group ranch participants. For example, in Meruishi ranch, the decrease of cattle and small ruminant population in the second census may be accounted for on two possible grounds. First, during the first census, most of Meruishi members had returned to their group ranch after three years of severe drought. However, after the first wet season of 1977, some members realized that the rangeland would not recover quickly enough to support all their cattle and small ruminants so they left. It is also likely that boreholes were not repaired in time to meet the dry season requirements between first and second census, thereby forcing some families to evacuate from the ranch with their livestock.

Second, differences in the two censuses for Meruishi and other ranches may be due to a slight difference in the methods used. Although, the methods of enumerating livestock in the two censuses were the same, the Government Census was carried out to update the livestock resources among members of each group ranch regardless of the geographical location of the members of the time of the census. Non-resident members and their livestock resources were counted with the livestock resources of resident members. However, in my census,

Table 20

The Variations of Livestock Numbers per Ranch and per Household in 1977 Using the Government 1977 and Theuri's 1977 Data

	Households			Cattle				Sheep & Goats			
	Govt. 1977	Theuri[1] 1977	T-R	Govt. 1977	Per HSH	Theuri 1977	Per HSH	Govt. 1977	Per HSH	Theuri 1977	Per HSH
Arroi	73	64	9	2619	36	1962	31	3981	55	4593	72
Embolioi	150	164	+14	2072	14	-	-	8660	58	-	-
Emarti	78	46	-32	1224	16	1240	17	3508	45	4168	91
Empuyankat	77	58	-19	1974	26	1921	31	8251	107	8315	143
Erankau	47	54	+7	1319	28	1027	19	3987	85	4679	87
Ilmamen	70	63	-7	1055	15	1139	18	3303	56	4663	74
Kiboko	48	47	-1	1912	40	1907	41	9147	63	4439	94
Mashuru	224	174	-50	3818	17	-	-	3134	41	-	-
Mbilin	52	68	+16	2317	46	2315	34	4383	60	4092	60
Mbuko	72	82	+10	2846	40	2224	27	2224	61	5922	72
Meruishi	50	23	-27	2373	48	964	27	4047	81	2465	107
Nkama	-	156	-156	-	-	3233		-	-	5914	38
Olkarkar	45	43	-2	1758	39	1757	41	2349	52	2711	63
Olkinos	68	71	+3	1034	15	1490	21	4556	67	5922	83
Poka	30	36	+6	1581	53	1885	52	2378	79	4379	97

[1](T-R) represents the differences between second cnesus taken by the author and the first census taken by Range Management Staff

[2]HSH - Household

I counted the livestock resources of resident members only. This explains why the livestock resources for a Meruishi household are fairly comparable in the two censuses although the overall livestock numbers differ by about 60 percent. (Table 20).

Another aspect of the variations due to semi-normadic movements is illustrated by Mbuko ranch. Migrations are mostly restricted to cattle and not people. The Masai split their herds into two or more groups. While retaining only a fraction of the original herd and small ruminants at the ranch, the others are herded many miles away from human settlements. It is possible therefore that during the period between the first and second censuses, households with large herds split their herds and retained only a portion of the cattle population, while people and small ruminants stayed behind. This factor of migrating herds and settled human population accounts for the discrepancy in Mbuko cattle population between the first and second census.

In other cases like Olkinos and Poka ranches in which the cattle increased in the second census, the extra cattle probably resulted from regrouping of undeclared scattered herds at the time of the first census, or as a result of the influx of members with many cattle after the end of the recent drought. Unlike most Kaputiei ranches, Olkinos and Poka have good to excellent range conditions (refer to Chapter 5).

By comparing the discrepancy between resources per household in the two censuses, another factor related to the definition of what constituted a household in the two censuses becomes important. Differences in the number of households due to differences in the definitions should not alter the overall total livestock resources in each ranch. This case is exemplified by Mbilin group ranch where the number of households are different in the two censuses while the total number of cattle remain constant. In the first census, households were defined according to the list of registered members. In the second census, a household constituted a married, economically independent male and his dependants. Only in very rare cases were heads of families females. The definition of a household in the second censuses includes non-registered households which had not yet been officially incorporated into the ranch register, and the total number of households therefore tend to be relatively higher in the second census.

Finally, the season of the census affects the total population of livestock. The six to seven month period between first and second census was enough to show the effect of the natural increase of the small ruminants. The rate of increase of sheep and goats is highest in those ranches like Kiboko, and Poka which were the last ones to be surveyed in the second census. (Table 20).

It is important to stress the circumstances which give high reliability to the Government data. After every census, the members of each group ranch would meet with the Range Management team and an AFC representative in charge of loan advancement. In this meeting the livestock holdings of each family would be read out before everybody to make sure that the loan advanced to each ranch was shared in proportion to the livestock resources of each household. In such circumstances, there is an incentive on all parties involved to give accurate information regarding the livestock resources because of loan repayment obligations.

OBSERVED VARIATIONS IN KAPUTIEI LIVESTOCK NUMBERS

Variations in Cattle Numbers

The chronological variations of cattle herds in Kaputiei ranches are shown in Table 21. Cattle population increased between 1968 and 1974 on all ranches except Olkinos , Eight group ranches censused in 1972 (shown on Table 21) indicate that cattle numbers had increased from a total of 24,749 in 1968 to a total of 36,152 in 1972, representing an overall increase of 46 percent.

In three south Kaputiei ranches (Kiboko, Mbilin and Olkarkar) livestock census in 1974 exhibit the same upward trend of cattle populations in Kaputiei. The cattle population in these ranches increased from 9,638 in 1968 to 19,681 in 1974, an increase of 104 percent. Appendix 3 gives an analysis of the variations of cattle numbers on individual Kaputiei group ranches in 1977.

The cattle population in Kaputiei after the 1976 drought was 31,135 heads according to the 1977 Government census. The total number of cattle casualties reported by interviewed livestock owners during the census in 1977 amounted to 91,830 heads. If we assume that the predrought herd contained the reported drought losses and the 1977 cattle holdings, the cattle mortality in Kaputiei during the 1976 drought averaged 75 percent. (Figure 24a).

Table 21

Cattle Numbers on Kaputiei Group Ranches 1968-1977

Government Census										Theuris Census	Percentage Change in Cattle Population (1968 as a baseline		
									GVT				
Group Ranch	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1977	1968	1972	1977*
Arroi	2,727		5,627							2,619	1,962	100	206(1970)	71.9
Embolioi	3,294				4,636			5,240		2,072		100	141	62.9
Emarti	1,376				3,426					1,224	1,240	100	249.0	90.1
Empuankat	3,696				3,867	3,078	2,286			1,974	1,821	100	104.6	49.3
Erankau	1,528				2,851					1,319	1,027	100	186.6	67.2
Ilmamen	1,943		3,639	2,595	3,190	Aug. 3,620	June 2,803			1,055	1,139	100	164.2	58.6
Kiboko	3,475			Nov. 5,263	July 5,307		May 7,208			1,912	1,907	100	152.7	54.9
Mashuru	5,827				Apr. 10,690					3,818		100	183.5	65.5
Mbilini	2,735		July 2,954			March 6,848	March 6,580	26/11 3,925	April 6,395	2,317	2,317	100	250.3(1973)	84.6
Mbuko	5,502		9,335							2,846	2,224	100	170(1971)	40.4
Meruishi	3,480					March 6,415				2,373	964	100	184.3(1973)	27.7
Nkama	8,489			July 13,282		March 16,874			6,444		3,233	100	307.3(1973)	58.9
Olkarkar	3,428		Sept. 3,378	Dec. 5,851			May 5,893			1,758	1,757	100	170.3(1973)	51.3
Olkinos	3,610				2,185					1,034	1,490	100	60.5	41.3
Poka	2,847	8/11 3,040	May 3,589 Oct. - 4,159							1,581	1,885	100		66.2

*1977 Government Data Used

March 1977

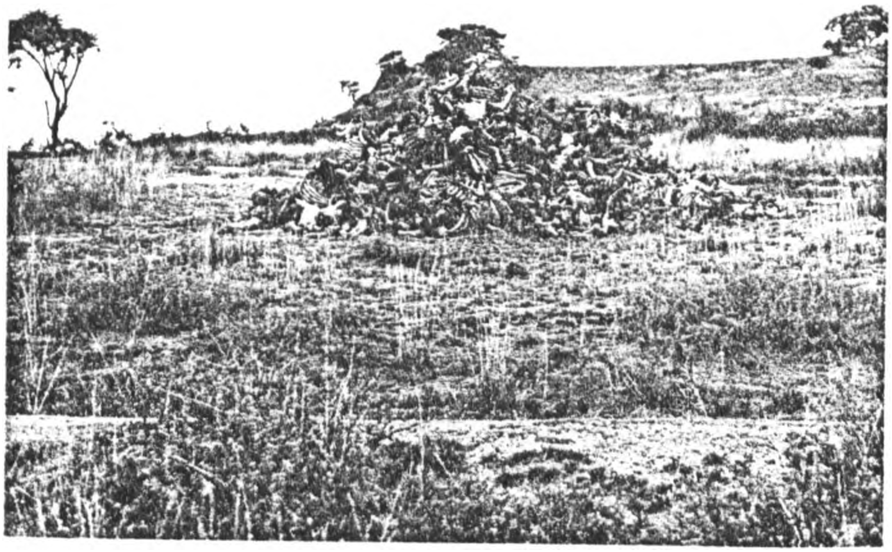


Figure 24a - Drought losses of cattle in Kaputiei ranches averaged between 70-75 percent of pre-drought cattle numbers. it was a common sight to find heaps of bones near kraal camps in 1976/77. The bones were being collected and sold to Nairobi for the production of bone meal feeds.

By using the latest cattle census of Mbilin herd, (Table 21), the ratio of post drought herd of 2317 in 1977 and a predrought herd of 6395 in 1976 show that approximately 36 percent of 1976 herd survived, and cattle mortality was 64 percent. However, Mbilin households reconed their losses at around 84 percent. This latter estimate is 20 percent higher than the one from actual cattle censuses. Apart from the likelihood that some members may have exaggerated their losses, it is also probably that household livestock losses include all drought-related mortality losses since the drought conditions started in 1973.

The drought losses compiled from estimates by Kaputiei households in 1977 indicate significant differences between southern Kaputiei rangelands in Ecological Zone V and north and central Kaputiei rangelands in Ecological Zone IV. An average household in north or central Kaputiei areas sustained a drought loss of 86 cattle, while a household in south Kaputiei area lost an average of 166 cattle. In Ilmamen ranch in central Kaputiei, 32 percent of the members (N=63) did not lose any cattle, and only 33 percent of the households lost more than 40 heads. In Mbilin ranch in the south, 6 percent of the members (N=68) lost no cattle while 78 percent of the households sustained a loss of more than 40 percent of the households sustained a loss of more than 40 heads. These differences show that the severity of cattle losses in Kaputiei was not uniform across the group ranches or even among the members in each group ranch.

The variation of cattle losses between 1974 and 1976 as calculated from the ratio of 1977 post-drought herds and the latest predrought cattle censuses, indicate that the southern ranches in

Ecological Zone V sustained a cattle loss of 70 percent; and the central and northern Kaputiei herds averaged a loss of less than 50 percent. These mortality levels estimated from actual censuses collaborate the losses claimed by Kaputiei households. Appendix 4 shows the variations of cattle losses in individual Kaputiei group ranches.

Variations in Sheep and Goat Populations

The chronological changes in the small ruminant population across Kaputiei are shown in Table 22. The number of small ruminants increased from 1968 to 1972 by a factor of 1.93 in eight selected group ranches (Figure 24b.) This trend of population increase among small ruminant probably continued through the recent drought. For example in these eight selected ranches, the small ruminant population in 1968 had multiplied by a factor of 2.63 by 1977 livestock census.

Although the sheep and goat censuses are limited to only a few years as shown on Table 22, the behavior of sheep and goat populations in Ilmamen group ranch which has more census than other ranches, confirms the pattern of small ruminant population increases as illustrated by Figure 24c(i). The sheep and goat population in Ilmamen increased steeply in the first three years and then remained fairly steady between 1970 and 1972. However, after 1972, the population increased steeply again probably until 1974.

The sudden rise in sheep and goat numbers concides with the period of inadequate rainfall. It also coincides with the rapid

Table 24

Trends in Sheep and Goat Population in Kaputiei Ranches

	Government Census									Theuris Census	Percentage of 1968 Sheep and Goat Populations in Kaputiei Group Ranches 1972/77		
Ranch	1968	1969	1970	1971	1972	1973	1974	1975	1977	1977	1968	1972	1977
Arroi	1,845		1,850						3,981	4,593	100%	136%(1970)	293%
Embolioi	2,675				5,705				8,660	-	100%	213%(1972)	324%
Emarti	610				2,680				3,508	4,168	100%	439%(1972)	575%
Empuyankat	3,323				5,246	7,476	7,496		8,251	8,315	100%	158%(1972)	248%
Erankau	1,655				3,493				3,987	4,679	100%	151%(1972	241%
Ilmamen	2,033		3,325	3,522	3,494	4,039	4,757		3,897	4,663	100%	172%(1972	192%
Kiboko	818			1,618	1,655				3,033	4,439	100%	202%(1972)	271%
Mashuru	3,184				8,336				9,147	-	100%	396%(1972)	287%
Mbilin	734		1,778			2,471			3,134	4,092	100%	337%(1973)	427%
Mbuko	2,036		4,406						4,383	5,922	100%	216%(1971)	215%
Meruishi	1,280					3,263			4,047	2,465	100%	255%(1973)	316%
Nkama	3,622			6,220		7,406		11,082	8,120	5,914	100%	204%(1973)	224%
Olkarkar									2,349	2,711	100%	-	
Olkinos	2,836				2,486				4,556	5,922	100%	88%(1972)	161%
Poka	958								2,378	3,479	100%	-	248%

Figure 24b

The Trend of Increasing Small Ruminant Population in Eight Kaputiei Group Ranches Since 1968

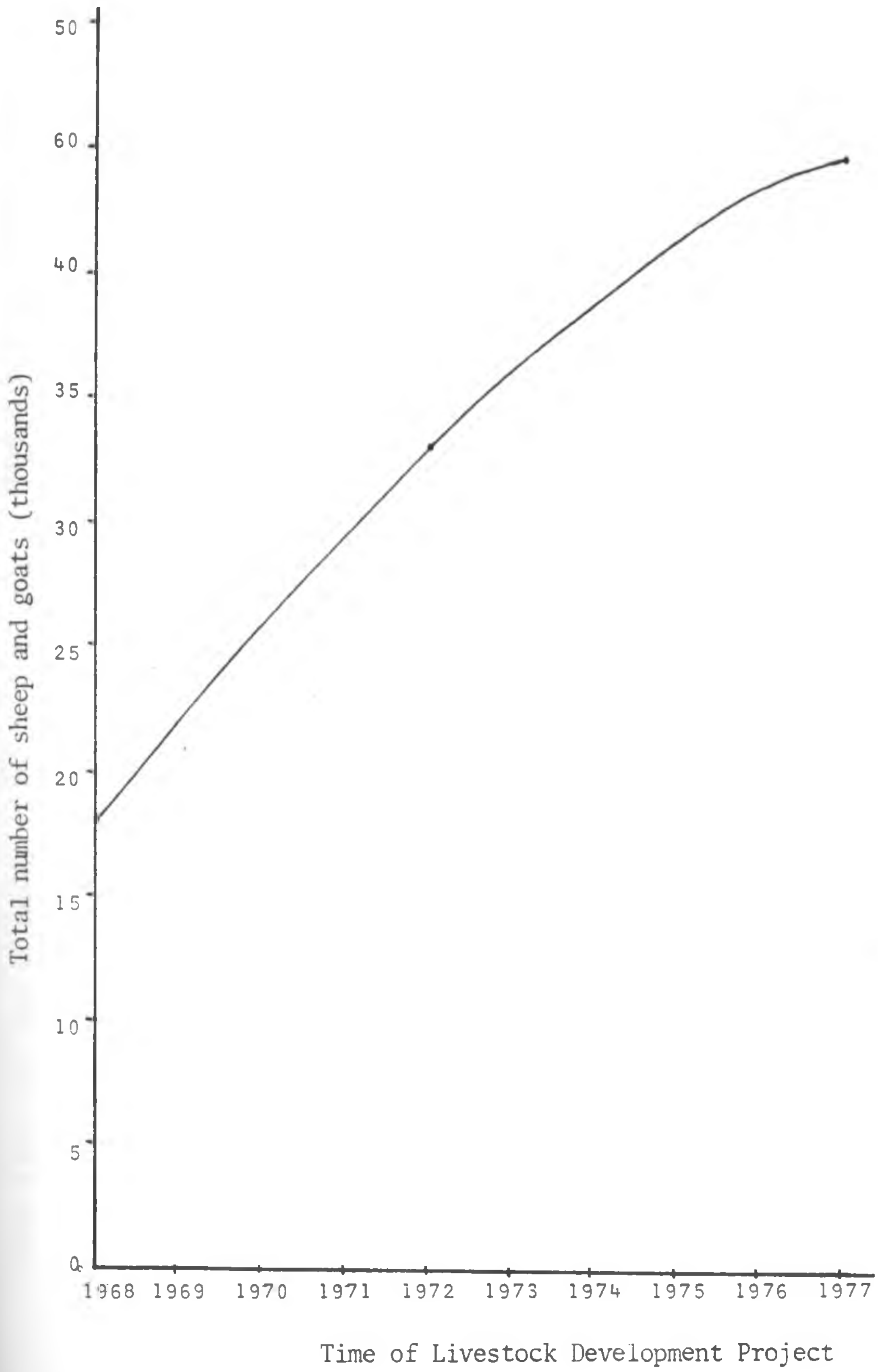
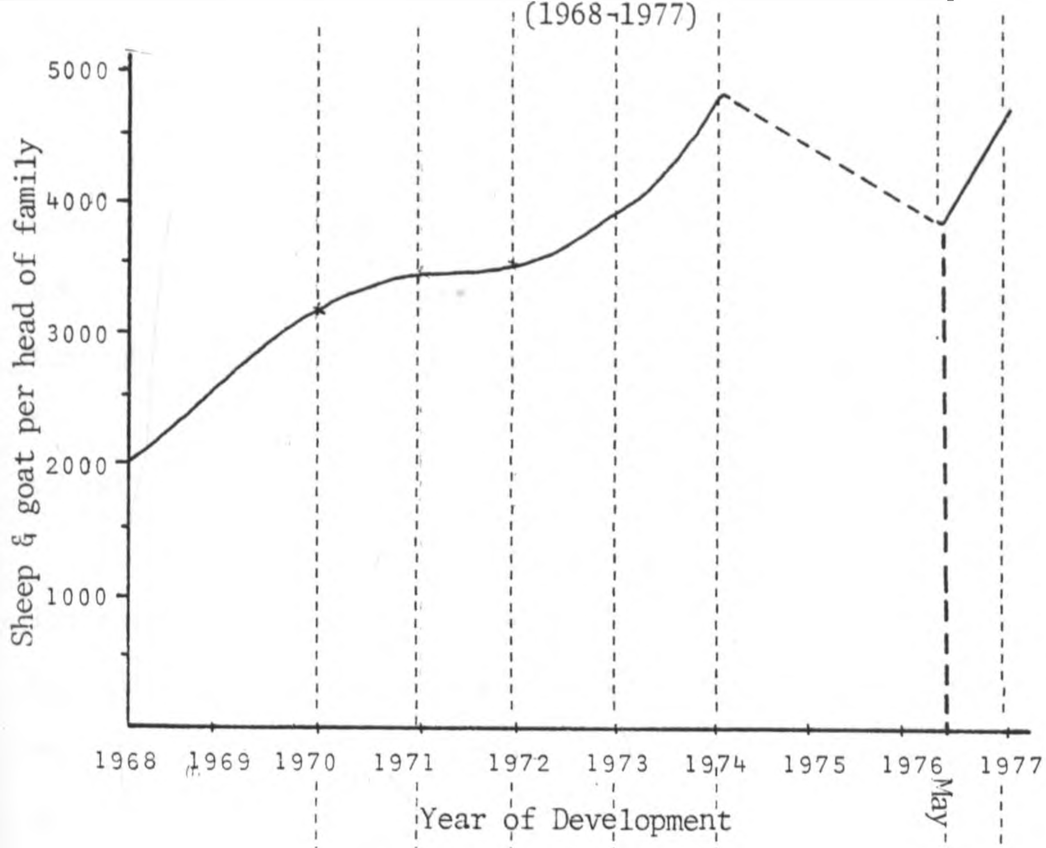


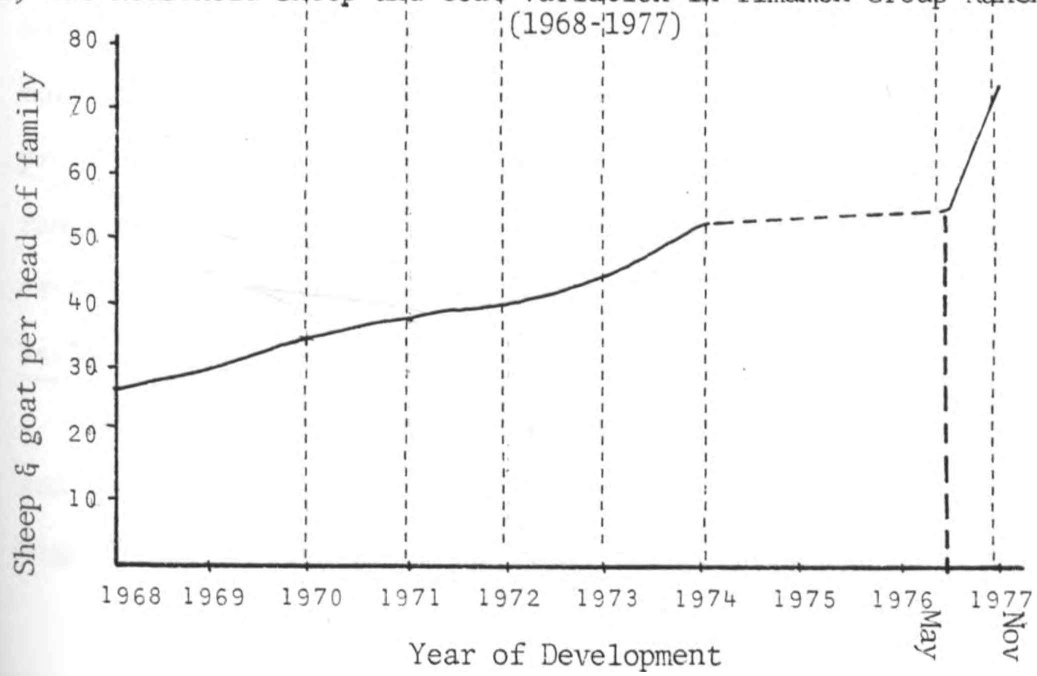
Figure 24c

The Relationship Between the Total Sheep and Goats in the Ilmanen Ranch and the per Household Flock Size During Development (1968-1977)

(i) The Trend of Sheep and Goat Population in Ilmamen Group Ranch (1968-1977)



(ii) Pre Household Sheep and Goat Variation in Ilmamen Group Ranch (1968-1977)



increase of cattle population particularly in the southern ranches.

The comparison of the total flock and the per household flock size in Ilmamen suggests that the sheep and goat population did not undergo heavy changes through the drought (Fig 24c(ii). The rate of increase however was checked through some light mortalities and probably through sudden increase in the offtake rates to meet the subsistence needs for the family during the drought. Appendix 5 shows the variations of small ruminants in 1977 among Kaputiei ranches.

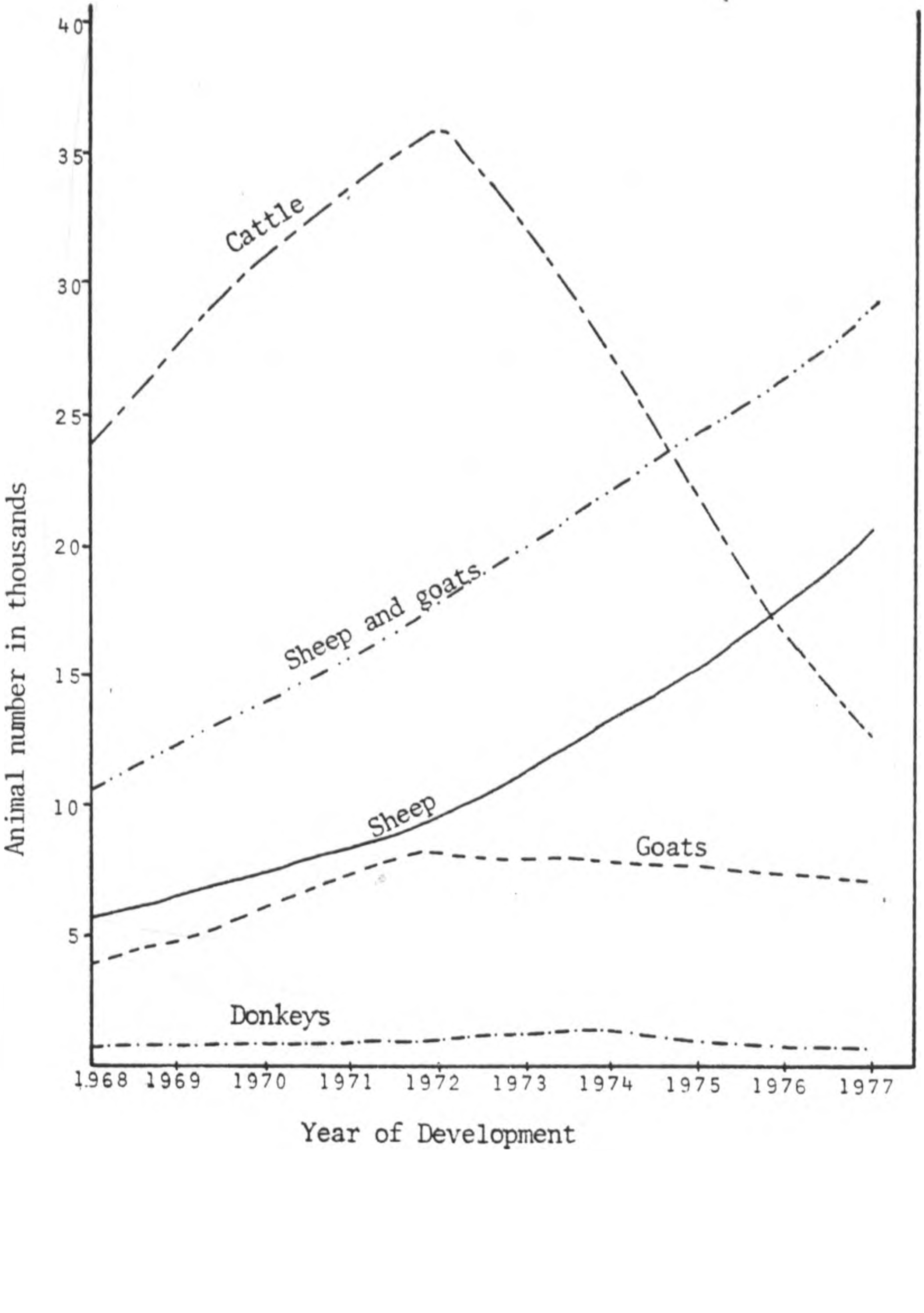
The sheep and goat losses during the same period of cattle losses discussed above, are shown in Appendix 6. An average household in Kaputiei claimed a loss of 62 sheep and goats through the recent drought. The mortality levels of the small ruminants averaged 36 percent in north and central Kaputiei area, and 50 percent in the southern area. This differential mortality level across Kaputiei ranches suggest that, although there has been a steady increase in the population of small ruminants since 1968, the drought mortality toll as claimed by the Kaputiei members maybe linked with progressive range deterioration. It was shown in Chapter 5 that the range condition is ralatively poorer in the south than in either central or north Kaputiei regions.

Variations in Livestock Mix

The relationship between the proportions of cattle, sheep, goats and donkeys between 1968 and 1977 are shown in Figure 25. Significant variations in the relative mix among the first three

Figure 25

The Relative Mix of Livestock Species in Kaputiei



species occurred during the operation of Kaputiei livestock development project between 1968 and 1977. The proportion of the total stock units contributed by the small ruminants (sheep and goats) in Kaputiei has increased from 13 ± 6 percent in 1968 to 41 ± 10 percent in 1977. (Table 25). In general south Kaputiei ranches in drier ecological Zone V carry a relatively lower proportion of small ruminants to the total stock units than north and central Kaputiei ranches in Ecological Zone IV.

One reason underlying this difference in the proportions of small ruminants may be related to the ecological limitations for cattle production under these two ecological zones. Livestock census by the Wildlife Management Project in 1976 showed one important cattle habitat difference under the two ecological zones (Table 26). During the dry season, cattle migrated from south Kaputiei for better pastures elsewhere, while in the remaining Kaputiei areas the difference between wet and dry cattle population show that cattle movements are less frequent. In south Kaputiei, until the recent trend toward settling of Masai within the group ranches, the emphasis on small ruminants which cannot migrate with large herbivores would have been antagonistic to cattle mobility in a relatively more arid environment.

Another factor which accounts for variations in the mix of cattle and small ruminants may also be related to differences in habitat requirements for both cattle and small ruminants. The general degradation of rangelands in Kaputiei was documented in the

Table 25

The Proportions of Sheep and Goat Population in Kaputiei Ranches in Relation to the Total [1]Stock Units 1968-1977

	Percentage of Small Ruminants to Total Stock Units for Year of Census	
	1968	1977
NORTH & CENTRAL KAPUTIEI RANCHES		
Olkinos		51%
Empuyankat	19%	54%
Emarti	10%	52%
Embolioi	16%	53%
Arroi	16%	37%
Erañkan	24%	53%
Ilmamen	22%	54%
Mashuru	13%	36%
Nkama	12%	33%
SOUTH KAPUTIEI RANCHES		
Kiboko	6%	38%
Mbilin	7%	30%
Mbuko	9%	35%
Meruishi	8%	33%
Olkarkar	-	29%
Poka	9%	30%
[2]Total Kaputiei Ranches n=13 ranches	13 ± 6%	41 ± 10%

[1]Stock Unit: as calculated in the Preinvestment Study in 1969.

[2]Olkinos and Olkarlar excluded in Kaputiei averages.

Table 26

Seasonal Changes of Livestock Biomass in North and South Kaputiei[1]

Proportion of Total Biomass $\Sigma \bar{X}i^2$	Athi-Kapiti (IV)		South Kaputiei (V)	
	Dry Aug.1976	Wet May 1976	Dry Sept. 1976	Wet April 1976
Cattle	766	789	714	1800
Sheep - Goats	1986	2072	477	565

[1]The data are summarized from Wildlife Management Project - Aerial Census in 1976. (Harvey, Croze 1978-personal communication)

[2] $\Sigma \bar{X}i$ = sum of the average kg/hectare for every occupied unit area (5X5 km^2 ?) at the time of aerial survey.

vegetation trend in Chapter 5. Probably as the cattle population increased from 1968 to 1974, the quality of cattle habitat diminished. The small ruminants are more hardy in a degraded cattle habitat and also during the time of drought.

This seems to have been the case during 1973-1976 period. While cattle sustained very high mortality through starvation, the small ruminant population sustained lower mortality levels and even increased overall during the drought conditions (Figure 25). The decrease in the rate of increase among small ruminants is probably related to both drought and higher offtake rates during the drought period to meet the needs of settled human population (see Kajiado hides and skins data on Figure 27).

The variations in the small ruminant population shown on Figure 25, indicate that the increase can be explained by the changes in sheep population alone. During the livestock development project, the total goat population in the ranches remained constant. However, the sheep population increased by factors of 1.96 and 3.25 by 1972 and 1977 respectively.

Why has the goat population remained stable while the sheep population has been rapidly increasing? Sheep and goats are herded together and almost all households possess both sheep and goats. One of the likely explanations comes from the process in sheep breeding programs in Kiboko Range Research Station in south Kaputiei, and Isinya Mission Demonstration Ranch in the north Kaputiei area. The Masai have noticed the superior performance of the crosses between their indigineous Masai-Red Head females with the Persian-Black Head rams, brought from Kiboko and Isinya. The demand for these rams is high and the proportion of the crosses in the sheep flock is increasing, Similar goat improvement programs do not exist.

Apart from the chronological variation of the relative mix of sheep and goats in Kaputiei, variation of the proportions of goats and sheep in Kaputiei ranches illustrate some degree of habitat preference of these species (Table 27). North Kaputiei ranches with low proportions of browse vegetation show relatively low proportion of goats in the flock; while some central Kaputiei ranches with high proportions of wooded grassland vegetation possess relatively higher proportion of goats in the flock.

Some Kaputiei group ranches possess donkeys, and their importance varies from ranch to ranch. Donkeys have almost disappeared in Kiboko, Empuyankat, Erankau and Olkinos, and completely disappeared in Ilmamen, and Poka ranches.

Donkeys have always been relatively unimportant in terms of exerting grazing pressure on the Kaputiei rangelands because the populations are low, 437 animals or less than 1 percent of the current total stock units.

Donkeys are beasts of burden and were very useful in transportation when semi-nomadic movements were frequent. Even today in areas of poor communication, these animals are used to draw water and to transport food from retail shops to settlement areas. Many families

Table 27

The Relative Mix of Goats to Sheep in Kaputiei Ranches in Relation to the Dominant Vegetation Types (1968 and 1977)

(Physiognomic Characteristics of Each Group Ranch)

Group Ranch	Physiognomic* Characteristics: Porportion of Bush and Woodland of Total Area	Goat/Sheep** Ratios 1968	Goat/Sheep** Ratios 1977
A. Grassland Ranches (North Kaputiei)			
***Embolioi	0%	0.45	-
Empuyankat	17%	0.57	0.16
Olkinos	0%	0.79	0.26
B. Bushland Ranches (South Kaputiei)			
Poka	33%	1.73	0.52
***Olkarkar	37%	-	0.77
Kiboko	41%	1.69	0.56
Mbilin	50%	1.75	0.36
Meruish	50%	1.58	0.61
Mbuko	88%	1.75	0.59
C. Woodland Ranches (Central Kaputiei)			
Emarti	43%	1.23	0.44
Arroi	69%	2.84	0.55
***Mashuru	74%	2.15	-
Nkama	75%	2.31	0.86
Erankau	90%	0.94	0.40
Ilmamen	90%	1.21	0.57
D Kaputiei (N=12)		153.3 + 0.18	0.49 ± 0.18

*From Pre-investment Survey (1969)
** Using 1968 and 1977 population
*** Ratio excluded in Kaputiei average

have no donkey power and even those who own a donkey do not take it as a compliment when asked to divulge the correct number of donkeys. In many situations donkeys were assigned to a camp when nobody would claim them in the settlement. There was an average of 1 donkey to a boma in 1977.

INFERENCES FROM OBSERVED LIVESTOCK TRENDS (1968-1977)

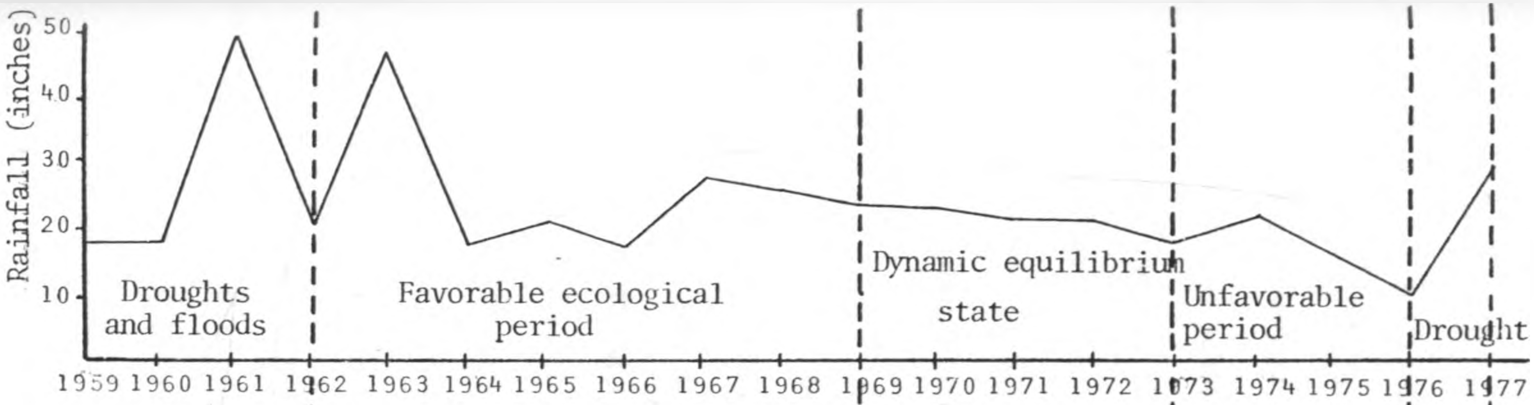
Variations of Cattle Numbers in Kaputiei Surroundings (1968-1977)

Unusually favorable climatic periods should lead to cattle increases, not only in Kaputiei ranches, but also in the surrounding Masai country. Figure 26 represents the behavior of cattle population in Kajiado district, in which Kaputiei is located. The livestock population figures in Kajiado district are taken from Western's summary (1973) for the period between 1960 and 1969. Western compiled this summary from the works of Prole (1962), Spinks (1964) Aldington and Wilson (1967), and Watson (1969).

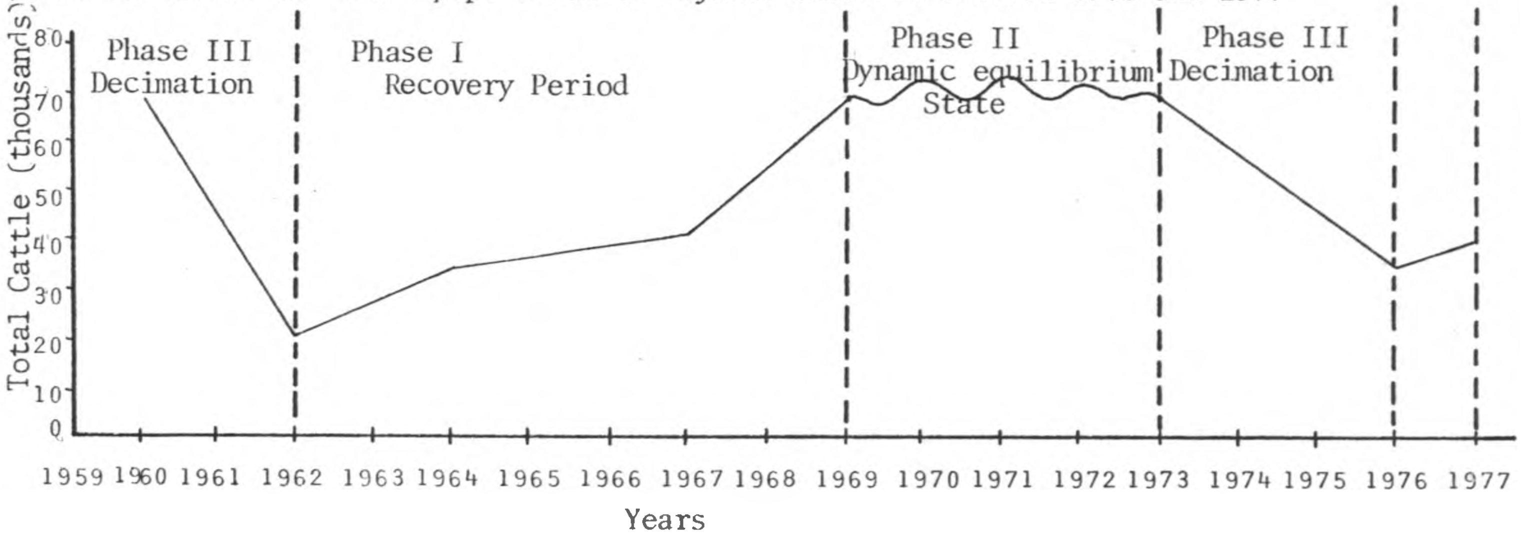
Watson's data comes from Aerial Livestock Survey of Kajiado district. Prole and Spinks derived their estimates from the veterinary vaccination records. The ratio of vaccinated animals to non-vaccinated animals were used to estimate the cattle population in the district. As Western correctly points out, such estimates could be fairly inaccurate because the proportion of vaccinated animals each year change according to the degree of risk that epidemic diseases will break in various localities of the district.

The livestock figures of 1973, 1976, and 1977 come from Kajiado district aerial censuses by the Wildlife management Project and

(i) The pattern of total annual rainfall records in inches at Joyce Farm near Konza



(ii) The variation of cattle population in Kajiado district between 1960 and 1977



Kenya Rangeland Ecological Monitoring Unit. In spite of some possible errors in estimation of livestock numbers by different methods, and by different people, cattle population in Kajiado, illustrates probable trends of cattle populations between two major consequtive droughts in 1960 and 1976. (Figure 26).

The cyclic behavior of the cattle population may be divided into three phases. Phase one, representing the sigmoid recovery period of cattle population in Kajiado district, lasted for nearly 8 years between 1962 and 1969. The recovery rate was characterized by a lag period between 1962 and 1967 of slow population growth, followed by a rapid increase of cattle population by 1969. The cattle population estimates just before the 1960 drought and in 1969 probably indicate the cattle carrying capacity of Kajiado district.

In phase two, the livestock population in Kajiado oscillated around the carrying capacity between 1969 and 1973. During this period the volume of hides and skins passing through the hands of licensed dealers did not deviate notably from the previous levels between 1962 and 1969 (Figure 27).

Phase three in the livestock cycle in Kajiado district represents the decimation period between 1973 and 1976. The phase was triggered by drought conditions during this period.

The cyclic behavior of cattle population in Kajiado district leads to the following observations:

(1) That cattle population in Kaputiei between 1960 and 1968 most probably followed the same pattern observed in Kajiado district.

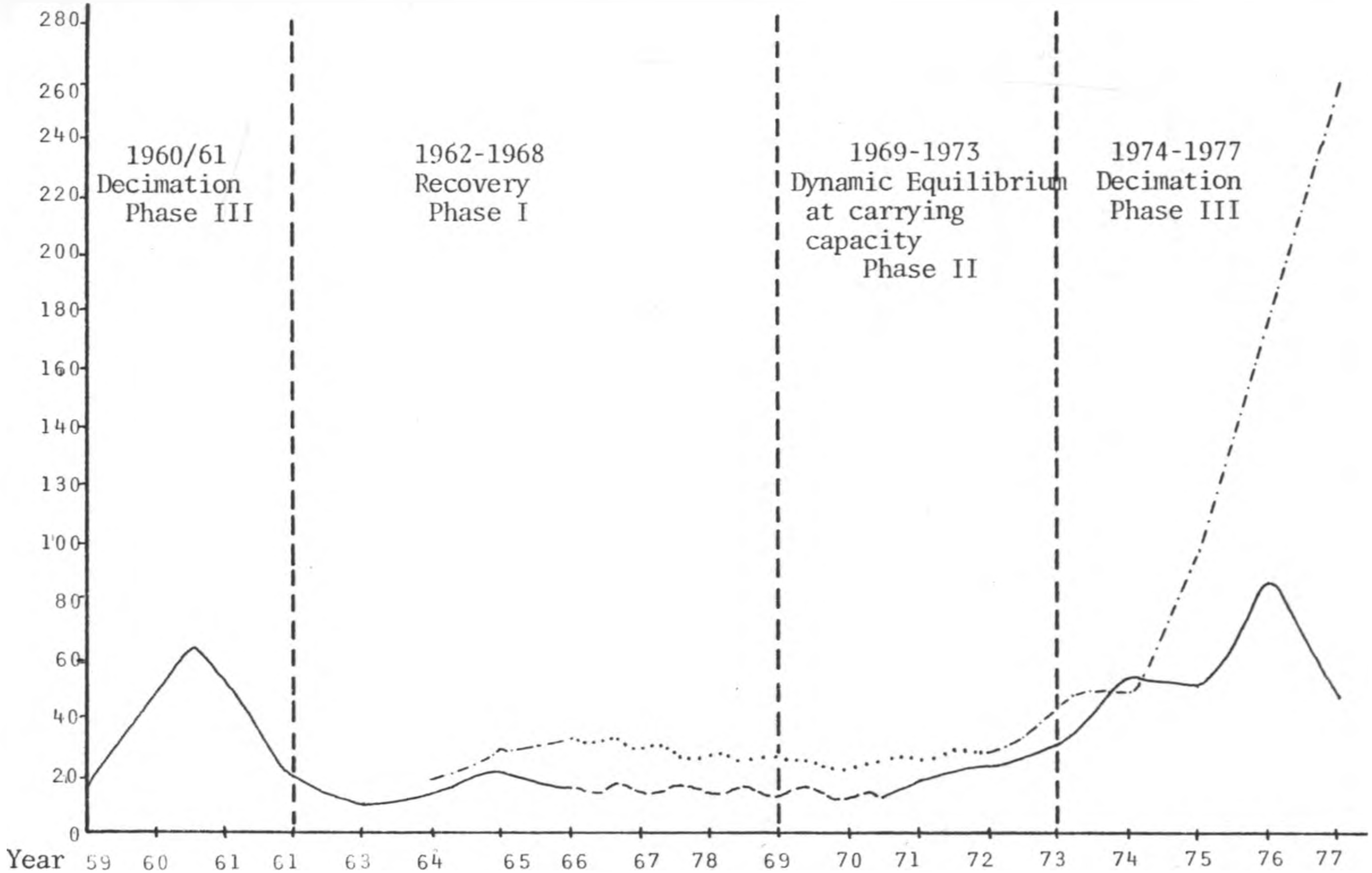


Figure 27

Trends in Livestock Offtake Rates - Using Hides and Skins Statistics from Kajiado Hides and Skins Report

(2) Without range development inputs between 1968 and 1974, the cattle population in Kaputiei would have remained at more or less the same level of the surrounding areas. This suggests that the livestock census in 1967 probably indicates a cattle population approximately near the grazing capacity of Kaputiei.

(3) The cattle decimation phase in Kajiado is also reflected in Kaputiei cattle variations. Hence the cattle population crush in Kaputiei cannot entirely be attributed to range development inputs.

(4) On the basis of lack of corresponding cattle population increase around Kaputiei between 1968 and 1974; and the metereological records of declining annual precipitation during this period (Figure 26), the livestock population increase in Kaputiei ranches is not due to unusually favorable ecological period between 1968 and 1974.

Causes of Livestock Increase in Kaputiei

One factor which might account for the unusual increase of livestock numbers in Kaputiei after 1968 is an influx of livestock from surrounding areas to take advantage of concentrated range improvement facilities. The correspondence in group ranch files indicates many incidences of illegal grazings from adjacent sections like Ilkisongo. There are also cases of unidentified trespassers whose origin may be from other non-Kaputiei areas, or who are nomadic members from other group ranches in Kaputiei. However, there are no estimates in any census which recorded livestock numbers belonging to non-members of Kaputiei ranches. Therefore, the chronological herd records of the 15 ranches in Table 21 probably represent only those animals belonging to identifiable registered participants of the group ranching organizations.

The most plausible cause of the rapid increase of cattle numbers in Kaputiei is linked with the response of livestock to alleviate ecological constraints by the range development inputs between 1968 and 1974. The range inputs stimulated livestock increase in two ways: extensive utilization of rangeland; intensive livestock management practices.

Between 1968 and 1974, new boreholes were drilled, old boreholes were renovated and fitted with better pumps; more water connections to the railway water pipeline were made in south Kaputiei ranches. The bulk of correspondence in the group ranch files rather to implementation of the proposed water development. By 1974, the water development plan in Kaputiei ranches more than doubled the 1968 water facilities.

The effects of more watering facilities dited strategically so as to diffuse grazing pressure over virgin rangeland stimulated the rapid increase of livestock in Kaputiei between 1968 and 1974. In areas where tse tse fly infested rangelands were unutilized by livestock, the use of proyhylactic drugs such as Berenil, in conjunction with water development in these areas, increased the carrying capacity of Kaputiei section by reclamation of new rangelands.

In addition to opening up new rangelands through water development and prophylactic drugs, there were real improvements in livestock management standards in Kaputiei ranches. Cattle were dipped regularly to control tick borne diseases (Figure 28). Vaccination programs and actual disease treatments increased between 1968 and 1974. Perhaps the best indicator of herd management standards is the proportion of suckling calves to mature cows. This proportion is expressed in a percent calving rate. The calving rates in Ilmamen and Mbilin group ranches and in adjacent commercial ranch in Table indicate important trends. The calving rates increased in Mbilin ranch from 38.4 percent in 1968 to 71.5 percent in 1974. The decrease in the population of calves to mature cows in Ilmamen in 1972 is probably due to the combination of poor management and drought conditions. The sharp decrease in calving rates after 1974 in Kaputiei ranches is a result of a drought condition which lasted from 1973 to 1976.

The calving rates in most of the group ranches in south Kaputiei approached the standard of calving rates in Joyce Commercial ranch. (Table 28).

Preinvestment study in 1967 estimated the calf mortality losses of approximately 10 percent in Poka ranch. Cameron (1970) carried out a study of the conception rates in 8 herds of Poka group ranch

Figure 28 - July 1977 - Kaputiei Masai are using modern herd management practices such as hand-spray for tick-control. The correlation between large family herds and families staying alone is likely to be the result of selective adoption of modern livestock management practices. (See Figure 39 and 40 in Chapter 7 pages 240 and 241).

Table 28

Variations in *Calving Rates in Two Kaputiei Group Ranches and Joyce Commercial Ranch Near Kaputiei

Year of Livestock Development Project	Ilmamen Group Ranch	Mbilin Group Ranch	Joyce Commer-cial Ranch
1968	55.6%	38.4%	
1970	68.0%	73.1%	
1971			
1972	46.0%		79%
1973	43.8%	68.4%	
1974	59.8%	71.5%	78%
1975		47.9%	84%
1976		44.2%	
**1977	23.9%	26.1%	
Average Sample Size (Number of cows)	1088 ± 502	1947 ± 129	504 ± 60.

*Calving rates are calculated as percentage of calves to mature cows in the herd at the time of census.

**Government census data used.

members. The study indicated a conception rate of 65.6 percent (N=204) in Poka herds between June 1969 and June 1970. The livestock census of 1969 in Poka indicated that the proportion of calves to mature cows was 55.8 percent. It can be inferred therefore, that the decrease between herd fertility of 65.6 percent and annual calving rate of 55.8 percent, represents a calf mortality loss of about 10 percent from stillbirths and disease. Hence any increase in the proportion of calves during the livestock development period can be linked with the lowering of calving mortality and improvement of conception rate. These improvements are only possible where high herd management standards are maintained. For example, in the Joyce Commercial ranch the conception rate approximates the calving rate which average 80 percent, because the total calf mortality averages less than 4 percent per year.

A comparison of commercial calf mortality level in Joyce with ranch estimated calf losses in Kaputiei ranches as of 1968 is shown on Table 29. The high calf mortality levels in Kaputiei group ranches prior to range development inputs, suggest that improved herd management standards in some ranches such as Mbilin between 1968 and 1974 resulted in lower calf-mortality losses and therefore higher calving rates in Kaputiei herds. Relatively high calving rates after 1968 led to cattle population growth in Kaputiei.

Table 29

*Calf Mortality Percentages in Kaputiei Ranches as Estimated in 1968

Group Ranch	Percentage Calf Mortality in 1968
Empuyankat	8.7%
Olkinos	22.8%
Emarti	22.7%
Erankau	13.4%
Arroi	18.7%
Nkama	27.8%
Kiboko	23.6%
Olkarkar	23.0%
Mbuko	19.7%
Meruishi	20.1%
Poka	10.0%
Kaputiei Average n=11 ranches	19.1 ± 6.0%
**Joyce Commercial Ranch n=4 years	3.4 ± 0.3%

*Calf Mortality: adapted from Pre-Investment Study - percentage of calves succumbing to diseases (as reported by herd owners in Kaputiei) to the total birth of calves in that year.

**Joyce Commercial Ranch: Calf mortality due to disease from 1972 to 1975. Taken from the ranch farm records.

EFFECTIVENESS OF INTRODUCED RANGE MANAGEMENT PRACTICES

Herd Structure

The transition from subsistence pastoralism into commercially-oriented enterprise entails the alteration of the proportions of various classes of cattle in the herd. The trend of changes in herd structures is therefore an appropriate indicator of the performance of Kaputiei Livestock Development Model.

The herd structures of Ilmamen and Mbilin group ranches are shown on Table 29. These two ranches are chosen because they have fairly complete livestock censuses. The herd structures of Kaputiei ranches reflect the prevailing ecological conditions. The proprotion of cows in Mbilin herds for example, coincides with the drought conditions between 1973 and 1976.

The extent to which the group ranch proportion of mature cows in the herd have approached the commercial standards is shown on Table 30. Two conclusions regarding the current status of herd management practices under the group ranch approach can be drawn. First, the relatively higher proportion of mature cows in the group ranch herds compared to Joyce commercial ranch, indicates that the Masai are still managing their herds to provide the subsistence needs. A large proportion of mature females in the herd provides a steady milk supply throughout the year, although there are peak calving seasons in November and December (Camerons 1970).

Second, a high proportion of mature females during poor ecological periods is probably an adaptive strategy to deal with

Table 29

Variation in Herd Structure of Ilmamen and Mbilin Group Ranches
(In Percentage of the Total Herd Size)

Year	Group Ranch	Herd size	Bulls	Cows	Calves	Heifers	Steers	Total Females	Total Males
1968	Ilmamen	1943	11.4	42%	23.2	18.0%	5.4	60.0	16.8
	Mbilin	2735	2.7	43.6%	16.7	17.3	19.7	60.9	22.4
1970	Ilmamen	3639	2.0	44.8%	26.7	12.5	13.0	57.3	16.0
	Mbilin	2954	1.5	37.0%	27.1	14.8	19.6	51.8	21.1
1972	Ilmamen	3190	2.4	30.9%	14.2	18.4	34.1	49.3	36.5
	Mbilin								
1973	Ilmamen	3629	1.9	47.3%	20.6	14.9	15.3	62.2	17.2
	Mbilin	6848	1.8	41.0%	31.0	12.8	16.4	50.8	18.2
1974	Ilmamen	2803	2.1	37.8%	22.3	17.5	20.1	55.5	22.2
	Mbilin	6580	1.2	38.0	13.8	18.9	14.7	70.3	15.9
1975	Ilmamen								
	Mbilin	3925	3.3	51.4%	24.6	9.8	11.9	61.2	14.2
1976	Ilmamen								
	Mbilin	6395	2.0	53.9%	23.9	8.8	11.4	62.7	13.4
*1977	Ilmanen	1055	2.3	37.7%	9.1	33.6	17.3	71.3	19.6
	Mbilin	2317	1.3	49.8%	13.2	17.7	18.0	67.5	19.3
**1977	Ilmamen	1139	5.7	39.8%	10.6	33.5	10.4	73.3	16.1
	Mbilin	2315	3.2	51.1%	16.8	22.5	6.4	73.6	9.6

*Government Data
**Theuri's Data

Table 30

Variations of the Proportion of Mature Cows in the Herd

Period of Development Year	Group Ranches		Commercial Ranch
	Ilmamen	Mbilin	Joyce Ranch
1968	42.0	44.0	
1970	44.8	37.0	
1972	30.9		19.5
1973	47.3	41.0	24.4
1974	37.8	38.0	30.3
1975		51.4	29.3
1976		53.9	
1977	37.7	49.8	
$\bar{X} \pm s$	40.1 ± 5.9	45.0 ± 6.7	25.9 ± 5.0

cyclic productivity of rangeland due to erratic rainfall patterns. A preponderance of females in the herd favors the chances of a quick recovery of pastoral herds after drought. Herds in Mao in Chad had 73.3 percent females in 1973 (Ferguson 1979). This proportion of females compares very closely with my post drought census data for Mbilin and Ilmamen (Table 29).

These two conclusions regarding herd management practices in Kaputiei group ranches suggest that the subsistence rather than economic conditions are still paramount among the Masai.

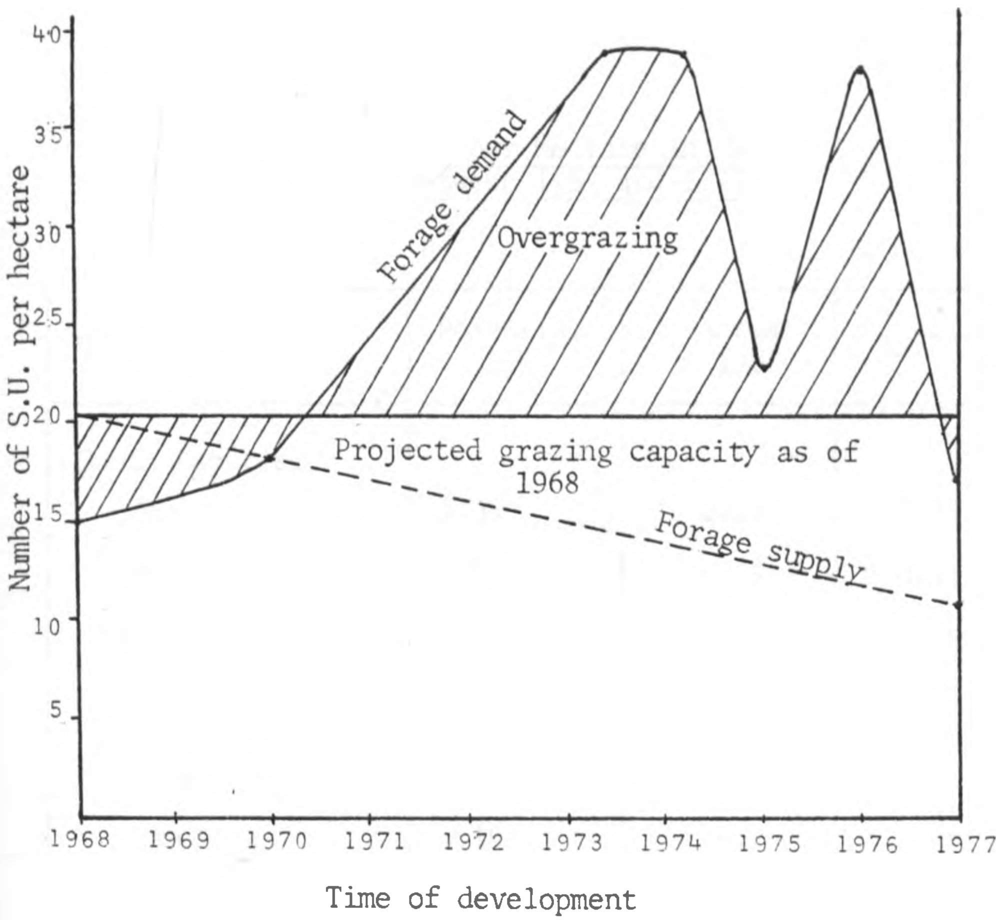
Range Management Practices

The control of livestock grazing pressure is perhaps the most important measure in improving and maintaining the productivity of rangeland. The project proposed three range menagement principles: destocking of excess livestock; proper utilization of current forage production; and implementation of suitable grazing management systems for each Kaputiei group ranch.

In all Kaputiei group ranches proper control of animal numbers was not attained (Figure 29). Table 31 shows the degree of overstocking in the middle of Kaputiei Livestock Development Model. Without livestock numbers matched to the forage supply, the second principle of proper utilization of forage was impossible to implement. Although no vegetational work was undertaken between 1970 and 1976, the trends of range condition suggest that the forage was overutilized throughout the livestock development plan. (Figure 29). The disappearance of desirable perennial plants is to a large extent

Figure 29

The Variation in Stock Units[1] per 100 Hectare in Mbilin Group Ranch from 1968 to 1977



[1]Stock units are calculated in the following
Sheep or goat = 0.2 S.U., Calves = 0.2, Yearling = 0.4, Heifers 1.0 and steers (2-3 yrs.) = 0.8, cows and bulls =1.0.

Table 31

<u>Changes in S.U. per Hectare in Kaputiei Ranches Between 1967 and 1977</u>

Group Ranches	Potential 1967	Actual 1967	1972/73	1977
South Kaputiei				
Mbilin	0.08	0.15	0.38	0.16
Mbuko	0.09	0.25	0.43	0.14
Olkarkar	0.06	0.26	0.48	0.18
North and Central Kaputiei				
Embolioi	0.10	0.17	0.26	0.18
Ilmamen	0.13	0.06	0.10	0.06
Erankau	0.09	0.06	0.12	0.09

related to the intensity and frequency of plant defoliation. (Hyder, et al 1959, Trlica et al 1971). The observed downward trend of the range condition is primarily due to overutilization of rangelands by too many animals. The trend of livestock densities per 100 hectares in Mbilin ranch typifies the pattern of the overgrazing during the livestock development period. (Figure 29). The forage under-utilization between 1968 and 1970 represents the lag period before the construction of water and dips and probably the delay in acceptance of range development inputs. The variation in the intensity of forage demand after 1975 in Mbilin represents a recourse to semi-normadic grazing as the 1973-1976 drought intensified.

Because the forage supply could not support livestock requirements, as shown by Figure 29, appropriate grazing management systems could not be implemented. Although the drought probably would have made some of these grazing systems impractical, such grazing management was not attempted even before the drought started at the end of 1973.

Some of the consequences of the failure to enforce the grazing management regulations by the provisions indicated in the development plan are clear after the recent drought. The drought reduced the number of stock units to a level below the 1968 grazing capacities of the Kaputiei ranches in 1977. Yet, even the 1977 livestock densities are so close to the grazing capacity level of 1968 that there seems to be little opportunity for range recovery before overutilization starts again.

The correlation between forage demand as a function of the number of stock-units on the one hand, and the vegetational changes in Kaputiei permanent transects on the other hand, is yet another evidence of the significance of grazing factors in the extensive degradation of south Kaputiei grasslands (Figure 29). Hence we can conclude that the current productive potential of south Kaputiei rangelands has decreased below the 1968 potential. The degree of overgrazing indicated in Figure 29 between 1968 and 1977 is therefore more severe because the grazing capacity was continously decreasing below the 1968 level due to both uncontrolled livestock numbers and low productivity due to inadequate annual precipitation.

Drought Management Strategies

The acid test of any development program as far as the people on the rangelands are concerned is its performance during extreme drought conditions. The Kaputiei Livestock Development Plan lacked any clearly defined strategies for handling drought emergencies. As mentioned in Chapter 4, the Kaputiei Livestock Development Plan was conceived and implemented during a favorable period (1966-1972).

The only provision in the development plan for dealing with drought emergencies resulted from some of the benefits of incorporating the Masai in the market exchange system. The basic premise of luring the pastoral nomadic societies from subsistence economy into a market economy is the proposition that such a transition increases the options for the people in the rangelands to improve their quality of life.

A market exchange system helps pastoral nomadic societies under two conditions. First, the cconomic market system must provide adequate incentives for the participants i.e. a fair price for the product, availability of marketing channels,etc. The increase of livestock numbers between 1968 and 1974 without corresponding increase in the offtake rates in Kaputiei may be in part due to low price incentives for the Kaputiei Masai to participate in the market.

Second, the market exchange system must demonstrate its dependability during critical survival periods in the rangelands. The failure of the market exchange system during the depth of drought conditions in 1976 was an unfortunate blow in demonstrating the dependability of an economic market exchange system to the Masai. The high livestock mortality level in Kaputiei partly resulted from inadequate slaughtering facilities in Kenya Meat Commission (KMC is official livestock buyer). Many Kaputiei Masai attribute their drought losses to KMC's failure to buy their livestock during that period. Ideally, the recent extreme drought period could have shown the Kaputiei Masai the virtues of a market system even if such an intervention could not have been justified on purely economic grounds. The drought strategy involving animal purchases would have generated enough cash for the Kaputiei Masai to buy grain. Instead the Masai were given famine relief in form of grain.

The group ranch governments disintegrated as the management committee members moved out of their ranches to areas with adequate grazing resources (between 1975-1976). For example, the failure of the introduced steer fattening project illustrates the difficulties of administrative breakdown during the drought. The AFC advanced 2000 steers to Kiboko and Olkarkar group ranches sometime between 1973 and 1974. The steers were under the management of each group ranch. As the drought intensified, concern over the proper management of these steers became a great concern to AFC. The Range Management personnel argued that it was not their responsibility to take charge of regular dipping, watering, and pasturing of these steers when the members of these ranches immigrated in 1975-1976 to north Kaputiei area, leaving the vulnerable steers behind. Of the total 2000 steers, only 577 steers found their way into KMC slaughter house. The remaining 1423 steers were lost through disease, iliegal sales, stealing and other unaccounted losses.

The maintenance of range development facilities such as water boreholes and dips were totally neglected during the drought period (Table 32). Expensive water pumps broke down; some were stolen when security services were momentarily discontinued by drought. Livestock congregated around fewer water sources and this problem probably magnified the deterioration of rangelands with permanent sources of water. It is important therefore to make provisions for security and service maintenance of expensive installations, particurarly during a chaotic drought period.

The breakdown of fragile group ranch governments in difficult ecological periods should be considered in all future rangeland

Table 32

The Water Maintenance Report in March 1978*

Group Ranch	Water Source	Current Condition March 1978	Remarks
Olkinos	1 borehole	Bad	No fuel, in danger of being stolen
Embolioi	2 boreholes	Bad	Engine stolen
Ilmamen	1 borehole	Functional	Needs urgent attention, danger of erosion
Erankau	1 borehole		
Mashuru	3 boreholes	2 in good 1 not functioning	
Emarti	2 boreholes	1 Good	
Arroi	2 boreholes	2 Bad	
Nkama	2 boreholes	1 Bad	
Poka	2 borehole	1 stolen	
Mbilin	1 borehole	Good	
Kiboko	2 boreholes	Bad	Engine stolen one broken
Mbuko	1 borehole	Bad	
Meruishi	2 boreholes		
Olkarkar	1 borehole	Bad	
Empuyankat	1 borehole	Good	

*Range water section, Kajiado District

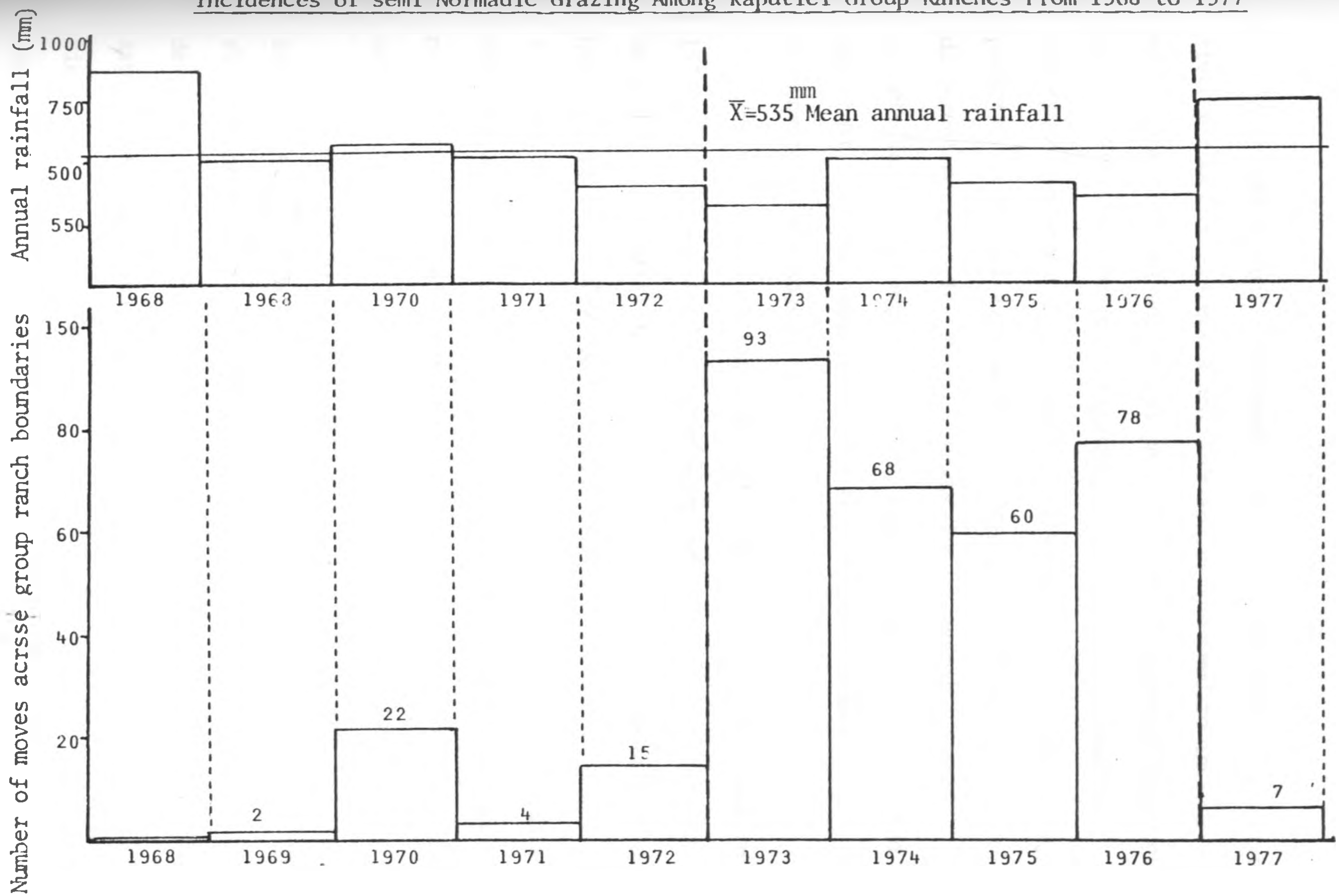
improvement projects. Droughts call for special intervention measures over and above any other measures which are deemed necessary in mobilizing developments in the rangelands.

The first drought management strategy involves mobility and flexibility. The group ranch boundaries did not enclose ecologically viable units during the drought period. Figure 33 shows that most Kaputiei families crossed their herds to other group ranches for grazing resources during the drought period. In the many instances where grazing occurred outside Kaputiei group ranches, most families took their herds to Kitengela Game Conservation area, Nairobi City, and the Ngong area. These areas were once a part of the Masai dry season grazing areas. The data show that the drought grazing strategies cannot be confined within the boundary of a group ranch. The definition of an ecologically viable group ranch in Kaputiei is probably an unrealistic expectation. An optimum ecological unit for Kaputiei, particularly in drought period would have to include Kitengela, Nairobi National Park, Ngong hills and the present location of Nairobi City.

For example during the peak of drought in July 1976, the Masai and their dying cattle flooded Nairobi City. This phenomenon raised quite a bit of public and political debate, but finally, the city authority, probably on sympathetic grounds, temporarily conceeded to tolerate toitering of Masai cattle in beautiful city parks, watered lawns, golf fields, along city boulevards and residential areas.

Figure 33

Incidences of semi Normadic Grazing Among Kaputiei Group Ranches From 1968 to 1977



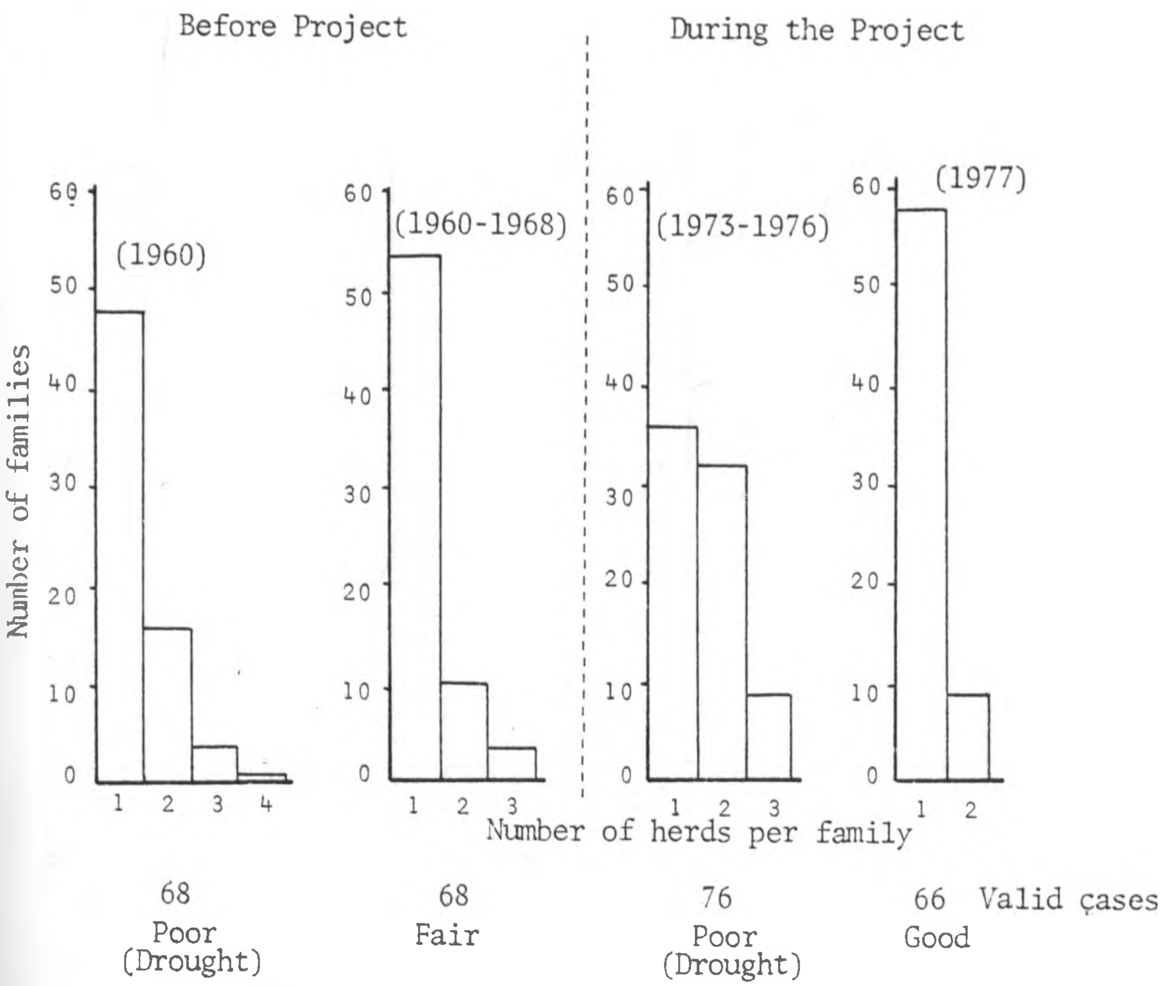
A second drought management strategy in the traditional livestock production systems again underscores the need to include both normal and critical ecological periods in the Livestock Management Plans. While a commercial enterprise innovates new management techniques in order to provide surplus production for market, a pastoral nomad will also engage in surplus production but for a different motive. The surplus production in pastoral nomadic society is used to meet the various subsistence needs. The most important of these needs is a provision of an insurance herd component for the household.

The proportion of families with multiple herds from 1968 to 1977 of among 148 families interviewed in 1977 are shown in Figure 34(i,ii). Relatively more Masai families in Kaputiei possessed more than one herd during 1973-1976 drought period than any other period between 1968 and 1977. One conclusion that can be drawn from these data is that the Kaputiei Masai failed to dispose of surplus livestock nubmers through the market system because the market system did not appear to provide as much subsistence security surplus live animals.

In conclusion, the performance of livestock development project in Kaputiei has underscored two improtant inseparable events. The first event is that the Masai responded to the virtues of new development inputs in accordance with his rationale judgment of those aspects of modern range management practices which are not antagonistic to his welfare as he lives on the rangelands. The second event demonstrates the need of the development planners to take proper

Figure 34 (i)

The Relationship of Multiple Herd Strategy to Environment Perception

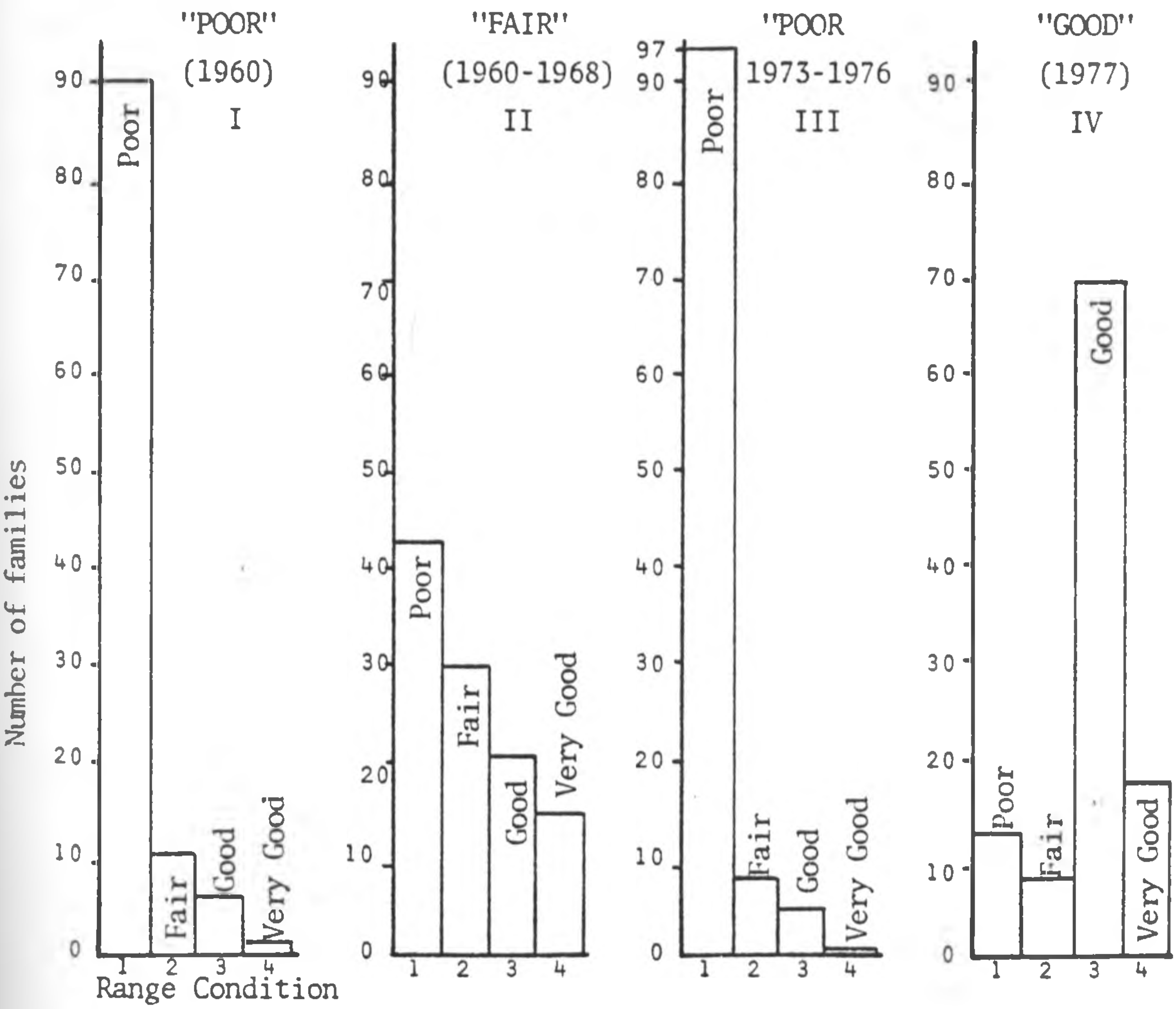


Pastoralists' perception of ecological conditions[1]

[1]Deduction taken from Figure 34 (ii).

Figure 34 (ii)

Perception of Range Condition by the Kaputiei Masai



Valid cases 109

steps in establishing those incentives which will generate the desirable behavioral characteristics of the Masai as he adopts a modernized pattern of resource use strategies. Kaputiei Livestock Development Project can be a good source of information for designing other livestock development projects.

Contrary to the common view that the Masai are "cattle complex people", the socio-cultural trends of Kaputiei Masai, dealt with in Chapter 7, introduces a different image of the Masai people in their struggle to redefine a broader resource base which includes both livestock and non-livestock resources.

CHAPTER 7

HUMAN RESPONSES TO CHANGING ENVIRONMENT IN KAPUTIEI

INTRODUCTION

METHODS OF DATA COLLECTION

DEMOGRAPHIC TRENDS

SEDENTARIZATION PROCESS

Acceptance of Group Ranch Development Model

Settlement Patterns

Significance of Sedentarization Trends

MULTIRESOURCE USE PATTERNS

Livestock Resources Revisited

Masai Dietary Changes

Other Supplementary Resources

SUMMARY AND CONCLUSIONS

Chapter 7

HUMAN RESPONSES TO CHANGING ENVIRONMENT IN KAPUTIEI

INTRODUCTION

The group ranch organization was designed primarily to facilitate the transformation of subsistence pastoralism into a commercial livestock production system. For this goal to be realized, racial changes in the social-cultural patterns of Kaputiei Masai were expected to accompany this transition. Hence the direction of the social-cultural trends among the group ranch participants is appropriate performance criterion of the Kaputiei livestock development model. The Kaputiei model succeeds or fails in this regard, depending on our value context in which we choose to interpret the direction of the recent socio-cultural trends.

In the previous two chapters significant range condition and livestock changes since the inception of the group ranch development were documented. This chapter has the purpose of showing significant trends in socio-cultural changes among the Kaputiei Masai which are directly or indirectly related to the Kaputiei livestock development . strategy. Indicators of these trends include demographic patterns of human population, the acceptance of the Kaputiei group ranch model by the participants, changes of the Masai lifestyles in the issues of sedentarization and multiresource use strategies.

METHODS OF DATA COLLECTION

Two complete human population censuses are available for Kaputiei, one at the beginning of the Livestock Development Project in 1968 and the other during the 1977 field study. Although the original raw data for the 1968 Survey were not available, the summary of the census information is contained in the Preinvestment Survey Report (1969). The human population data in 1968 included heads of families, wives, young warriors (morans) aged 16-24 years, boys and girls between 5 - 15 years, children under 5 years, dependent relatives and visitors in the families. A special problem noted in this census involved the unusually high number of heads of families. Young unmarried morans posed as heads of families; possibly because there were expectations that grazing quotas would later on be allocated to the heads of families.

The second complete human population census in Kaputiei was carried out during 1977 concurrently with the livestock census already discussed. The variations of the number of families per ranch between 1968 and 1977 censuses are shown on Table 33. The number of families residing in each ranch by 1977 is partly related to the ecological conditions within each ranch as well as the availability of domestic and livestock water supply from boreholes. Ranches with 100 percent of the total families in 1968 represent both an increase in the number of registered families and good ranch facilities which retain the registered members.

Meruishi is an extreme example in which 70 percent of the total families were residing outside the group ranch at the time of the census.

Table 33

Variations in the Number of Families in Kaputiei Ranches in 1977 Census in Relation to 1968 Census

Group Ranches	Number of Families		1977 families as a percentage of 1968 families	Ecological Zone
	1967	1977		
ATHI-KAPITI RANCHES				
Olkinos	90	71	79%	IV
Embolioi	141	161	114%	IV/V
Empuyankat	91	58	64%	IV/V
CENTRAL KAPUTIEI				
Emarti	48	39	81%	IV/V
Ilmamen	78	65	83%	IV/V
Erankau	59	55	93%	IV
Nkama	274	165	60%	IV/V
Arroi	81	37	46%	IV
Imaroro/Mashuru	218	111	51%	IV/V
SOUTH KAPUTIEI				
Kiboko	77	47	61%	V
Mbilin	66	68	103%	V
Mbuko	86	83	97%	V
Meruishi	80	24	30%	V
Olkarkar	51	43	84%	V
Poka	29	36	124%	IV

Variations in the number of families per ranch therefore introduce an under-estimate of the total number of people in the ranches where a large number of the families had migrated outside their respective ranches due to the drought conditions.

In addition to the human statistics collected during 1968 censuse, other types of data in 1977 census included a detailed socio-cultural survey, and a settlement survey questionnaire. The detailed survey sampled the changes in attitudes toward the group ranch organization concept, livestock production strategies, and the scope of multiple use of non-livestock resources such as agricultural crops, employment, wildlife, and mineral resources in Kaputiei ranches. A total of 148 families were randomly selected from approximately 1200 heads of families in Kaputiei.

Special emphasis was also attached to settlement sites and the data collected included: number of families per settlement site, presence of permanent and semi-permanent structures, availability of water for domestic use, extent of cultivation near settlements and availability of shopping centers in the area. A total of 327 settlements were enumerated. This sample represents all settlement sites in Kaputiei ranches except the Embolioi and Mashuru group ranches.

DEMOGRAPHIC TRENDS

World population currently grows at 2.0 percent per year. According to official population censuses, the annual rate of increase in Kenya was 2.3 percent, 3.2 percent and 3.3 percent for the years 1948, 1962, and 1969 respectively. A later estimate in 1974 set the Kenya population at nearly 13 million with an annual rate of increase of 3.5 percent. (Kenya 1974).

The recent trend of human population in Kenya is shown on Table 34. Between 1969 and 1979, the Kenya population increased by 40 percent. For the same period the population in Kajiado district has increased 73 percent. The Kajiado human population trend indicates that even in such predominantly pastoral districts, the human population is not static, but also increasing rapidly.

Examples of population growth rates in countries with nomadic population reveal similar trends to those apparent in Kajiado District. The population growth rates for Somalia and Niger according to the Year-book of UN Statistical Abstract (1976) are set at 2.6 percent and 2.7 percent respectively. These rates of increase are significantly above the world average factor of 2.0 percent a year.

Kaputiei demographic trends indicate a similar upward trend in population growth as in the rest of Kenya. Kaputiei Section had a population of 7,623 according to the 1962 human census. At the time of Kaputiei Livestock Development Feasibility Study in 1968, the human population had increased to 8,658 or by 14 percent over the 1962 level. (Pre-Investment Study 1969).

Population level in seven ranches shows that the Kaputiei population increased by about 52 percent between 1968 and 1977, an average growth rate of 5.2 percent per year over the ten years of livestock development. (Table 35) In the northern and central Kaputiei ranches the population rose by 30 percent from 1968 to 1977,

Table 34

Kenya Human Population Trend 1962-1974 According to Official Census Records

Census	1962	1969	1979
[1]Kenya	8,636,263	10,942,705	15,322,000
[2]Kajiado District	68,400	85,900	149,000
[3]Kaputiei	7,623	8,658	-

Data Source: 1, 2 Human settlements in Kenya 1978.

Data Source: 3 Preinvestment Study Report 1969.

1979 data taken from Weekly Review, (Kenya) 1979.

Table 35

The Demographic Trends of Kaputiei Human Population 1967-1977

Kaputiei Group Ranches	Area in Hectares	Eco Zone	Potential Stock Units 1967[1]	Total Human Population 1967	Total Human Population 1977	Percentage increase over 1967	Potential A.E. in 1967[2]	Total A.E.[3] 1967	Total A.E.[3] 1972/73	Total A.E.[3] 1977	Recommended A.E. using 1977 S.U.[4]	1977 A.E. above or below recommended	1977 A.E. as percentage of 1967 potential	A.E. per 100 Hectares Potential (1967)	A.E. per 100 Hectares 1967 census	A.E. per 100 Hectares 1977 census
North & Central																
Emboloi	19483	IV/V	5780	793	1016	28%	1156	591	649	703	699	+8	61%	5.93	3.11	3.62
Erankau	22202	IV	2260	276	406	47%	452	210	240	269	303	-34	60%	2.04	0.95	1.21
Ilmamen	30132	IV/V	2090	353	432	22%	418	274	283	291	329	-38	70%	1.39	0.91	0.97
	71817		10130	1422	1854	30%	2026	1075	1172	1266	1331	-64	63%	2.82	1.52	1.76
South Kaputiei																
Mbilini	14773	V	3060	378	628	66%	612	259	345	430	463	-33	70%	4.14	1.75	2.91
Mbuko	18477	V	3430	432	753	74%	686	324	436	548	513	+35	80%	3.71	1.75	2.97
Olkarkar	10280	V	3100	235	492	109%	620	187	264	341	357	-16	55%	6.03	1.82	3.32
	43530		9590	1303	2278	75%	1918	770	1045	1319	1333	-14	66%	4.41	1.77	3.07
Kaputiei	115347		19720	2725	4132	52%	3944	1845	2217	2585	2664	-78	66±9%	3.42	1.78±.75	2.50±1.12

[1] Data taken from Preinvestment Report 1969.

[2] Potential A.E. (Adult equivalents) using the estimated grazing potential in 1967 and a subsistence allowance of 5 S.U. per A.E.
A.E. Conversion factors: Children < 5 yrs. = 0.4 A.E., > 5 and < 15 yrs = 0.6 A.E., Adults over 15 yrs. = 1.0 A.E.

[3] Human population in 1972/73 estimated as an average of 1967 and 1977 censuses.

[4] Recommended A.E. calculated from the total S.U. in 1977 and a subsistence allowance of 5. S.U. per A.E.

while the southern ranches show an overall increase of 75 percent, an average of 7.5 percent per year.

Visitors on Kaputiei ranches constituted only 2.7 percent of the total population in 1977. A visitor is a family which was counted in another group ranch outside the ranch in which that family is officially registered. We may therefore conclude that the population trends in Kaputiei are the result of the natural increase and not immigration from neighboring areas. Most of the visitors came from within Kaputiei. The potential human carrying capacities in 1967 on Table 35 are based on the potential livestock units estimated in 1967. The recommended human carrying capacities in 1977 are based on the 1977 livestock units divided by the estimated subsistence allowance of 5 S.U. per A.E. (Adapted from Brown (1971). The human density in 1977 approximated the recommended carrying capacity on the basis of the inventory of livestock resources in 1977. If the range condition potential of 1967 was maintained, the 1977 human carrying capacity averages only 66 ± 9 percent of the potential carrying capacity (Table 35).

Comparative changes in adult equivalents per 100 hectares are shown in Table 35. An adult equivalent (AE) is computed using a factor of 0.4 for children less than 5 years, 0.6 for boys and girls between 5 and 15 years, and 1.0 for people over 15 years. These factors are used in the 1968 baseline data. In the course of the Livestock Development Project, the mean population density in southern ranches increased from 1.86 ± 0.19 A.E. per 100 hectares in 1968 to 3.03 ± 0.20 A.E. per 100 hectares in 1977. But in the remaining

Kaputiei areas, the population density increased only slightly during the same time interval. (Table 35).

The structure of Kaputiei human population is shown on Table 36. The proportion of children under 15 years in Kaputiei has increased from 52 percent in 1967 to 58 percent in 1977. The higher proportion of youthful population in 1977 emphasizes the upward trend of population growth in Kaputiei ranches. Factors promoting population growth in Kaputiei are closely linked with the general improvements of health services and agriculture development in Kenya after independence in 1963. The surplus of grains from high potential areas as a result of the green revolution is likely to have had some beneficial spillover effects in the rangelands. Masai families now subsist largly on agricultural foods as it will be shown later in this chapter.

The average number of wives per male head of family has increased from 1.13 $\pm$ 0.36 in 1967 to 1.76 $\pm$ 0.47 in 1977 (Table 36). The fact that the average family size per wife has not changed as significantly as the average family size per head of family suggests that either Kaputiei women are marrying at an earlier age now than before or that there is an importation of women from the surrounding areas of Kaputiei. The number of children per head of family and the average family size per head of family have nearly doubled between 1967 and 1977 in response to the increase of wives per head of family and the improvement in the survivorship of children per wife (Table 36).

Since the variations of the heads of families in 1967 and 1977 censuses in Mbuko, Poka, Ilmamen and Erankau ranches (Table 36) are small, to affect the averages of children and wives per head of family

Table 36

Changes in the Structure of Human Population in Kaputiei Group Ranching Scheme

Group Ranch	[1]Kaputiei Section		[2]South Kaputiei		[3]North & Central Kaputiei		South Kaputiei Ranches								Central Kaputiei				North Kaputiei	
							Mbuko		Meruishi		Kiboko		Poka		Ilmamen		Frankau		Empuyankat	
Ecological Zone			V		IV/V		V		V		V		IV		IV		IV		IV/V	
Year	1967	1977	1967	1977	1967	1977	1967	1977	1967	1977	1967	1977	1967	1977	1967	1977	1967	1977	1967	1977
Female heads of family	10	2	9	1	1	1	2	1	3	0	4	0		0	0	0		1	1	0
Total heads of family	472	368	241	190	231	178	85	83	50	24	77	47	29	36	78	65	58	55	95	58
Total human population	2178	2984	1244	1749	934	1235	390	761	310	227	336	425	208	336	318	399	241	370	375	466
Total number of wives	483	631	269	401	214	230	89	177	67	55	61	103	52	66	68	74	51	66	95	90
Children under 15 yrs.	1134	1740	684	1016	450	744	212	439	169	122	189	238	114	217	160	226	117	209	173	289
Percentage of children < 15 yrs.	52.13±3.83	58.16±3.79	55±0.88	58± 4.7	48.3±2.11	58.4±3.15	54.4	57.7	54.5	53.7	56.3	56.0	54.8	64.6	50.3	56.6	48.5	56.5	46.1	62.0
Children < 15 yrs. per wife	2.38±0.39	2.82±0.46	2.55±0.39	2.58±0.49	2.15±0.29	3.14±0.08	2.38	2.48	2.52	2.22	2.10	2.31	2.19	3.29	2.35	3.05	2.29	3.17	1.82	3.21
Average family size per wife	4.55±0.53	4.83±0.63	4.63±0.64	4.41±0.46	4.45±0.44	5.39±0.22	4.38	4.30	4.63	4.13	5.51	4.13	4.00	5.09	4.68	5.39	4.73	5.61	3.95	5.18
Wives per male head of family	1.13±0.36	1.76±0.47	1.28±0.42	2.11±0.20	0.92±0.08	1.30±0.22	1.07	2.11	1.43	2.29	0.84	2.19	1.79	1.83	0.87	1.14	0.88	1.22	1.01	1.55
Children < 15 yrs. per head of family	2.59±0.78	4.92±0.88	3.06±0.72	5.37±0.46	1.96±0.13	4.09±0.79	2.49	5.29	3.38	5.08	2.49	5.06	3.43	6.03	2.05	3.48	2.02	3.80	1.82	4.98
Average family size per head of family	4.93±1.23	8.27±1.35	5.58±1.34	9.25±0.18	0.11	6.97±0.97	4.58	9.17	6.20	9.46	4.36	9.04	7.17	9.33	4.08	6.14	4.1[illegible]	6.73	3.95	8.03

[1]Kaputiei figures are calculated from group ranches located above.

[2]South Kaputiei data are computed from Mbuko, Meruishi, Kiboko and Poka.

[3]North and Central Kaputiei data are compiled from Ilmamen, Erankau and Empauyankat.

it is proposed therefore that the differences between 1967 and 1977 demographic characteristics are primarily due to Kaputiei livestock development projects and the overall economic development of Kenya.

Differences in demographic characteristics between south Kaputiei ranches and the remaining ranches show that in 1967, south Kaputiei had a greater proportion of youthful population, which has not increased significantly in 1977 compared to the changes in north and central Kaputiei ranches (Table 36). While the survivorship of members of children per wife in north and central Kaputiei ranches has increased significantly between 1967 and 1977, no corresponding changes are observed in southern ranches. The survivorship of children has increased in those ranches under better ecological concitions in zone IV and has not changed for ranches under ecological zone V.

Differences in survivorship of children in Kaputiei regions may come from two factors. The first factor is related to the differences in normadic movements. Families in south Kaputiei ranches in ecological zone V have been moving more frequently because of poorer range condition trend (Chapter 5) and poorer rainfall reliability (Chapter 4). These families therefore may have been preoccupied with following scattered grazing resources instead of seeking medical attention.

The second factor concerns the differences in diffusion of medical facilities and availability agricultural foods which are concentrated on old shopping centers along the railway stations and in Mashuru and Isinya centers. The concentration of medical facilities is high in ecological zone IV than in ecological zone V. We can therefore conclude that the population growth in south Kaputiei ranches is a function of the number of wives, while in the rest of Kaputiei, the population growth is largely due to improvement of the survivorship of children due to better medical facilities and better development infrastrature in communities with less nomadic movements.

It was documented in Chapter 6 that the south Kaputiei families are relatively more well off in terms of livestock numbers than the remaining families in Kaputiei. If we define the success of a household in terms of its total number of stock units, we can then observe that those families under the greater environmental danger of low unreliable rainfall, carry the greatest number of stock units probably as a form of insurance against subsistence risk.

Since it is more difficult to build up a herd in poor rainfall areas in south Kaputiei, the families in the south have evolved well-timed resource extraction strategies to respond quickly to any environmental changes. The nomadic way of life calls for intensive labour supply. Herds are sometimes split into two or three groups and each group is herded in a different direction (refer to Chapter 6). In such a nomadic system, for a family to succeed in building up a large security herd, labour is a crucial factor. The head of family deals with this problem by diverting some of his livestock units to acquire more wives and hence more children who generate enough labour resources within the household to manage large herds.

SEDENTARIZATION PROCESS

Acceptance of Group Ranch Development Model

One of the major objectives of the Livestock Development Project in Kaputiei was to settle the Kaputiei Masai in self-contained ecologic and socio-economic land units. Hence the inception of group ranches, in which the establishment of water and good management practices would promote a sedentary life-style among the group ranch participants.

It is clear from my recent survey that most of the Masai families, in theory, accept the settled lifestyle, but a host of many other factors continue to undermine their total commitment to a sedentarized life. Indicators of sedentraization trends are the changes in settlement patterns and their implications on livestock management practices, erection of permanent structures and acceptance of cultivation as an alternative means of dealing with subsistence risk factors.

From the detailed social survey of 148 families, 76 percent of them indicated that they liked the group ranch organization. Of the 24 percent of the people not in favor of this form of ranch organization, 85 percent preferred an individual ranch.

At the time when group ranches were being formed, a few progressive Masai were allocated individual ranches near Kajiado, Sultain Hamud, and Konza areas. An individual ranch belongs to one family in contrast to a group ranch which is owned by a group of families. These individual ranches have developed far ahead of the group ranches partly because of easier access to adequate loans from the AFC. The individual ranches were proposed as demonstration programs for the participants of the group ranches.

Members within the communal group ranches are increasingly anticipating parcellation of the group ranches into small individual ranches. This trend is neither ecologically nor economically justifiable and therefore the government is not in favor of it.

When the participants were asked if they would change their membership to a different group ranch other than the one they were currently registered in, only 10 percent of them indicated that they would accept the offer.

The range improvements in the ranches were hailed as the most important advantage of belonging to the group ranch (Figure 35(ii). Water, dips, shopping centers, and schools jointly scored 48.5 percent of the benefits of the group ranch organization. It is also important to note that these facilities favor sedentary lifestyle.

Another category of the various advantages of the group ranch organization is the traditional resource patterns within the boundary of each ranch. In ranch development planning it was stressed that as far as changes in the cultural use of grazing resources were concerned, each group ranch was free to improvise as necessary. In general, there was no attempt by the government to restrict the communal use of land within each ranch. Hence the participants feel that free grazing and free settlement sites are important facets of their freedom that were well preserved within the ranching scheme.

The concept of "a group title deed" is another added benefit of the group ranch scheme. The Kaputiei Masai now possess legal force to keep

Figure 35

Advantages and Disadvantages of Group Ranch Development Model
(Responses compiled from 148 families)

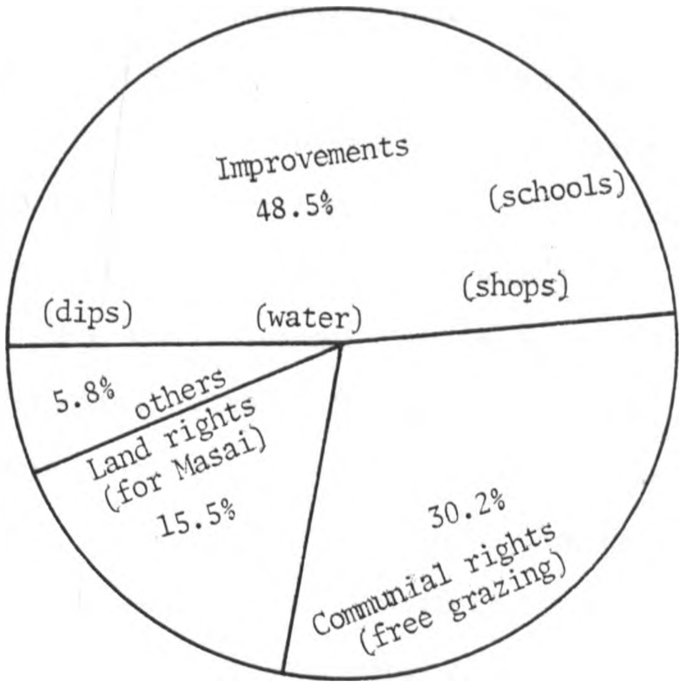


Figure 35(i)
Advantages

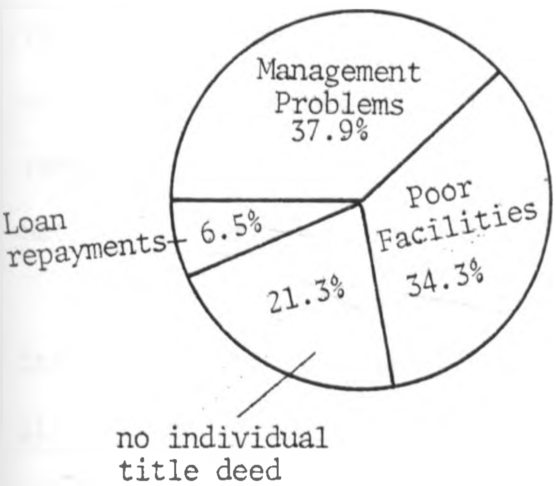


Figure 35(ii)
Disadvantages

out not only the agricultural ethnic groups such as Kikuyu and Kamba but also inelligible Masai from other sections.

But the Kaputiei Masai cannot have their cake and eat it too. The greatest disadvantage, that is poor ranch management, is closely linked with the second most important benefit, i.e. communal sharing of grazing resources within the group ranches. Poorly maintained ranch facilities which cause constant complaints from participants are also linked with poor ranch management.

Among the management problems mentioned, are poor grazing and overstocking, disease transmission, and lack of cooperation among members of the same ranch (Figure 35(ii). A small proportion of the members (6.5%) dislike the idea of loan payments probably because of the recent drought losses of their livestock.

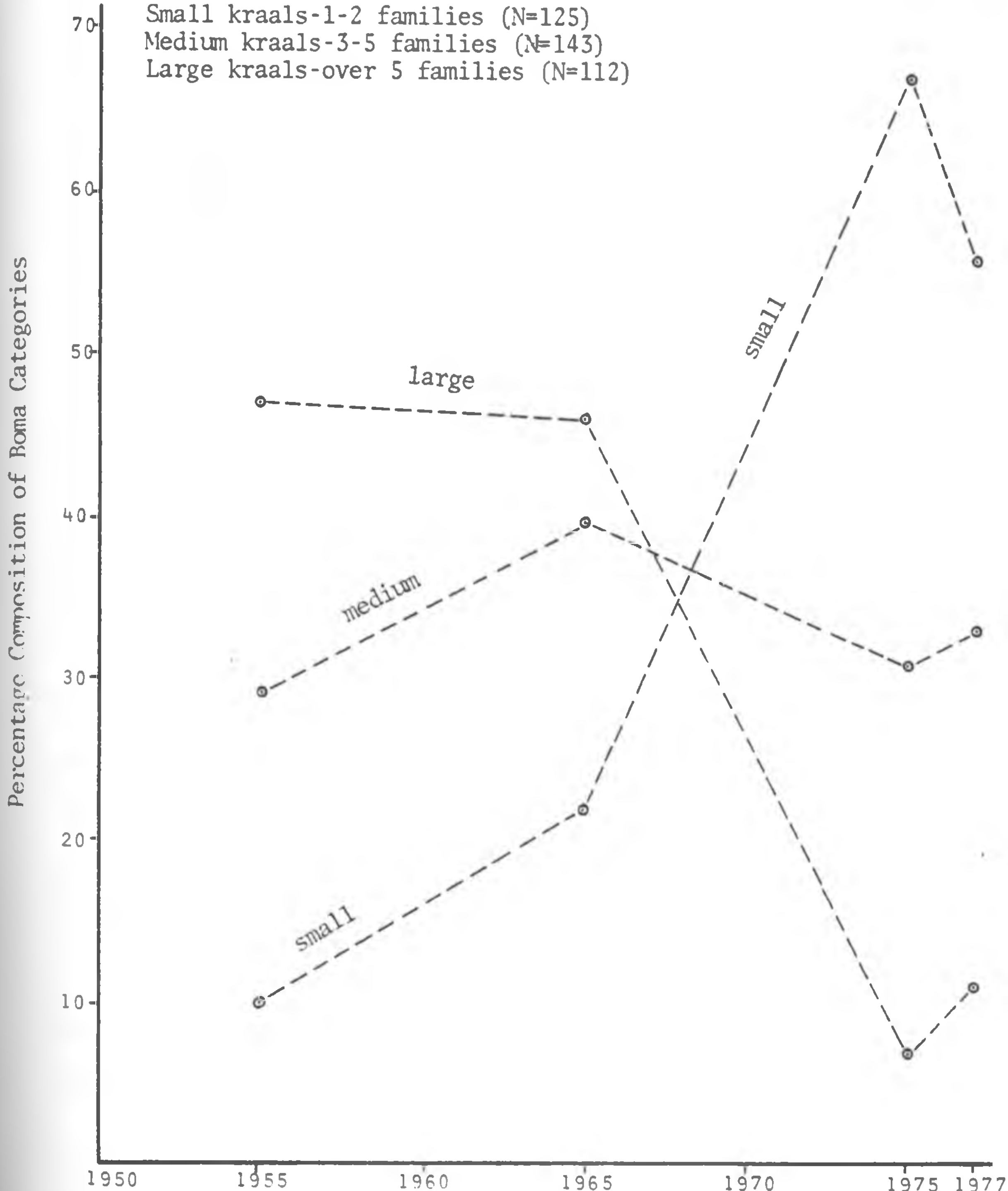
The problem of individual title deed arises from the dissatisfaction with communal sharing of declining resources contrasted with the more successful individual ranches who participated in the Individual Ranch Demonstration Program. Many members blaim the poor performance of the group ranches to the lack of individual parcellation of the group ranches.

<u>Settlement Patterns</u>

A historical persective of the disintegration of large kraals into small ones is shown on Figure 36a. This information was compiled from the social survey questionnarie. Each head of family interviewed was requested to enumerate by name the heads of families, and his relation to these families, who shared residence in the same kraal during 1950's, 1960's and 1970's. Only 12 percent (N = 136) of

Figure 36a

Disintegration Trends of Large Kraal Camps and Proliferation of Small Kraal Camps (1950's to 1870's)



the persons interviewed could not recall all the names of the families sharing the same kraal during 1950's and 1960's respectively. All the persons interviewed remembered families sharing the same kraal in 1970's. (N = 138).

The settlement sites in 1970's show that small kraals (1-2 families) constituted 62 percent of the total kraals; while the medium size (3-5 families) and large size kraal (over 5 families) represent 32 percent and 6 percent respectively. The kraal size distribution during 1950's represents the reverse of the trend shown in 1970's. The large size kraals constituted 49 percent of the 1950's kraal sizes, while the medium size and small size kraals respectively constituted 39 percent and 12 percent (Figure 36). My actual observation of the distribution of kraal sizes are based on settlement data collected during the 1977 human population census. (Figure 36, Table 37). These data show similar results to the 1970's data. The trend in kraal fragmentation between 1950's and 1960's show a gradual change, while the trend of kraal fragmentation between 1960's and 1970's represent a very rapid transition. (Figure 36). The mean number of families per kraal during 1950's, 1960's and 1970's are on Table 38.

Jacobs (1965) calculated 7.23 ± 3.17 families (N=123) per kraal in 1956 among the Tanzania Masai which compares reasonably well with my figure for 1950's of 6.22 ± 3.85 families per kraal for Kaputiei Masai.

Table 37

Absolute Frequencies and Percentages of the Number of Families per Settlement (Kraal Camp) According to 1977 Human Census

Number of Families per Settlement (or Kraal Camp)	Absolute Frequency	Percentage Frequency
1	137	34
2	84	21
3	55	14
4	48	12
5	28	7
6	12	3
7	12	3
8	10	2.5
9 and over	11	3.5
Number of Settlements	397	100%

Table 38

Variation of the
Mean Number of Families Living Together in One Kraal
Between 1950's and 1977

	1950's	1960's	1970's	*1977
Mean number of families	6.22 ± 3.85	5.13 ± 3.26	2.70 ± 2.07	2.84 ± 2.07
Sample size	108	136	138	395

*1977 data represent my actual observations during the human census while the rest of the data is compiled from the survey questionnaire data.

The length of time in which a family resides in the same kraal, averaged 5.03 ± 4.41 years in 1977 (Table 39). This figure was computed from the dates given by interviewed heads of family regarding the time they joined their current kraal. The figure compares well with estimates of time each person stayed in a specific kraal during 1950's, 1960's and 1970's.

Though there seems to be no significant change in the composition of the relations among families sharing the same kraal from 1950's to 1970's the densities of relations per family in the kraal have decreased very significantly from 3.67 relations per family in 1950's to 1.51 relations per family in 1970's (Table 40). This trend probably indicates an increasing breakdown of social structure to accommodate a more or less individualistic use of resources as a result of livestock development project in Kaputiei.

Reasons given for selecting and abandoning a kraal may shed some light upon the factors underlying kraal disintegration trend in the group ranches. According to the results from the social survey, 67.2 percent of the settlement sites were chosen in order to maintain legal sites were selected because of improvements such as water, livestock dips, schools and roads (Table 41).

Reasons given for abandoning the previous settlement sites are shown on Table 42. As a result of poor maintenance of boreholes and dips, 22.3 percent of the families abandoned their previous kraals.

Another significant reason given for leaving the old kraal is related to poor hygenic conditions (20.9%). The Masai usually change

Table 39

Variation in
the Mean Number of Years per Settlement in a
Kraal for each family

	1950's	1960's	1970's	*1977
Mean number of years	6.09 ± 3.64	5.27 ± 4.25	5.52 ± 4.50	5.03 ± 4.41
No. of valid cases	110	135	138	145

*1977 data represent my actual observations during the human census while the rest of the data comes from the survey questionnaire.

Table 40

Relations Among Families Living in the Same Kraal During 1950's, 1960's and 1970's in Percenages

Relations	1950's	1960's	1970's	Mean
Mother	27%	27%	19.4%	26%
Friend	25%	27%	21%	25%
Brother	17%	14%	15%	15%
Inlaw	15%	14%	15%	15%
No Relation	13%	13%	14%	13%
Relative	0	T	1%	
Uncle	1%	1%	2%	
Father	1%	2%	10%	
Sister	0	T	T	
Son	1%	T	2%	
Daughter	0	0	0	
Others	0	2%	1%	6%
Total	100%	100%	100%	100%
N Responses (Relations)	396	402	206	1004
N Cases	108	136	136	380
Relations per Case ($\overline{X}$)	3.67	2.96	1.51	2.64

Table 41

Reasons Behind Current Settlement Sites

	Number of Responses	Breakdown Percentage	Total Percentage
A. Legal Land Rights			67.2%
(i) Land registration	120		
To become member of the ranch	77	52.5	
(ii) To stay alone	55	14.7	
B. Ranch Facilities			32.8%
(i) Dips	44	11.7	
(ii) Water	44	11.7	
(iii) School	32	8.5	
(iv) Road	3	0.9	
Valid Responses	375	100%	100%

Table 42

Reasons Why Previous Kraal Camps Were Abandoned

	Percentage
Poor facilities	22.3%
To establish a more hygenic settlement site	20.9%
Poor animal and grazing management	20.3%
To join a group ranch	16.9%
Unsuitability for cultivation	9.4%
Poor relations with other kraal members	6.8%
Drought	3.4%
Total valid responses	300
N of cases	148

their settlement sites to another area which may be just near the old area because of sanitary conditions.

A recent factor now hinges upon a new mode of resource exploitation for which 9.4 percent of the families abandoned their previous kraals in order to practice cultivation in good sites.

Sometimes when poor relations occur among families staying together, the freedom to choose a different settlement site resolves the problem. As a result of poor relations among members 6.8 percent of the families left their previous kraals. It is significant to note that only 3.4 percent of the families abandoned their previous settlement because of the drought factor. During the recent drought, 74.3 percent of families obtained subsistence from retail shops (N = 148).

Other miscellaneous reasons include scarcity of firewood, particularly in Athi Kapiti area, disease problems, particularly due to wildbeest presence, and preference to join particular stock-associates or brothers.

Erection of permanent structures indicates an increasing trend towards sedentary lifestyle among Kaputiei Masai. There are two categories of such structures in Kaputiei. In the first category are those permanent and semi-permanent structure belonging to a family. These include houses with a metal roof, granaries and barb-wire fencing around the kraal. About 45 percent (N=148) of Kaputiei kraals had one or two such structures at the time of 1977 survey. Eighty-two percent of the structures were erected between 1971 and 1977, during which period, the group ranching organization was in operation (Table 43, figure 36b.)

Table 43

Periods of Erection of Permanent Structures in Kaputiei
(Houses, Wire Fences)

Dates When Structures Were Built	Absolute Frequency	Percentage Frequency
Before 1968	4	7.5%
1968 to 1970	7	10.6%
1971 to 1973	30	45.5%
1974 to 1978	24	36.4%
Valid cases (settlements)	66	100 %

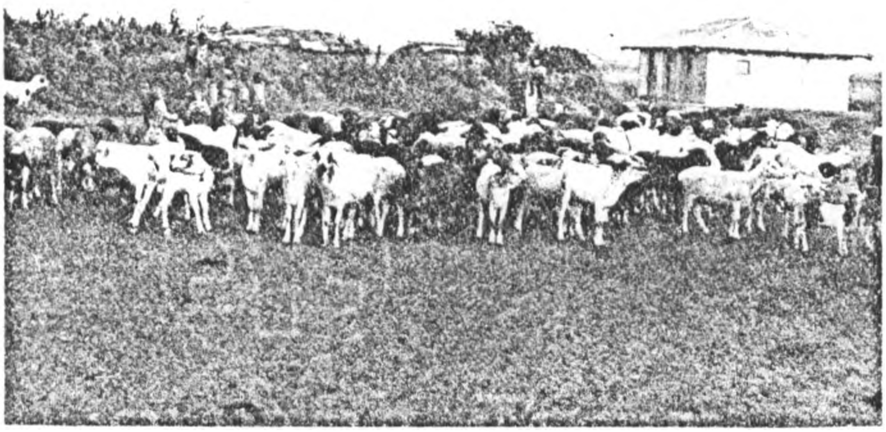


Figure 36b - June 1977 - Sedentarization trend in Kaputiei group ranches. Permanent structure such as the house in this picture. The proliferation of sheep and goat population in Kaputiei between 1968 and 1977 is likely to be linked to sedentirization trend.

In the second category are communal infrastructures such as shopping centers, schools and sources of domestic water. The trading centers along Nairobi/Mombasa railway line were built early in this century. Sixty-percent of Kaputiei settlement sites shop in the railway trading centers, such as Simba, Emali, Sultan Hamud, Kibini, Kima, Kiu, Ulu and Konza (Figure 6b). A few other centers have been opened inside the group ranches.

Over 70 percent (N=327) of the settlement sites depended on near-by schools for the education of their children. However, schools built between 1968 and 1977 attracted children from 76 percent of 229 settlements currently using the school facilities.

Domestic water supply for settlement sites is an important factor which contributes to the increasing trend toward sedentary communities in Kaputiei. Settlements using water from river, boreholes, and a water pipeline constituted a total 128,143 and 84 kraals respectively in 1977.

The increasing number of permanent structures and public infrastuctures in Kaputiei indicate willingness of Masai to adopt a settled way of life. This trend is also supported by my observation that during the recent drought, although cattle moved far and wide in search of grazing resources, most of the settlement sites were still inhabited, particularly by women, children and old men.

A change of resource use that includes cultivation is only possible where the people are willing to stay in one place long enough to clear the land, prepare the seed bed, plant, weed and protect the crop from pests in order to get a reasonable yield.

More than 50 percent of the families which I interviewed indicated that they had attempted cultivation at one time or another. Figure 36c shows that periods in which most of the families started cultivation. It is significant to note that the majority of the families started cultivation during 1976 and 1977.

Maize and beans are favorite crops among the cultivating families. Sixty-percent of the cultivators locate their plots within a few meters from human settlements in order to protect the crops from destruction by some wildlife. Supplementation of food supply is the main reason given by the families participating in the cultivation.

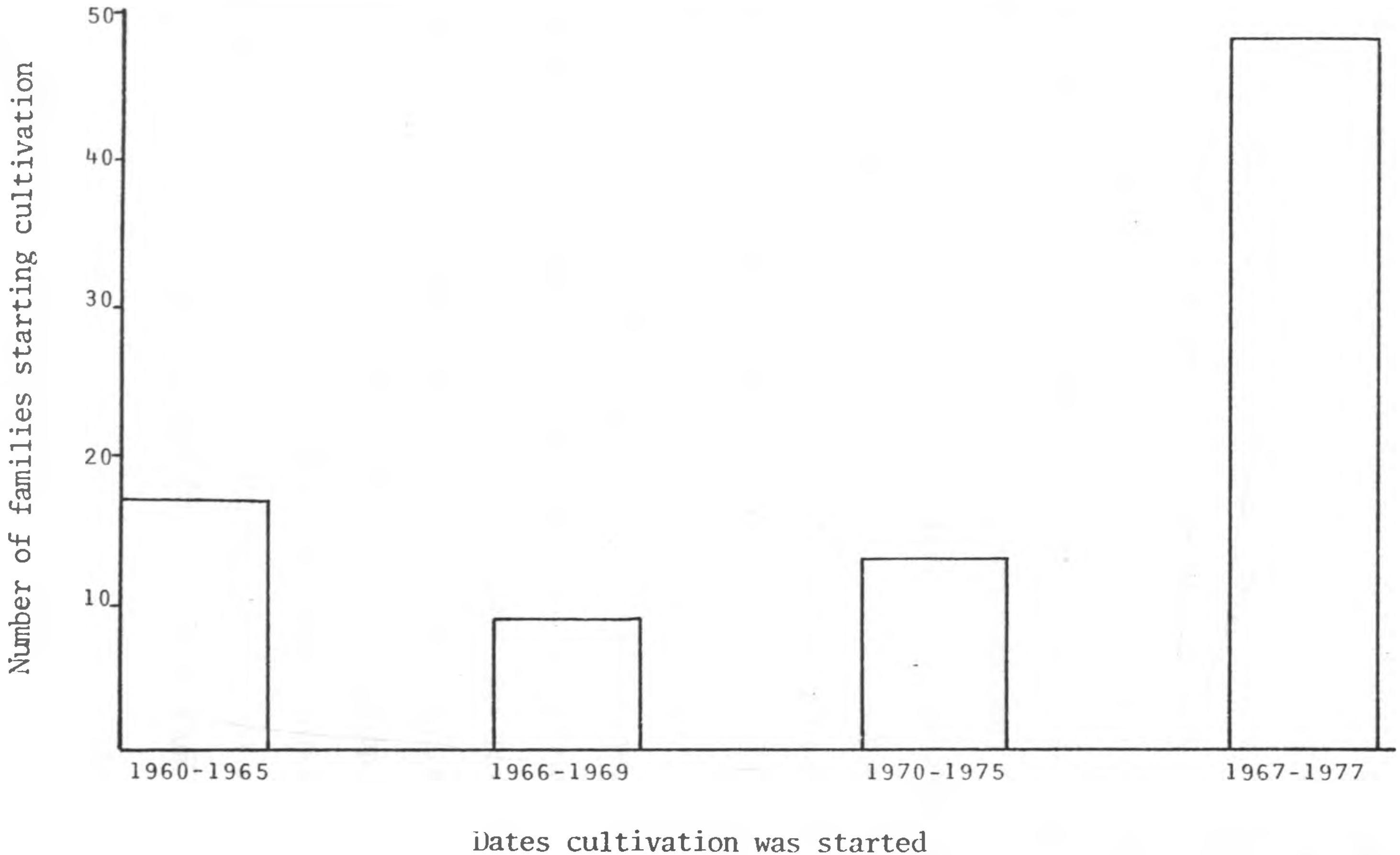
While 51 percent (N=148) of all families interviewed indicated that they intended to buy good agricultural land in the future, only 4 percent of the families owned land outside their respective group ranches.

Forty-one percent of the families indicated that they preferred agricultural land in north Kaputiei area especially around the Ngong Hills, 23 percent preferred Emali, while 18 percent considered the fertile agricultural land around Loitokitok area at the foot-slopes of mount Kilimanjaro.

The acceptance of cultivation practice among the pastoral Masai indicates that the cultural barriers that formerly locked the Masai in subsistence pastoralism are breaking down. Cultivation is only possible where a family contemplates to use the cleared good land for a number of years in order to justify the initial costs of breaking virgin land. Hence the high incidences of actual and intended cultivation strengthen

Figure 36c

Periods in which Kaputiei Families Started Cultivation



the evidence that the Masai would settle from a semi-nomadic way of life if the ecological condition favored such a mode of resource exploitation.

Significance of Sedentarization Trends

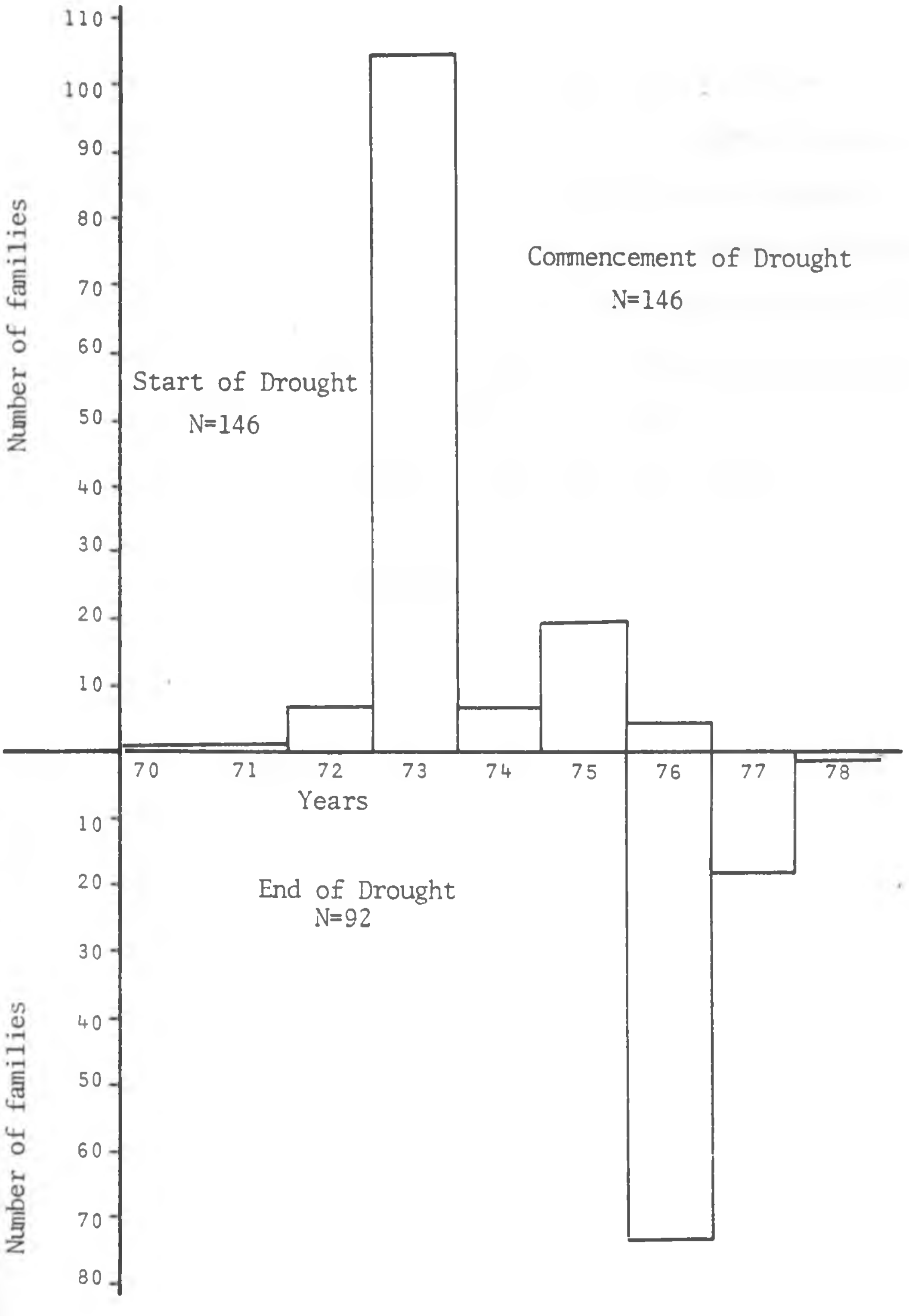
The ecological limitations are the most crucial determinants of a successful settlement program. In particular, drought cycles and the general deterioration of rangelands are central factors in the success of the group ranch organization program which was primarily designed to control semi-nomadic practices of Kaputiei Masai.

Drought has been defined as "the deficiency of precipation of sufficient magnitute to interfere with some phase of the economy" (Columbia Dictionary 1975). According to the Masai definition of the start and end of the recent drought, 71 percent of the families asserted that the drought started in 1973, while 79.3 percent think that the drought ended in 1976 (Figure 37). The high proportion of missing cases in the definition of the end point of the recent drought indicate that many families were still experiencing severe drought impact even by the end of 1977 and therefore they did not accept that the drought had ended at the time of the interview.

The cumulative effects of inadequate annual rainfall from 1971 to 1976 no doubt promoted the massive cattle movements in Kaputiei as shown in Figure 33. Since such drought cycles seem to recurr once or twice in every decade, we should therefore accommodate some form of inter-group ranch movements of livestock as one of drought management strategies. However, it is difficult to isolate the synergistic effects

Figure 37

The Masai's Definition of the Start and the End of the Recent Drought in Kaputiei



of inadequate rainfall and the range deterioration due to overgrazing by livestock. A deteriorating rangeland produces less forage even when the ecological conditions are favorable. Such is indeed the case with many of south Kaputiei ranches.

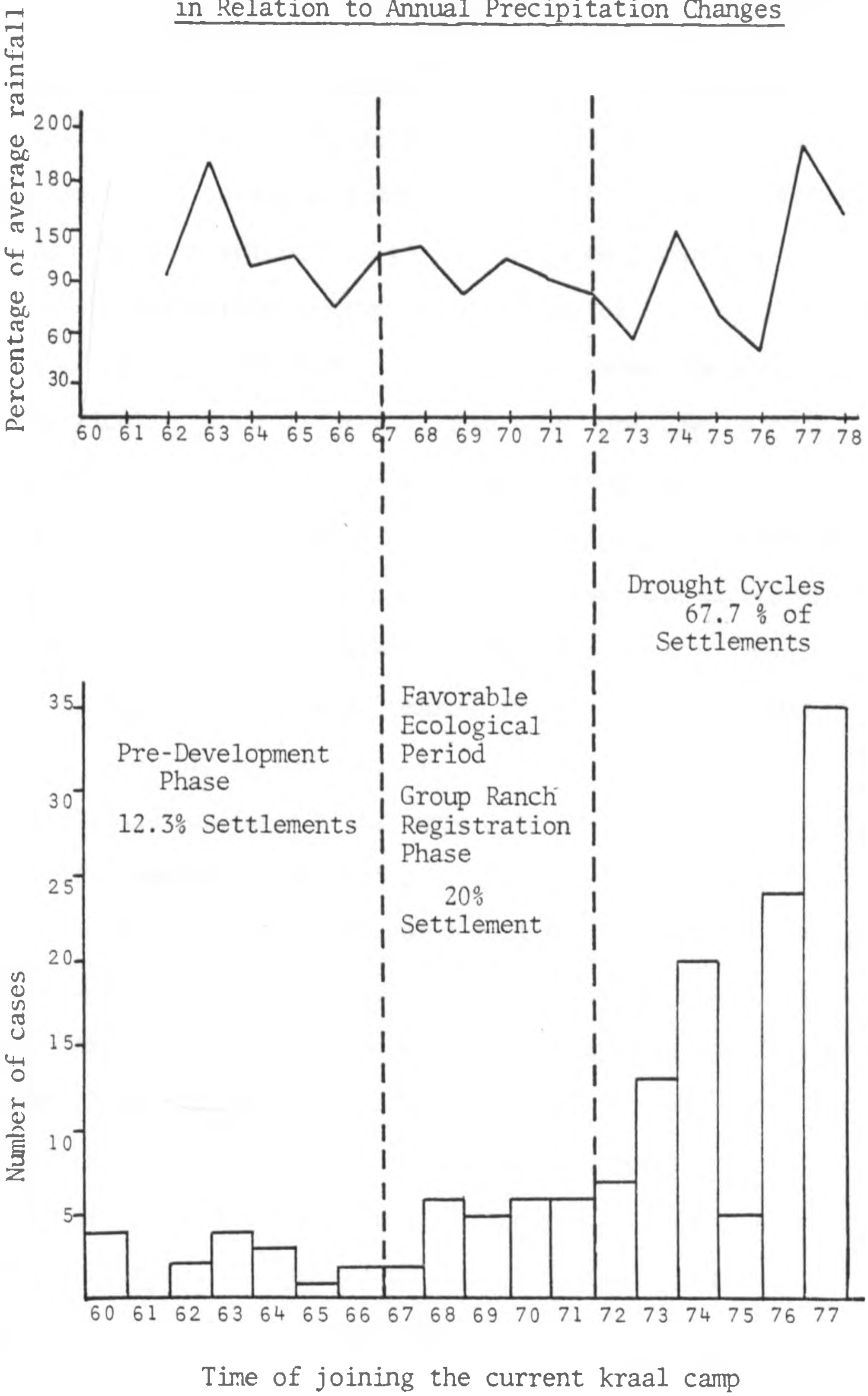
Further, the upsurge of sheep and goat population between 1968 and 1977 may be well correlated with a trend towards a sedentary way of life. As the cattle move farther each day for grazing because of frequent droughts and poor range conditions, small ruminant husbandry has become more significant. The impact of many scattered small kraals and increasing livestock numbers exacerbates pasture degradation as a result of trampling by large animals to and from pastures and, overgrazing near kraals by resident sheep and goat population.

Although the Masai have shown every desire to settle down whenever possible (i.e. permanent structures, cultivation and individualized small kraals), the duration of stay in any kraal from 1950 to 1977 has not increased significantly. This fact indicates that although the families may not be migrating across group ranch boundaries, there is high degree of instability of settlement sites within each group ranch as shown in Figure 38. The establishment of new kraals is strongly correlated with the fluctuation of total annual rainfall. In particular 40 percent of new kraals since 1960 were established between 1976 and 1977.

Hence the abandoning of old settlement sites is likely to be as a result of both weather patterns and pasture deterioration around settlement sites. Although the length of residence in a kraal during

Figure 38

Trend in Settlement Patterns in Kaputiei Ranches in Relation to Annual Precipitation Changes



1950 and 1977 is the same, it is important to keep in mind that there are more kraals abandoned nowadays than in the past because of over-peopling as well as the multiplication of small kraals. The peaks of joining new kraals during 1974 and 1976-1977 in Fig 38 may be sympomatic of the Masai's greater sensitivity to poor range conditions as soon as less than average rainfall occurs. Since most of the new kraals are established near the old ones, the process of range degradation is worse, particular in south Kaputiei than other previous observations.

The rapid disintegration of large kraal camps during 1970's coincides with the inception and operation of the group ranch development program in Kaputiei. It is most likely that the participants of the group ranch schemes perceived the allocation of land to groups of families as being only one step removed from individualization of and single ownership in the ranches.

The division of large kraal camps into small ones has implication in terms of livestock management practices. Traditionally, the Masai lived in large camps which averaged 4 to 8 families and an average camp had 400-700 cattle (Jacobs 1965). This association of many families in a single camp had beneficial effects on participating families as far as livestock management was concerned. Jacobs enumerates the mutual benefits to have included: sharing of labor resources, protection of livestock from predation, transfer of traditional livestock technology to young inexperienced families through joint meetings among herds of households to determine the movements of cattle, etc.

Cattle were herded together as a camp herd and not according to household herds.

The impacts of recent trends towards strict herd and flock management for each household can be used as one performance criterion on how far the Masai have indirectly or directly adopted sedentarization concepts of group ranch approach in Livestock Development Project (Figure 39 and 40).

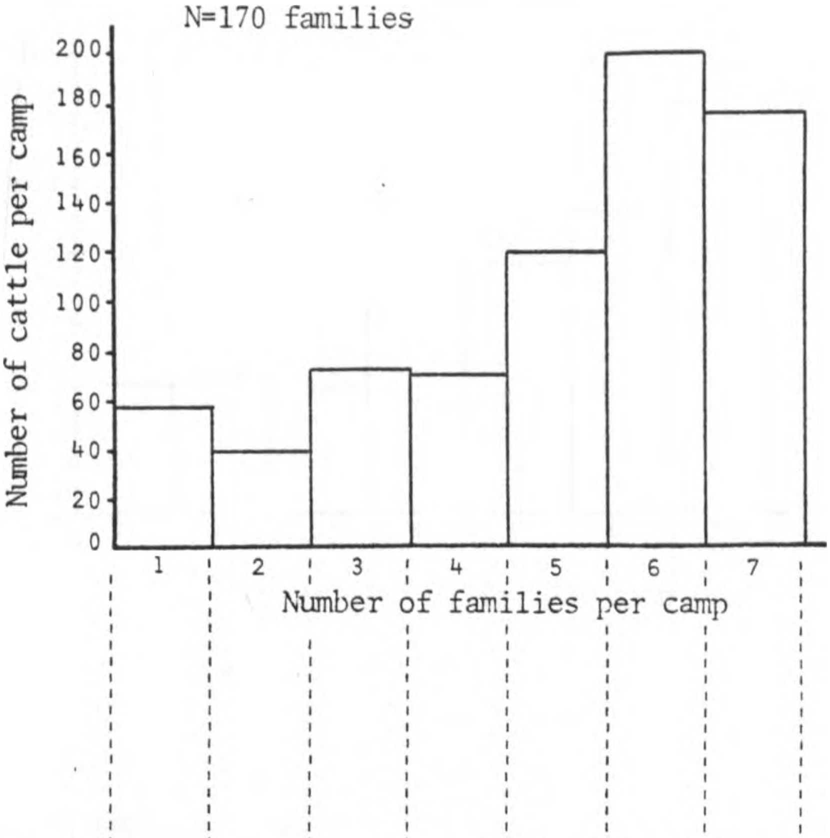
The households living alone in a camp possess nearly twice as many numbers of cattle, and sheep and goats as households residing together in two or more in one camp. Under such circumstances the households living alone prefer to carry out individual livestock management practices, rather than be involved in the traditional dependence on mutual benefits of families staying in a large camp. The solution for labor requirements to manage individual herds and flocks is usually, by having more than one wife, a common observation among rich families; or by hiring elders who are experienced in livestock management practices.

The benefits of adopting an individual livestock management approach instead of relying upon communal benefits in a large camp management allow an individual to accept and implement new livestock management practices without being dragged behind by stock-friends, relatives and inlaws. In addition, herd management problems increase with increasing size of the herd. For example, an individual can make a conscious effort to dip his animals regularly, vaccinate them at the right time, undertake proper genetic improvement by introducing improved

Figure 39

The Variation of Camp and Family Herd Size in Relation to the Camp Size (Number of Families Residing in the Same Kraal Camp)

(i) Number of cattle per camp in relation to the camp size



(ii) Number of cattle per family in relation to the camp size

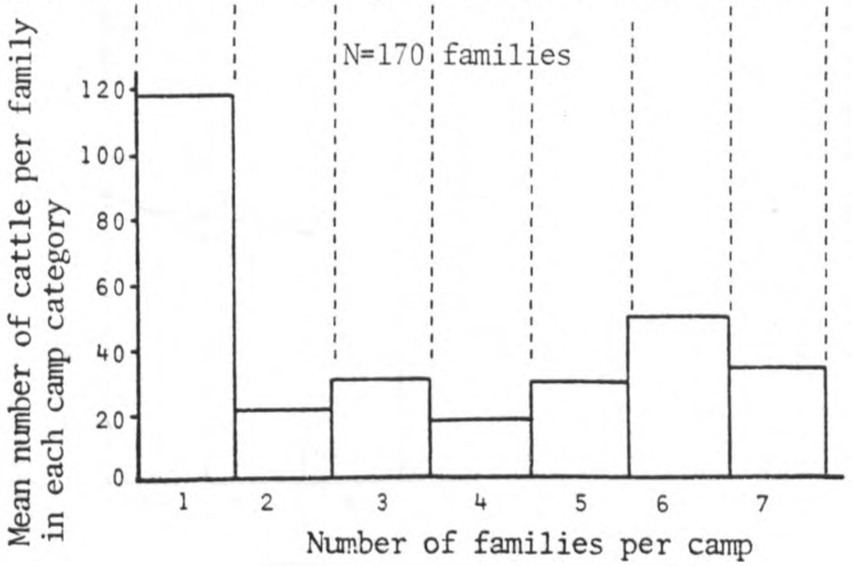
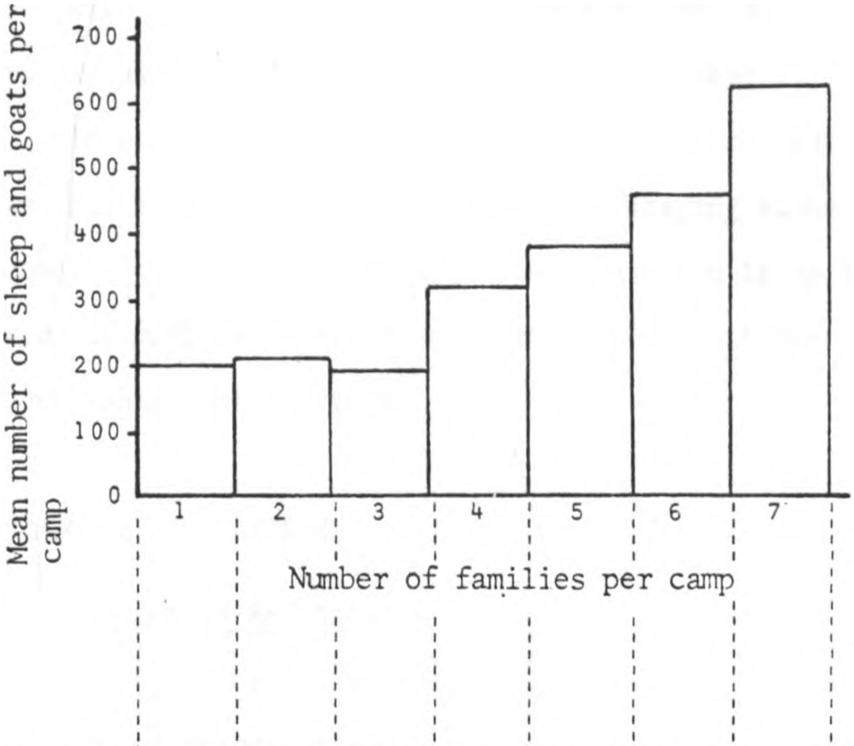


Figure 40

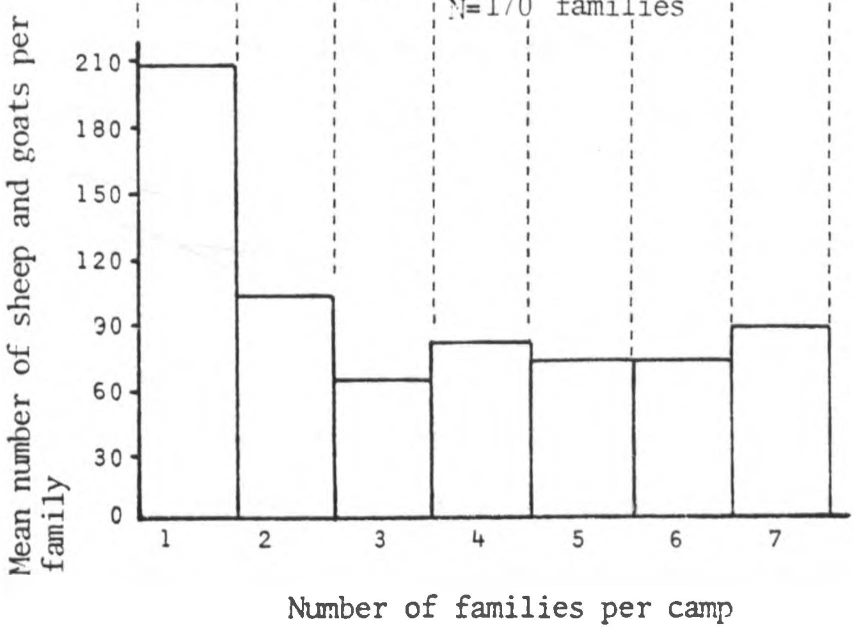
(i) The relationship between mean camp flock and the camp size in Kaputiei ranches

N=170 families



(ii) The relationship between mean flock size and the camp size in Kaputiei ranches

N=170 families



Boran or Sahiwal bulls or Persian Black head rams.
Since the number of animals increase with increasing number of families residing together, livestock management problems also increase with increasing camp size. In addition, an individual is customarily allowed to enclose a piece of land near his camp to serve as his calf paddock (ololopoloi). The calf paddocks have become more or less individual property for households staying alone in a settlement site. It is therefore likely that the large livestock resources of members living alone represent the outcome of good livestock management practices.

MULTIRESOURCE USE PATTERNS

Livestock Resources Revisited

The socio-cultural trends are also reflected in changes of multiple use of resources among the pastoralists. Definition of the resource base has widened to include hitherto unpopular livestock products, agricultural foods as well as high demand for good agricultural land for cultivation. The concept of multi-resource use was introduced earlier in Chapter 2. Livestock resources are by far the most important among Kaputiei Masai. In this section we examine the changes in the use of both livestock and non-livestock products in Kaputiei. It has been estimated that a pastoral family of 8 members requires 40 head of cattle to meet its subsistence requirements (Brown 1971). This is equivalent to 30 S.U. per family of approximately 6 A.E., or 5 S.U. per A.E. set for a family that is purely dependent on livestock products for dietary intake. The effect of using livestock and non-livestock products in the diet on the total subsistence S.U. requirement has not been determined.

The relationship between livestock and human density is suitable performance criterion for assessing the effects of the Kaputiei livestock development model from the standpoint of the level of subsistence risk danger. The higher the livestock/human density above the subsistence requirement of 5 S.U. per A.E., the lower the subsistence risk factor. Table 44 shows that south Kaputiei ranches in poorer ecological zone V had a higher density of S.U. per A.E. in 1968 and therefore had lower subsistence risk than other Kaputiei ranches. The effect of the Kaputiei livestock development project at the middle of the project in 1972-73 was to minimize the subsistence risk danger by increasing the S.U./A.E. density in Kaputiei ranches. However after the 1973-76 drought, the subsistence risk danger in Kaputiei increased by nearly a factor of 2 above the 1967 level (Table 44).

By diversifying the livestock production system to include cattle, sheep and goats relatively more families in Kaputiei survived the recent drought losses with adequate subsistence needs. (Table 45). Kaputiei families with $\geq$ 30 S.U. constituted 59.3 percent (N=789) after 1973-76 drought when cattle, and small ruminants were aggregated. If we include an insurance component of an extra 30 S.U. for each family, only 21.4 percent of Kaputiei families had more than 60 S.U.

Table 44

Changes in Relationship Between the Livestock/Human Density and the Level of Subsistence Risk Factor in Kaputiei Group Ranches

Group Ranch	Ecological Zone	Livestock/Human Density (S.U/A.E)			Subsistence Risk Factor[1]		
		1967	1972/73	1977	1967	1972/73	1977
North & Central Kaputiei							
Embolioi	IV/V	5.6	7.8	4.9	0.89	0.64	1.02
Erankau	IV	6.6	11.2	5.6	0.76	0.45	0.89
Ilmamen	IV/V	6.9	11.1	5.7	0.72	0.45	0.88
South Kaputiei							
Mbilini	V	8.7	16.7	5.4	0.57	0.30	0.93
Mbuko	V	14.1	18.3	4.7	0.35	0.27	1.06
Olkarkar	V	14.4	18.5	5.2	0.35	0.27	0.96

[1]Subsistence risk factor is calculated as a reciprocal of the ratio between S.U. per A.E. and the recommended subsistence allowance of 5.0 S.U. per A.E.

Table 45

Post Drought Livestock Distribution Among Kaputiei Households (1977)

Percentage of Households Under Each Category of Livestock Resource Ownership

	Total Stock Units (S.U.) i.e. sheep + goats + cattle		Cattle S.U.		Sheep and Goats	
	Relative Frequency	Cumulative Frequency	Relative Frequency	Cumulative Frequency	Relative Frequency	Cumulative Frequency
Category of Livestock Ownership per Household in S.U.	%	%	%	%	%	%
0 - 15	36.9	36.9	61.0	61.0	63.4	63.4
15.1 - 30	22.4	59.3	14.4	75.4	19.7	83.1
30.1 - 45	11.4	70.7	7.0	82.4	7.0	90.1
45.1 - 60	7.9	78.6	5.9	88.3	5.6	95.7
60.1 - over	21.4	100	11.7	100	4.4	100
Number of families	789	789	789	789	789	789

Hence a destocking program in 1977 would be appropriately addressed to only one third of the total families owning livestock in Kaputiei.

The significance of building insurance herds rather than merely subsistence herds becomes clear as we examine the aftermath of the recent drought in central and south Kaputiei areas. A central Kaputiei family lost approximately 3.5 times its current average herd size of 22.6 head of cattle, while in south Kaputiei, with a greater drought risk factor, an average family lost approximately 4.5 times the current herd size of 36.9 herds of cattle.

In addition to increasing livestock numbers beyond immediate subsistence needs as a form of insurance against future contigencies of drought, theft, diseases etc., a family also has some other options of dealing with subsistence risk danger.

The traditional livestock distributive mechanism among the Masai act in two useful ways. Firstly, the distribution of livestock from a rich to a poor family moderate the livestock ownership differences. Such a mechanism is a traditional social security system in which genuine poverty-stricken families receive some support.

Secondly, since such livestock transitions carry the understanding of a reciprocity exchange between the two families involved, the family giving some of the livestock to another family in need, reserve the right to claim help from the recipient family should such a need arise in the future. Therefore the more reciprocal exchange transaction in which a family with excess livestock members is involved the better the future possibilities of offsetting subsistence risk danger.

The extent of livestock reciprocal exchanges in Kaputiei during 1977 involved approximately 30 percent of the total families in Kaputiei who had borrowed either cattle or sheep and goats (Table 46). Approximately 2000 head of cattle or 7.7 percent of the total cattle population in Kaputiei were involved in these transactions, while sheep and goats borrowings together accounted for only 4.9 percent of the total sheep and goat population. Figure indicates the category of the types of livestock commonly requested for various reasons. Only 5 percent of the family had borrowed more than 10 head of cattle, while about 9 percent of the families had borrowed more than 10 sheep and goats. In general, the total number of livestock requested were few. (Table 47).

The social links in reciprocal livestock exchanges are dominated by inlaws (38 percent) and exchanges among brothers (27 percent). Friends of stock-associates accounted for 23 percent. The remaining small percentage involve distant relatives. It is significant to note that there is very little exchange interaction between a father and his sons. (Figure 42).

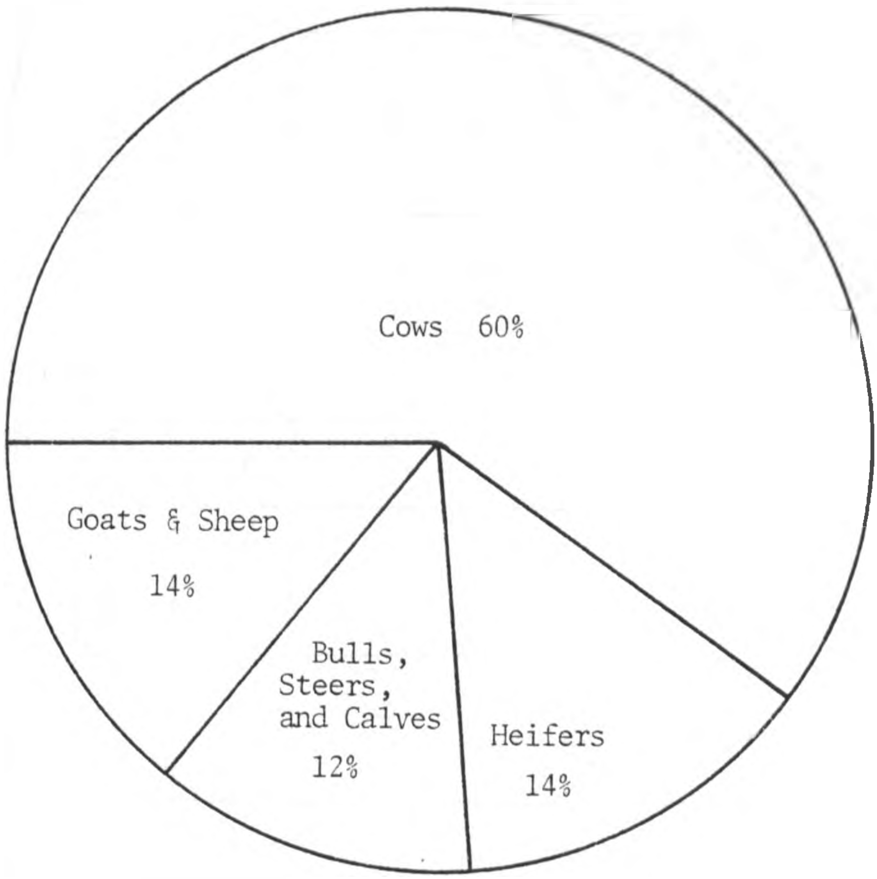
Table 46

Livestock Reciprocal Exchange Transactions Among Kaputiei Families in 1977

	Absolute Frequency	Relative Frequency in Percentage of the Total Valid Cases
Total (number of families)	789	
Families borrowing cattle	226	28.6%
Families borrowing sheep and goats	239	30.3%
Total number of cattle	25,896	
Number of cattle involved in reciprocal exchange	1,994	7.7%
Total number of sheep and goats	64,898	
Number of sheep and goats involved in reciprocal exchange	3,180	4.9%

Figure 41

Class of Animals Involved in Reciprocal Exchanges



N=231 Animals

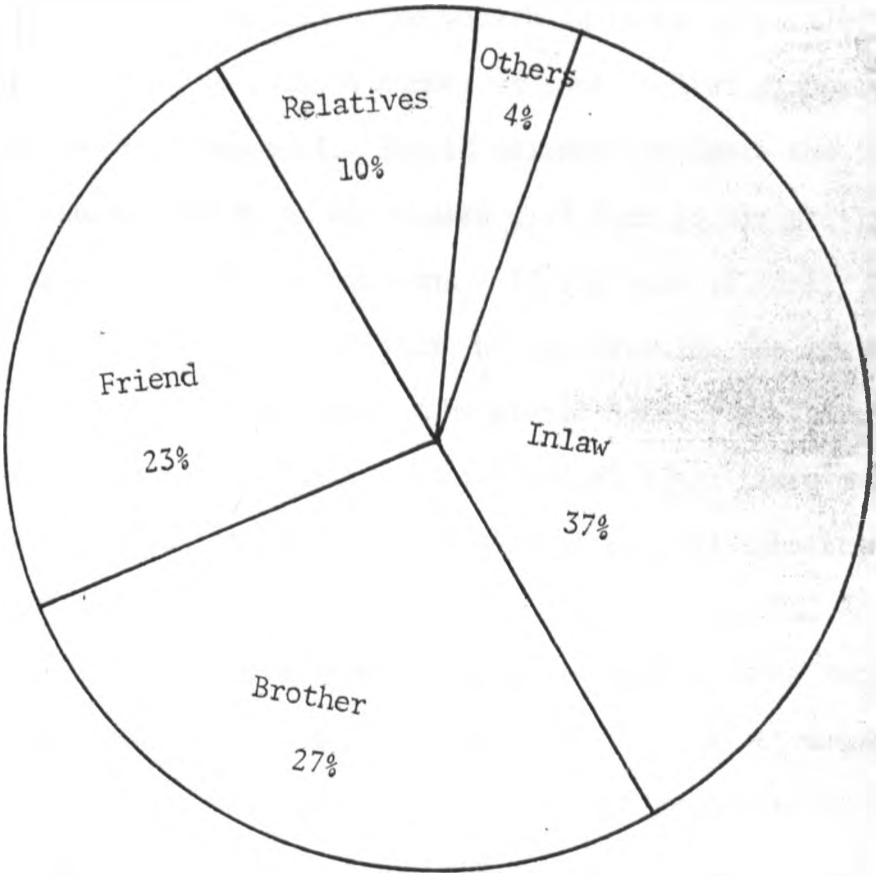
Table 47

Percentage of Families Involved in Reciprocal Transaction Under Each Class of Animals

Number of Animals per Category	Total Cattle	Bulls	Cows	Calves	Heifers	Steers	Sheep and Goats
Non-Participating families	71.4	94.7	77.6	87.7	88.0	95.6	69.7
1 - 2 animals	9.0	4.8	10.3	8.0	6.1	2.9	7.0
3 - 4 animals	6.0	0.3	5.8	2.5	1.9	0.4	5.3
Over 4 animals	13.7	0.3	6.3	1.8	4.1	1.1	18.0
N of Cases (families)	789	789	789	789	789	789	789

Figure 42

Social Links in Reciprocal Exchanges



N=569 responses from 148 families

These exchange-ties underscores the importance of building large families in pastoral areas. Not only does a large family provide adequate labor especially during drought periods, but it also serves as one of the valuable components of a family insurance system. A polygamous head of family with many daughters will in future acquire a substantial bride wealth in terms of cattle, but more important too, he gains a number of sons-in-laws probably located anywhere in Kaputiei. Should calamity decimate the family herd, the head of family in many cases will turn to his son-in-law for help, and hardly to his own sons. If the head of family has many full brothers and bond-friends, he can exercise the reciprocal exchange process to get at least subsistence needs from those possible sources. The larger the family and its social links therefore, the greater the range of the possibilities of offsetting subsistence risk danger.

If the livestock Development Program is roding these social connections by emphasizing increased offtake rates of livestock, then there must be provision for a compensatory mechanism to replace the traditional social security system.

The extent to which the Masai are participating in economic exchange transactions is still not very clear. The following data were collected from 148 cases during the detailed social survey. Each person interviewed was questioned on the number and class of livestock brought or sold during different ecological periods from 1960 to 1976. The number of families participating in economic transaction during this period are shown in Figure 43.

For the same period, the total number of livestock purchased constituted only about 10 percent of the total sales of 14,264 heads. This is partly because, only 47 percent of families interviewed had ever been involved in livestock purchase transactions compared with 87 percent of families participating in the livestock sales. Only 12.2 percent of the total cases (N = 148) either refused to disclose their livestock economic transactions or they had never participated in any economic transaction. The mean purchase and sales per family participating were 20 $\pm$ 25 animal heads and 115 $\pm$ 146 heads respectively. The categorical breakdown of families participating in the purchase and sales transactions are shown in Figure 44.

Forty-five percent of families participating in purchases buy animals in the first category (1 - 10 animals) while for the sales the highest number of families of 68 percent have sold more than 40 animals.

The frequency of families using the various classes of livestock for economic transactions show that for purchases, the majority of families buy sheep and goats (46 percent) possibly due to the relatively little capital outlay involved. Families buying mature cows constitute 25 percent while other families opting for either heifers, bulls or steers constitute 29 percent of total cases (Figure 44). The families selling small ruminants constitute 27 percent. Mature cows, possibly

Figure 43

Families Participating in Purchases and Sales of Livestock

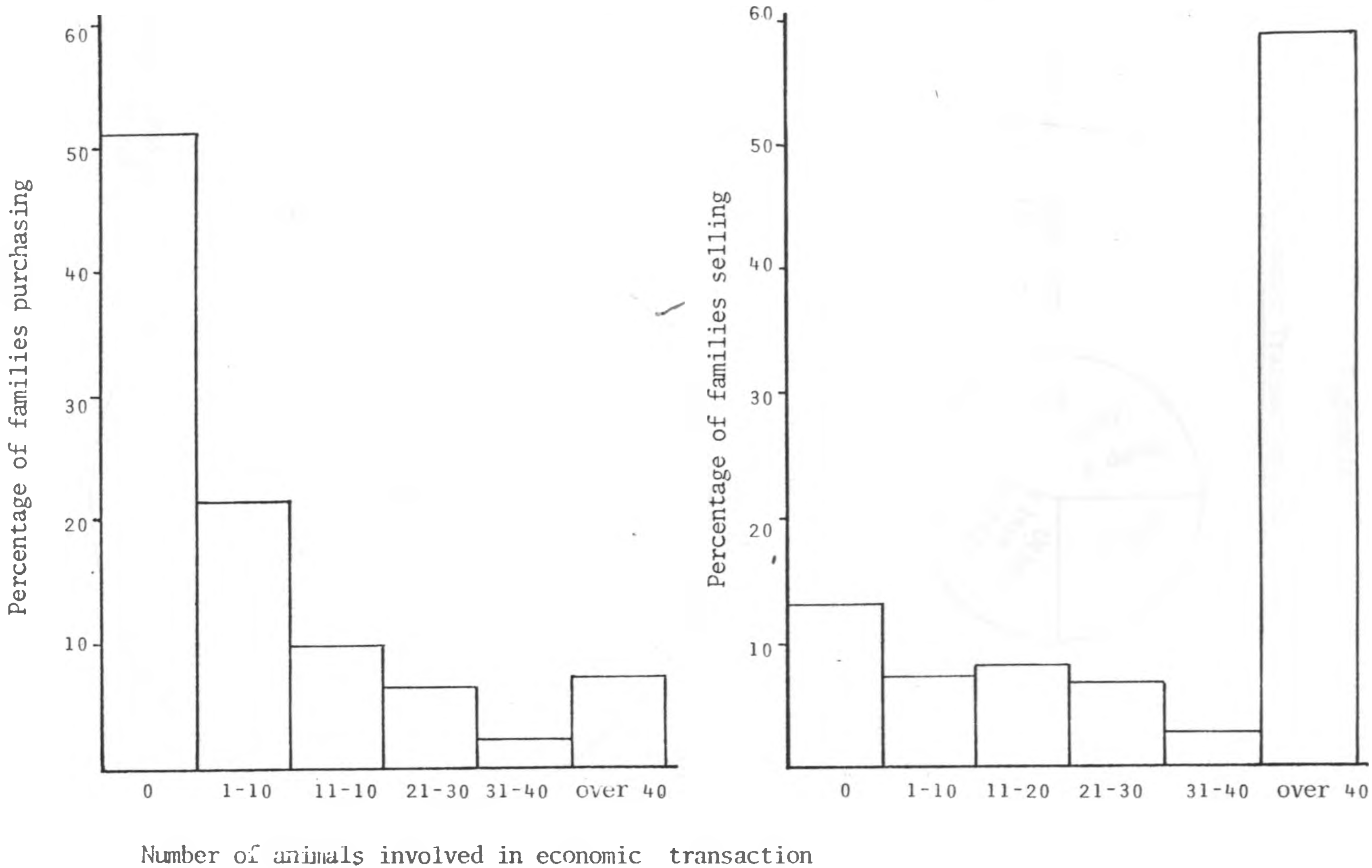
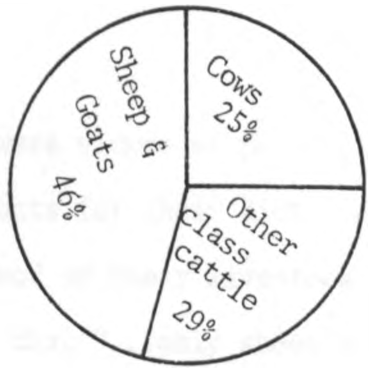
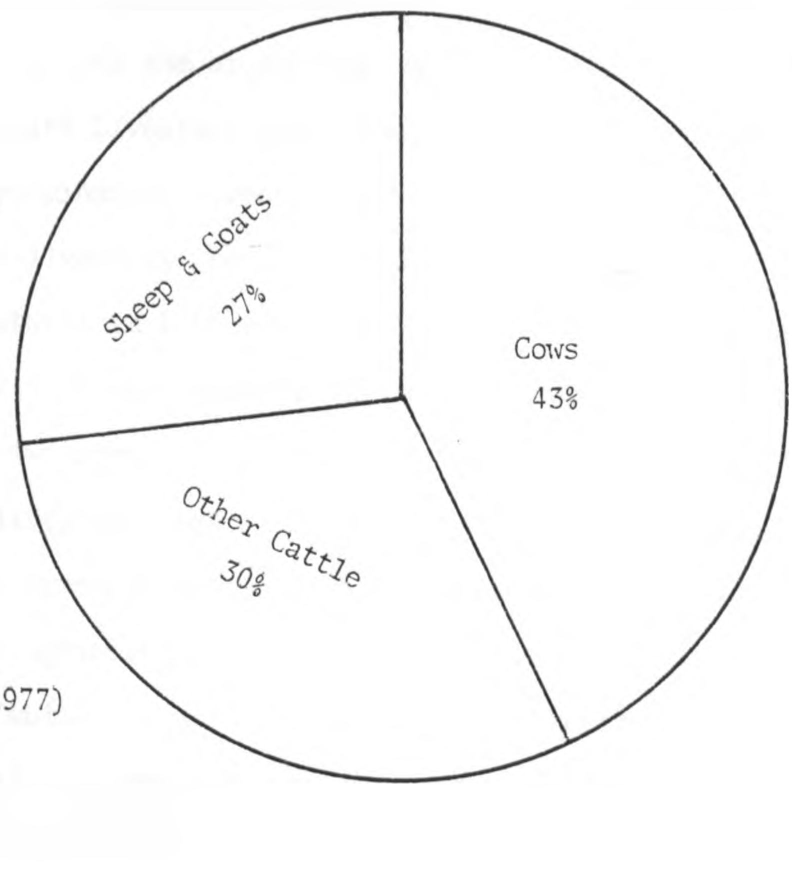


Figure 44

Economic Transactions of Animals

Purchases (1968-1977)
N = 122





Sales (1968-1977)
N = 575

those culled because of age, were sole by 43 percent of total families, while the families selling bulls, steers and heifers constitute about 30 percent.

Masai Dietary Changes

The Masai in the past were viewed as pastoralists totally dependent on livestock products for their diet. Jacobs (1965) records that "The milk, meat and blood of their livestock form the stable (sic) diet of Pastoral Masai" and that "...only sheep's milk is used by women and children during the dry season as the supplement to low cow milk yields." (page 148)

My view about the current dietary composition of Kaputiei Masai is that it reflects a significant trend in the multiple use of resources due to changes in both the biophysical and the socio-cultural environment. The Kaputiei Livestock Development Project anticipated the switch from predominantly livestock dietary intake to a diet with a wide spectrum of non-livestock products as the Kaputiei Masai shift from subsistence pastoralism into a form of commercial production system.

The analysis of diet composition of the group ranch participants is crucial for two reasons. Firstly, if indeed substitution of a predominantly livestock diet with non-livestock products has succeeded, this reflects a transcendence of one time cultural barriers associated with the use of agricultural foods among Masai pastoralists. But a valid question which is beyond the scope of my thesis is whether such a socio-cultural acceptance of non-livestock foods has had an adverse affect on the overall nutritional quality of the Masai diet.

Secondly, significant dependence on agricultural foods produced outside the rangeland areas raises an important question on ecological grounds. Is it possible that under-priced agricultural foods from high potential areas are subsidizing a subsistence pastoralism in the rangelands? This question is central to the argument that resources used in the transformation of traditional pastoralism will enhance higher livestock offtake rates in the evolution of a commercial production enterprise.

Such a dependence on agricultural food suggests that the exchange between pastoral and agricultural communities has increased. Under the circumstances in which the terms of trade with agricultural community favor the pastoralist, the income from the sale of one cow will bring more agricultural foods, particularly maize by-products, to maintain the family for a long time before selling a second cow.

It is likely too that with a predominately agricultural diet, the Masai continues to build a large herd without intention of selling more animals beyond the cash needed for buying agricultural foods. The preservation of such undesirable traditional elements in subsistence pastoralism under the subsidy of underpriced surplus output from agriculturally high potential areas may be a major factor that is accelerating range degradation by well intended range development programs.

The data from the diet section of my field social survey were collected in order to characterize the trend of the current diet status among the group ranch participants. In addition, since many families with inadequate livestock resources cannot live on a purely livestock oriented diet, other alternative non-livestock products become relevant issues in showing ecological trends in Kaputiei.

The foodstuffs making a typical Masai diet in Kaputiei can be classified into two categories: livestock products and non-livestock products.

The livestock products include milk, meat and rarely blood. Significant changes in the use of livestock products in the Masai diet focus on the increasing importance of the milk and meat from the small ruminants i.e. sheep and goats. Although in the past, the Masai derided the milking of goats (Jacobs 1965), recent data show that milk from small ruminants, and in particular goat's milk, became an important food item after 1960/61 drought (Table 48). After the drought (1973-1976), 88 percent of the families interviewed (N=148), were using sheep's milk, compared to only 32 percent of these families which used sheep's milk during and after the 1960/61 drought.

The introduction of the use of milk from sheep and goats is credited to the women. Fifty-one percent (N=148), and 45 percent (N=148) of the families were respectively using the milk from goats and sheep daily by the end of 1977. Drought is singled out as the major factor leading to the current emphasis on milk yields from sheep and goats.

Another significant feature of changes in the use of livestock products is the decreasing importance of cattle blood in the diet particularly during the dry seasons. Of the total families interviewed, 71 percent used blood to supplement their diet during the 1960/61

Table 48

Importance of Various Food Items During the Droughts of 1949/50, 1959/60 and 1973/76

Drought Foods	Droughts		
	1949/50	1959/60	1973/76
Maize cake (Ugali)	68	136	136
Tea	75	138	140
Porridge (Uji)	76	138	141
Maize	59	136	139
Beans	54	125	130
Wild fruits	48	47	43
Blood	97	105	30
Sheep and goat meat	94	129	124
Cattle meat	97	121	118
Wildlife meat	1	51	75
Cow milk	91	95	106
Goat milk	2	107	137
Sheep milk	1	48	130
Powder milk	0	53	51
Valid cases	148	148	148

drought, while only 20 percent of these families used blood during the recent drought (N = 148). It is also interesting to add that about 35 percent of these families used powder milk during 1960/61 and 1973/1976 drought. Livestock meat is not a daily item in the pastoral diet, but an occassional food item for social ceremonies and cases of illness.

The introductions of non-livestock products in the diet of Kaputiei Masai show increasing trend of the diversity in the diet over the past few decades. Some of the foodstuffs have totally been accepted for some time by the majority of Kaputiei Masai. Sugar, tea, maize cake (ugali), maize porridge (uji), and beans, were popular among most of the families even before 1950. (Table 49).

The acceptance of rice and Irish potatoes among the Kaputiei has been gradual over the decades, while such food items like wheat bread, wildlife and meat were known to most families only after 1960. Chicken is the most recent introduction among only a few people in Kaputiei (Table 49). All the people interviewed were shocked when asked if they had ever eaten fish meat, thus showing a strong cultural barrier in its acceptance among Kaputiei Masai.

The people credited with the introduction, particularly of non-livestock food items include Asians (47 percent), agricultural sedentary communities (Kamba 15 percent, Kikuyu 8 percent), women (10 percent) and Europeans (9 percent). (N = 841 responses).

The special role of Masai women in altering the diet composition is because of the high cases of intermarriage of Masai men to Kikuyu

Table 49

Periods of New Food Introductions

	Valid Cases	Percentage of Valid Cases Before 1950	1950's	1960's	1970's
Sugar	86	97%	3%	0	0
Tea	82	94%	5%	1%	0
Maize cake (Ugali)	84	67%	21%	12%	0
Maize porridge (Uji)	79	73%	14%	11%	2%
Beans	67	67%	18%	15%	0
Rice	94	23%	14%	39%	23%
Potato	85	41%	21%	21%	17%
Bread	68	7%	3%	56%	34%
Wildlife meat	56	2%	4%	48%	46%
Chicken	34	3%	3%	15%	79%
Goat milk	78	0	4%	77%	19%
Sheep milk	73	0	1%	44%	55%

and Kamba women. These non-Masai women not only bring along their food habits from agricultural areas, but they are also probably responsible for the many cultivated plots near settlement sites.

The Asians came to East Africa as railway builders at the end of the 19th Century. After their mission was over, most of the Asians settled in East Africa and became active business men. They infiltrated into the interior of the country and particularly in trading centers along the railway lines. The introduction of many consumer goods in many rural areas is therefore appropriately accorded to the Asians.

The frequency of intake of the various food items found in the Masai diet is shown on Table 50, and the categories of the persons in the family who use the various types of new foodstuffs are also shown on Table 51.

The food types in the various droughts indicate wildlife meat, milk from sheep and goats and powder milk became important after 1960 drought. However the agricultural foods have always been the most significant components of the drought foods even before 1960. (Table 51).

Famine relief is appropriately mentioned in this category because it has become a critical means of intervention in extreme cases of starvation. For example in the recent 1973-1976 drought, 52 percent of 409 families in Embolioi and Mashuru group ranches received maize flour as a form of famine relief. Only 7.3 percent of the families in these ranches indicated that they did not receive any famine relief.

Table 50

Frequency of Various Food Items in the Diet of Kaputiei Masai (Absolute Frequency)

	Zero Cases	Valid Cases	Daily	Weekly	Monthly	Yearly	Rarely
Sugar	50	98	97	1			
Tea	58	90	85	5			
Maize cake (Ugali)	52	96	63	33			
Porridge (Uji)	63	85	72	8	3		2
Beans	74	74	24	24	27		1
Rice	54	94	5	36	42	6	5
Potatoes	65	83	9	34	30	3	7
Bread	73	75	5	33	31		6
Beer	69	79	19	52	4	1	3
Chicken	110	38	3	5	8	9	13
Fish	146	2	1	1			
Wildlife	96	52	2	1	6	12	31
Goat milk	59	89	76	2	3	1	7
Sheep milk	71	77	67		1		9

Table 51

Members of the Household Using Various Food Items in the Diet
(Absolute Frequencies)

Food Item	Valid Cases	All Members	Some Members
Salt	43	43	
Sugar	96	95	1
Tea	89	88	1
Maize Cake (Ugali)	94	94	
Porridge (Uji)	84	82	2
Beans	73	57	16
Rice	91	85	6
Potato	79	76	3
Bread	74	67	7
Beer	81	34	42
Chicken	35	8	24
Wildlife meat	45	23	22
Goat	86	81	5
Sheep	78	70	8

Other Supplementary Resources

Forty-three percent of the heads of families had been employed at one time (N = 148). Types of the employments taken included government jobs in the police, ministries and teaching (37 percent), private jobs as farm laborers (33 percent), company jobs (25 percent) and self employment in private business (5 percent).

The dates when various jobs were taken show that the trends of labor sales among the pastoralists is increasing. Seventy-five families (i.e. 56 percent) were employed after 1970, while only 21 cases were employed between 1960 and 1969.

Labor sale in the family comes mainly from the head of family and his sons (96 percent, N = 75). Reasons given for labour sale outside the household touch on the need for money and also an alternative means of coping with drought stress.

By contrast to the sale of labour, 39 percent of the families (N = 148) had engaged the services of another person from outside the household. Ninety-one percent (N = 68) of the hired services came from elders of the Masai.

Ninety-five percent (N = 62) of the families hiring outside labour diverted it to herding of livestock. The labour requirements for herding the livestock during the 1973-1976 drought period show that 83 percent (N = 148) of the families depended on labour supply by the head of family (35 percent) and his sons (48 percent). Only 7 percent of the families hired outside labour for herding purposes, and 5 percent of the families depended on in-laws for labour assistance during the recent drought.

From the very beginning of the Livestock Development Project in Kaputiei, the significance of the wildlife resources in the welfare of the Masai was highlighted.

The data from the ledger aerial wildlife counts of 1967 indicated the biomas and diversity of wildlife species in Kaputiei. The four most important ungulates in Anthi-Kapiti plains (751 sq. miles) i.e. wildbeest, zebra, Coke's hartebeest and eland, together constituted a total of 20,182 animals, equivalent to a biomass of 20.3 per acre. The central and South Kaputiei area (704 sq. miles) showed only one third as much total biomass as were the Athi-Kapiti plains.

The diversity of wildlife species possible for food in Kaputiei region according to 1967 inventory includes: zebra, wildbeest Coke's hartebeest, Grant's gazelle, Thompson's gazelle, impala, eland, water-buck, fringe-eared oryx, bushbuck, dik-dik, red duiker, steinbok, reedback, klipslinger, gerenuk, lesser kudu, buffalo, elephant, black rhinoceros, giraffe, warthog, (lion, leopard, cheetah, black-backed jackal, hunting dog, spotted hyena) and ostrich.

A comparative analysis of the 1967 and 1976 wildlife resources show a declining trend in the abundance of these resources. Elephants and rhinoceros were notably absent from 1976 species list (Wildlife Management Project 1976). In Athi-Kapiti area zebra biomass comprised 104 percent of the wildbeest biomass in 1967. but only 11 percent in 1976.

The declining trends in both the biomass and diversity of the wildlife resources are primarily due to two factors. Firstly, a drought in 1973 to 1976 caused heavy wildlife mortalities. In Athi-Kapiti area of 2,000 sq. km. drought loss constituted a total of 9,880 animals between 1973 and 1974. Of the total drought loss, 89 percent consisted of wildbeest, Coke's hartebeest and zebra. (Casebeer Report 1974).

Secondly, poaching of certain species of wildlife such as elephant, rhinoceros and zebra has become a serious issue since 1967. For example, of the total zebra loss of 11,000 animals between 1973 and 1974, 45 percent of the loss was attributed to poaches (Annual Mortality Report 1974). Until 1977 when hunting and wildlife trophy industry were prohibited in Kenya, zebra skins and other wildlife items found a very lucrative market in Nairobi which is less than 40 miles away from Athi-Kapiti area.

Regardless of drought losses and poaching problems the revenue from the ministry of wildlife and tourism has increased tremendously since 1967. The Kaputiei Masai have contributed to the growth of this revenue from tourism industry in Kenya. Nairobi National Park, the most popular tourist resort, depends on Kitengela wildlife conservation unit to accommodate the wildlife seasonal movements to and from the National Park. Accordingly, the Kitengela area was removed from the group ranching development in Kaputiei. Both the National Park and Kitengela area were traditionally the dry season grazing area for Kaputiei Masai.

The role of wildlife in the ranch development program can only be assessed by the Masai themselves. It is therefore important to explore the current thinking in relation to wildlife resources among the participants of this Kaputiei development program.

Of the families that were questioned, 78.4 percent (N = 148) of the respondents complained of problems related to wildlife presence in their ranches. The types of problems associated to wildlife includes predation (31.4 percent), disease transmission (29.3 percent) crop distruction (1.4 percent), and human danger. On the issue of predation, 34.5 percent, 35.1 percent and 10 percent of the families had lost a sheep, a goat or a calf respectively to predators.

The animal species associated with predation problems include wildbeest predation (66 cases) hyena (17 cases), eland (11 cases), impala and gazella (4 cases), kongoni (7 cases) and others such as elephant, jackals, monkeys, buffalos porcupines.

The benefits accruing from wildlife were clearly defined out in the pre-investment study and inspite of the frequent attempt to emphasize its importance to the Masai economy, only 15.5 percent (N = 148) families recognized the potential benefits from wildlife in their group ranches.

Some of the benefits mentioned include the revenue from the tourism industry (18 families), source of drought food (4 families) and others (3 families.

As regards the future of wildlife in the group ranches, 28 percent of the families (M = 148) specifically mentioned that wildbeest should be exterminated from the scene while fortunately the 55.4 percent of the families (N = 148) called for some conservation measures within National Park areas, and not inside their respective ranches.

The results indicate that much remains to be done in demonstrating the benefits of wildlife in the group ranches. Many Masai feel that they are not being compensated for losses sustained due to problems associated with wildlife presence on their ranches.

In one example in which a lion maulled a cow belonging to a member of Emarti group ranch, he reported that it was just bad luck for him since nobody would compensate him. The government has a compensation program. This man was later compensated for the loss sustained but he represents one of the few people aware that such arrangements exists.

Although ambitious plans to utilize wildlife resources through hunting and cropping programs have been tried in Kajiado district, the Kaputiei Masai are quite ignorant of the actual value of wildlife presence in their ranches.

The trend towards wildlife and livestock resource use conflicts probably stems from a skewed distribution of the costs and benefits of wildlife conservation. While on the one hand the Masai shoulders the actual costs of forage competition between livestock and wildlife,. disease transmission and displacement of the Masai from his former dry season grazing by National Parks, the benefits from wildlife on the other hand, are mostly enjoyed outside Masailand. Hence it is natural for the Masai people to feel that they are not only bearing the social costs of conserving wildlife within their ranches without tangible benefits from this resource.

The mineral resources are only limited to a few ranches unlike the widespread wildlife resources, relatively more people are aware of tangible benefits accring from mineral resources.

Gypsum for cement production is the major mineral from Kaputiei. Some members regard manure as a mineral resource. Livestock manure from Kaputiei is increasingly on demand in the agricultural areas.

Benefits from mineral resources are recognized by 28 families. The benefits mentioned include: schools (23 responses); and general ranch development benefits such as roads, water, dips, jobs, loan repayments (32 responses). Similar benefits from wildlife resources are possible to demonstrate, but such benefits do not exist as far as the Masai are concerned.

Charcoal is also becoming an important resource particularly in wooded areas in central Kaputiei. In north Kaputiei, where trees are only found along river courses like Isinya, charcoal burning represents a serious problem in the conservation of riverine vegetation. Selective bush clearing in central Kaputiei to produce charcoal and firewood would benefit the areas without firewood in north Kaputiei and in addition these resources will find high demand in Nariobi city and the agricultural areas.

At present only 7.4 percent of Kaputiei families are involved in charcoal business (N = 148). Of the interviewed eleven families in this business, 5 families started between 1976 and 1977, while nine families started after 1970. All the families involved in charcoal burning were doing it for sale.

SUMMARY AND CONCLUSIONS

The monitoring of the human behavioral sector provides perhaps the most important performance criterion of the Kaputiei Group Ranch Development Model.

The human census was conducted in 1977 to study the changes in demography characteristics since the 1967 census. The population increase in north and central Kaputiei ranches resulted from the survivorship of children. The proportion of children under 15 years in the ranches increased from 48.3 $\pm$ 2.11 percent in 1967 to 58.4 $\pm$ 3.15 percent in 1977. By contrast, the south Kaputiei human population resulted from an increase of married women per head of family from 1.28 $\pm$ .42 in 1967 to 2.11 $\pm$ 0.20 in 1977.

A sample of 148 families was taken to study in detail the mutual adaptation processes between the Kaputiei Masai and their changing environment.

Seventy-six percent of the families were satisfied with the group ranch organization and its mode of operation. Forty-nine percent of the advantages of belonging to a group ranch were related to range improvements such as dips, water, schools and shops. The main disadvantages included management problems and inadequate range improvement facilities.

The settlement patterns in the group ranches are changing from large settlement camps ($>$ 5 families per camp) to small settlement camps (with 1-2 families per camp). For example, in 1950's, 1960's and 1970's, the settlement camps with one-two families constituted respectively 10 percent, 22 percent and 62 percent.

Reasons behind the choice of current settlement sites leaned heavily upon the need to protect legal land rights (67 percent) and the availability of development inputs (33 percent) such as dips, water, schools and roads. Eighty-two percent of the total permanent and semi-permanent structures (i.e. inconventional houses, wire fencing etc.) were erected between 1971 and 1977.

Drought is the major factor undermining the Masai's committment to settle down. For example, 85 percent of the total livestock movements (N = 350) occurred between 1973 and 1976. In addition, 67 percent of the current settlement sites were chosen between 1973 and 1976.

The definition of a new resource base by the Kaputiei Masai has enabled their addition of new livestock and non-livestock items in their diet. The livestock subsistence resources increased from 9.4 S.U. per A.E. in 1967 to 13.9 S.U./A.E. in 1972/73; but then decreased to 5.3 S.U. per A.E. in 1977. Over 59.3 percent of Kaputiei families possess less than 30 S.U. per family and therefore cannot meet their subsistence needs from livestock resources alone.

The traditional livestock reciprocal exchanges in 1977 involved about 30 percent of the total Kaputiei families (N = 789) and 7.7 percent of cattle and 4.9 percent sheep and goats populations. Reciprocal exchanges take place along well defined social relations such as inlaws (38 percent, N = 148) brothers (27 percent) and stock associates (23 percent (N = 148) and 87 percent of families participated in livestock purchases and sales respectively between 1960 and 1976.

Fifty-eight percent and 53 percent of the families in Kaputiei were respectively using goat's milk and sheep's milk daily by 1977. Sheep milk became an important diet supplement only after 1973. Agricultural foods such as maize, beans, rice, potatoes, etc. have always been common among Kaputiei Masai even before 1968, but their use is increasing. Even chicken and wildlife meats are popular among a few families.

Other supplementary resources within the scope of multiresource use patterns of Kaputiei Masai include a dwidling wildlife resource, minerals, charcoal burning and outside employment.

The conclusions drawn from the analysis of Masai's responses to the development changes in Kaputiei depends on the performance criteria chosen. From the view point of the planners, the performance criterion of the Kaputiei Livestock Project is based on the sedentarization trend. It was shown that the families continue to practice semi-nomadic practices within and across ranch boundaries when the ecological conditions are unfavorable. From this aspect therefore the group ranch organization has failed on ecological grounds.

In my judgment, the subsistence risk factor is a reasonable criterion of the performance of the Livestock Development Project. One aspect involves the use of the magnitude of subsistence risk factor as performance criterion. The Kaputiei livestock Development Project temporarily reduced this subsistence risk factor in 1972/73, but in 1977, the Kaputiei families were exposed to a greater subsistence risk factor than before the project began in 1967. Another aspect of the

Subsistence risk factor concerns the hierarchy in food perference of a community. The Masai usually prefers cow's milk whenever possible. The switch from the use of milk from a cow to the use of milk from sheep and goat occured during the drought between 1973 and 1976. It is therefore very probable that the use of milk from small ruminant occurred because of the scarcity of the preferred cow's milk. We can therefore argue that the subsistence risk factor has increased as a result of the Kaputiei Livestock Development Program for two reasons. Firstly, cattle production is one of the major strategies of meeting subsistence needs of the Masai. In parts of Kaputiei today, sheep and goats are the only means of utilizing the rangeland. The subsistence risk factor has therefore been enhanced by the reduction of options in the use of rangeland resources, i.e. no cattle production.

Secondly, sheep and goats accelerated the rangeland degradation. It is therefore likely that if the range trend continues to deteriorate, the productivity of sheep and goats will also decline leading to greater subsistence risk dnager for the Masai.

This aspect of the projects' failure comes from the mutual disrespect between the Masai on one hand, and the development planners on the other. The Masai are insensitive to the flow of future benefits from conservation of the rangeland resources and therefore their response to the development program is unacceptable on two accounts. Firstly, before drought losses and serious pasture degeneration, the Masai responded to intensive water development by keeping more cattle and selling very few. Secondly, when the rangeland could no longer support cattle as in the past, the Masai have emphasized sheep and goats to meet their expendient needs. This decision accelerates the destruction of the rangelands. Hence, although the Masai are quick to adopt survival measures to cope with their misfortunes, they nontheless adopt resource use patterns that pay no regards for future benefits through conservation. A reasonable cause of action in solving this problem is to sensitize the Masai to the problem of short-term horizon of resource use.

The planners, on the other hand, are guilty of insensitivity on the overall welfare of the Masai. Although water development, veterinary services and marketing channels were proposed, the administrative capacity to innovate these range improvement programs was inadequate. In addition, the planning and implementing teams did not establish a reliable method of evaluating the development program as it progressed. The introduced range improvement practices are largely responsible for the ecological and cultural changes in Masai.

Chapter 8

SUMMARY AND CONCLUSIONS

CHAPTER ONE: INTRODUCTION

The Kaputiei Group Ranches were proposed in the 1960's and implemented after 1968. Their purpose was to provide and to test a model for pastoral nomadic development in Kenya. The development objectives were justified on the need to transform a traditional and largely subsistence pastoral economy into a modern commercial enterprise. The intent was to enhance the economic welfare of the Masai as they enter into a market exchange economy.

My study was carried out between September 1976 and July 1978 to analyze the impact of range developments in the group-ranch model. In order to determine the success or failure of the group-ranch scheme many parts of the Masai ecosystem were examined including a broad review of pastoral nomadism, and a detailed analysis of the physical environment, vegetation, livestock, and human resources. Comparisons were made with baseline data on pre-group ranch conditions.

CHAPTER TWO: OVERVIEW OF PASTORAL NOMADISM

Chapter 2 explores the general aspects of pastoral nomadism in order to put the Kaputiei case study in the context of other types of intervention measures in pastoral nomadic societies. The adapttive features of pastoral nomadism i.e. free mobility, multi-resource use and the flexibility of social organizations are now constrained by the rapid changes in the socio-political, economic and ecological environments of the pastoral communities. Intervention measures in subsistence pastoral sectors are motivated by a desire to rectify the apparently maladaptive features of pastoral nomadism.

CHAPTER THREE: BACKGROUND OF KAPUTIEI GROUP RANCH DEVELOPMENT MODEL

Chapter 3 traces the background of Kaputiei case study. The Kaputiei Group Ranch Development Model was conceived to effect:

(1) Sedentarization of Masai within social-political and ecological units or group ranches.

(2) Transformation of pastoral nomadic livestock production system into a viable commercial enterprise.

(3) The learning model for similar interventions in the subsistence pastoral sector.

The historical circumstances which precipitated this approach and the implementation aspects of the development proposal are reviewed briefly.

CHAPTER FOUR: THE KAPUTIEI ENVIRONMENT

Chapter 4 describes the Kaputiei biophysical environment and the definition of appropriate management units. The most significant component of the physical environment in Kaputiei is the erratic, unreliable low and bimodal rainfall regime. It was noted that the high potential ecological zones III and parts of ecological zone IV were not included in the Kaputiei Group Ranch Development Model. The earliest available rainfall records of Kaputiei show that the 1960's, when the group ranch development proposal was conceived, was the wettest decade since 1914. By contrast, the implementation of the proposal in the 1970's coincided with the driest period since 1914.

CHAPTER FIVE: RANGE CONDITION AND TREND ANALYSIS IN KAPUTIEI GROUP RNACHES

This chapter deals with the environmental impacts of the Kaputiei development model. There are many types of vegetation changes caused by different types of factors in the rangelands. In this chapter, only those vegetation changes which have significance in the ecological changes in Kaputiei group ranching scheme are emphasized. Further, the identification of trends associated with range development inputs, which are due to climatic or edaphic trends, are used as indicators of performance of the development program.

Kaputiei permanent vegetation transects show that the total species frequencies of desirable plants decreased from 3713 in 1969 to 2082 in 1977, a decrease of 44 percent. During the same period, the proportion of undesirable plants increased from 2013 to 3561 counts, an increase of 77 percent. Desirable plants are palatable, perennial grasses preferred by livestock, while the undesirable plants constitute either unpalatable and perennial grasses, or ephemeral grasses.

The Athi-Kapiti grasslands in north Kaputiei, according to data from permanent transects sustained the least changes in the frequency counts of desirable plants and basal cover measurements. In south Kaputiei areas, the frequencies of desirable plants in the permanent transects decreased from 987 counts in May 1969 to 311 counts in May

1977, a decrease of 68 percent. The mean basal cover in southern grasslands also decreased from 18 percent in May 1969 to 2.4 percent in May 1977.

Measurements in relict areas where the vegetation has not been disturbed through heavy grazing, shows the grazing factor to be largely the causal factor for decline; no other factors like climate or site differences.

The botanical changes on Kaputiei permanent transects were used in developing a subjective range condition assessment scheme on the basis of probable successional patterns in Kaputiei grasslands. The proportion of desirable plants, undesirable plants and soil characteristics were scored separately at each sampling point. The summary range condition classes of 300 sampling points taken at intervals of one kilometer collaborate the evidence of vegetational changes in permanent transects. The rangeland in north Kaputiei on black soils is least affected by development inputs with 66 percent, 27 percent and 7 percent of the Athi-Kapiti land under good, fair and poor conditions, respectively. South Kaputiei rangeland was the most severely degraded with 21 percent, 33 percent and 46 percent of the range in good, fair and poor condition, respectively. The central Kaputiei uplands under good, fair and poor range condition classes constituted respectively 44 percent, 38 percent and 18 percent of the range in this zone.

CHAPTER SIX: LIVESTOCK TRENDS IN KAPUTIEI (1968-1977)

The livestock trends in Chapter 6 show that:

(1) Cattle numbers increased between 1968 and 1974 in Kaputiei group ranches. The north and central Kaputiei ranches showed an increase of 46 percent between 1968 and 1972. South Kaputiei ranches cattle numbers increased by 104 percent during the same period.

(2) Drought losses during 1975-76 averaged 75 percent according to the subjective data provided by interviewed families (N=148). However, using the pre-drought and post-drought livestock censuses, families in south Kaputiei area sustained about 70 percent cattle loss.

(3) Sheep and goat populations increased by a factor of 2.63 between 1968 and 1977 in Kaputiei. Drought losses among the small ruminants amounted to 36 percent in central and north Kaputiei area, and 50 percent in south Kaputiei.

(4) Livestock mixes between cattle and small ruminants show that the population of the total stock units contributed by the small ruminants increased from 13 $\pm$ 6 percent in 1968 to 41 $\pm$ 10 percent in 1977.

The livestock increase in Kaputiei was the result of the intensive developments such as water and veterinary services.

CHAPTER SEVEN: HUMAN RESPONSES TO CHANGING ENVIRONMENT IN KAPUTIEI

The behavioral sector describes the changing ecological and socio-cultural environment, which requires evaluation of human responses as performance criteria. The main observations are listed below:

(1) Demographic trends: (a) The Kaputiei human population increased by about 52 percent between 1968 and 1977. The human population in north Kaputiei region showed 30 percent increase during the ten year development period, while the south Kaputiei population, inhabiting the arid region showed 75 percent increase. (b) The mean number of wives per head of family in Kaputiei increased from 1.13 _ 0.88 in 1967 to 1.76 ± 0.47 in 1977. The number of children under 15 years per family has nearly doubled from 2.59 ± 0.78 to 4.82 ± 0.88 during the same period.

(2) Indicators of sedentarization: (a) Seventy-six percent (N=148) of Kaputiei families favor the group ranch organization. The remaining 24 percent prefer individual to group ownership of land. (b) The 1970's kraal camps constituted 62 percent (N=138) in the small size category of 1-2 families, and only 6 percent of the total kraals in the large size categories with more than 5 families per settlement. This kraal size distribution pattern contrasts sharply with the 1950's proportion of large kraals which constituted 49 percent (N=108) and the proportion of small kraals represented by 12 percent. The trend of disintegration of large kraals into small kraals coincides with the group ranch development mode. (c) Kaputiei kraal camps with one to two permanent structures such as metal-roofed houses, wire fences etc. constituted 45 percent (N=148). Eighty-two percent of these

structures were erected between 1971 and 1977, the period in which the group ranch model was being implemented and operated in Kaputiei.

(3) Ecological conditions are the ultimate determinant of the commitment to a sedentarized life style. For example, 67 percent of 1977 settlement sites (N=145) were selected during the recent drought (1973-1976).

(4) Multi-resource use strategies: (a) Kaputiei Masai have diversified their livestock mix to include more small ruminants. After the 1973-76 drought, 41 percent (N=783) of the families obtained enough subsistence requirements (30 S.U. per 6 A.E.) from their combined livestock resources of cattle, sheep and goats. If the families specialized in cattle alone, or in small ruminants alone, only 25 percent and 17 percent of families respectively could obtain subsistence requirements of > 30 S.U. per family of 6 A.E. (b) The Masai diet composition has for a long time included agricultural crops such as maize (corn) and beans. Recently, the daily dietary intake has broadened to include sheep milk (53 percent, N=148) and goat milk (58 percent, N=148).

SOME OVERALL COMMENTS

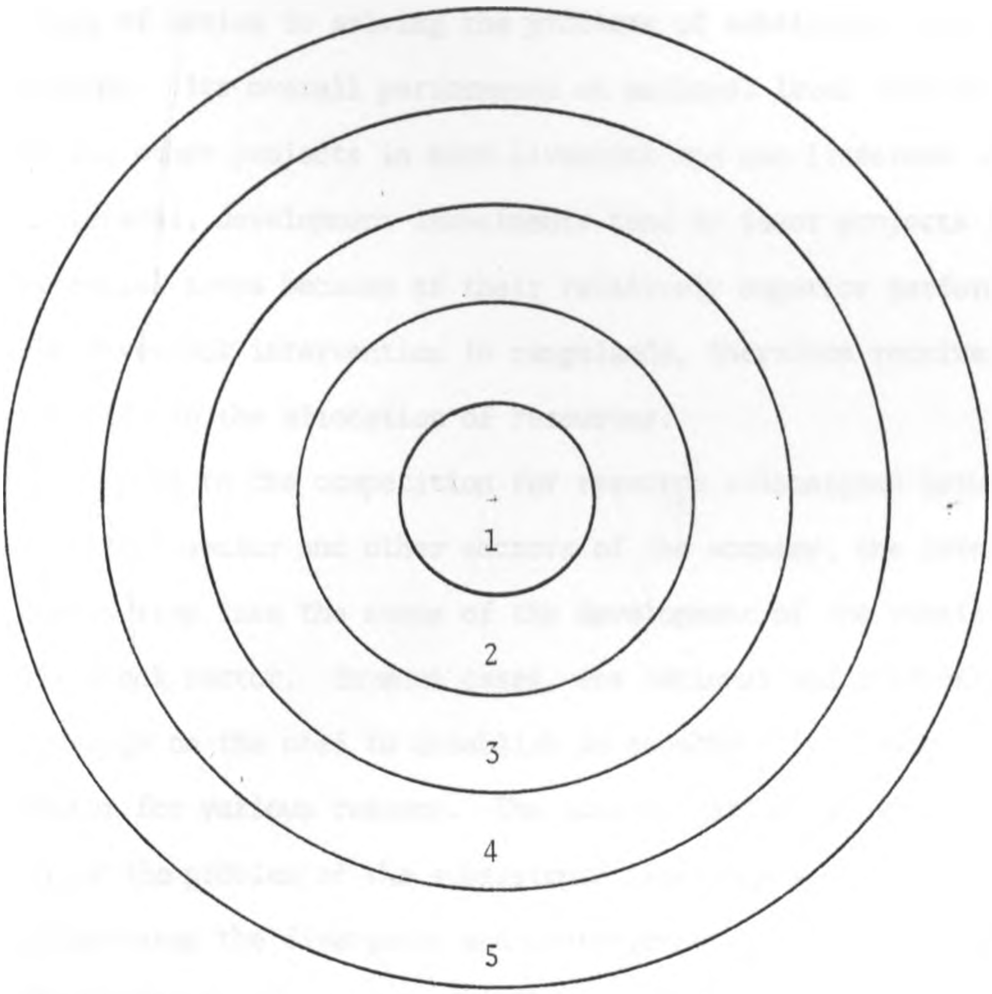
The issue of whether the Kaputiei Livestock Development Model has performed according to the originally stated objectives brings into view the many interest groups involved. The performance of the model must, therefore be judged against the expectations of the various interest groups involved. Figure 45 summarizes the concentric levels of interest in the Kaputiei Project. At the center of the project are the households (N=1300) basic production units. The households are organized into socio-political units, or group ranches (N=15) which cover most Kaputiei Section of Masaland. This section constitutes a small part of Kenya's large subsistence livestock section that occupies about more than two-thirds of the country. The international agencies and donors comprise yet another level of interest in the pastoral sector. Goals and means of the various interest groups converge or diverge at various levels of production i.e. household, group ranch, Kaputiei, national and international levels.

At the household level the national concern focuses on altering and improving livestock management practices from traditional to more commercially oriented, and on establishing economic incentives to increase offtake rates. However, the behavior of pastoral households is largely moulded by their perception of the subsistence risk factor. In many instances, as a result, only those aspects of the modern technology that build upon the traditional risk control measures are readily accepted.

At the group ranch level, the national concern is the establishment of viable socio-political and ecological units. Development inputs are allocated to the group ranch units, but the responsibility of the group ranch government. However, the group ranch governments have not

Figure 45

Levels of Problem Perception and Analysis of results for the Kaputiei Livestock Development Project



[1]Households N = 1300 "Production Units"

[2]Macro Production Units Group Ranches (N = 15)

[3]Kaputiei Section - Part of Livestock Subsistence Sector

[4]Kenya: National Economy

[5]International Agencies and Donors

performed satisfactorily in carrying out their mandate primarily because of their undeveloped leadership.

The Kaputiei project as a whole is an experiment on the possible cause of action in solving the problems of subsistence pastoral economy. Its overall performance at national level must be compared to the other projects in both livestock and non-livestock sectors. In general, development investments tend to favor projects in high potential areas because of their relatively superior performance. The livestock intervention in rangelands, therefore receives lower priority in the allocation of resources.

Owing to the competition for resource allocations between the livestock sector and other sectors of the economy, the international donors step into the scene of the development of the subsistence livestock sector. In most cases, the national and international goals converge on the need to establish an economically viable livestock sector for various reasons. The identification, definition and designing of the problem of the subsistence livestock sector in Kaputiei illustrates the divergence and convergence of goals and means between the professionals and the Kaputiei Masai. To the professionals, the Kaputiei subsistence economy was maladaptive and therefore an appropriate action was the introduction of development inputs which would rectify the nomadic movements and the subsistence production emphasis of the traditional livestock production system. Hence the professional goals were to change communal land tenure into some form of private ownership, i.e. group ranch ownership, and to establish appropriate internal group ranch governments to take charge of development inputs and livestock management practices which would lead into the evolution of group ranches as commercial enterprises.

However, from the Masai's perspective of the problem, the legal segmentation of Kaputiei into socio-political units was a timely solution against the "land grab" of their commercial land by individuals. In regard to livestock service infrastructure and other development inputs, the Masai accepted those which alleviated constraints on their traditional resource use strategy. The consequence was a convergence of views on the land tenure changes for different reasons, and the divergence on the crucial tenets of the development package such as destocking and control of livestock movements.

The divergence and convergence of goals is the result of an incorrect assumption by the professionals that mobility and subsistence livestock management strategies are maladaptive features. Although the land tenure reform was a welcome idea to the Masai, primarily on political grounds, it was unrealistic to assume that each socio-political unit (i.e. group ranch) possessed adequate grazing resources throughout cycles of wetness and dryness. The definition of resource boundaries for each socio-political unit should be flexible to cater for unpredictable weather patterns.

If the Masai were to accept that mobility and herd management strategies were maladaptive features of their subsistence pastoral economy, they would behave irrationally in two ways. First, the professional's definition of the carrying capacity of the environment is usually conservative compared to the opportunistic resource use strategy involved by pastoralists in precarious arid environments (Sandford 1977). Hence sessility strategy recommended by the professionals in the group ranch organization is the maladaptive feature and not the mobility strategy.

Second, the modification of livestock in terms of herd structure and genetic material for a commercial production enterprise probably exposes the basic household production unit to a high subsistence risk factor. The relative merits, in terms of risks and uncertainties, of the conversion of surplus livestock production into a market exchange system versus conversion into higher human biomass are yet to be shown. It was pointed out in Chapter 7 that in more arid areas of Kaputiei, surplus livestock was transformed into a higher human biomass.

In the developed countries, the riskiness of a market exchange system is backed by income maintenance or social security programs. In the precarious environments of the pastoral nomads, it is not enough to speculate that higher off-take will lead to higher household income and, therefore, an enhanced capacity of the household to cope with stress. Consequently, it may be postulated that the "conservative" aspects of pastoral production systems are primarily mechanisms to protect the household units from environmental risks (both biophysical and socio-political in nature). In other words, the so-called "irrationality" of pastoralists is related to different perspectives and goals. If on the one hand, the pastoralists conform to the behavioral pattern postulated for them by the professionals' world view, they are recokoned to be rational. On the other hand, if the professionals' pastulates are based on a narrow interpretation of the pastoralists' world view, it is this basis that the pastoralists are deemed to be irrational and backward.

Even in light of evidence presented in previous chapters, concerning the unsatisfactory performance of Kaputiei project in regard to environmental impacts, and the selective adoption of the development package, the Kaputiei project has been a great success as a learning model in many ways. It is this experimental nature of the Kaputiei model that deserves a great plus. The Kaputiei project has demonstrated that: (1) mobility is more of an ecological determinant than a socio-cultural or political decision. Inter-group ranch movements must be legitimized when circumstances warrant. (2) The internal organizational structure of group ranch government institutions has been accepted by the Masai, but because these are new institutions, training of leaders is needed if the group ranch governments are to be effective in the control of stocking rates and maintenance of development inputs. (3) Most of the conclusions derived from the Kaputiei study were possible because pre-investment baseline data were taken. This shows that if we want to evaluate the performance of development projects, we must put time, effort and finance into collecting the baseline information. All development projects, therefore are experiments and warrant careful study of pre-development conditions against which future studies can indicate the direction of change. (4) The performance of interventions is a function of both the divergence and convergence of perspectives held by the parties concerned i.e. the pastoralists, the professionals and the public officials. The focus on the pastoralists as the scapegoats in the poor performance of many livestock programs is most unfortunate. The less than satisfactory performance of the Kaputiei Livestock Project is therefore a function of the different perspectives resulting in different behavioral characteristics of the Masai, the professionals the public officials and the international donors identification of behavioral aspects which need changing.

What aspects of the Kaputiei Livestock model should be carried forward, discouraged or introduced if the project were to be replanned or replicated elsewhere? The main aspects of the Kaputiei Livestock Project that can be carried forward include the allocation of land to groups of families and the establishemnt of strong group ranch governments. The group ranch development strategy has a good future in the wave of the current socio-political and cultural changes in pastoral areas.

The group ranch approach, however, should not obstruct or discourage cooperation among and movements between group ranches, particularly when weather conditions so dictate. It is relevant to note that even under commercial management, cooperation is not uncommon. Joyce Commercial Ranch, near the central Kaputiei, has arrangements with ranches in Nanyuki, Gilgil and coastal areas in order to deal with drought induced emergencies. These ranches are located 300 miles apart and in different directions from the Joyce ranch. Hence, the legitimization of inter group ranch movements and even intersectional arrangements, should not be ignored in the group ranch development model in Kaputiei. Jacobs (1978) has aptly brought up this point concerning the relationship of high and low potential grazing areas in the planning of development schemes in Masailand. He concluded that "development schemes have tended to be limited in scope to the more obvious high potential areas of Masailand, thereby unwittingly creating a host of new problems in the low potential areas".

Project objective s which focus primarily on the offtake from the livestock sector and only tangentially on the people involved in this sector should be discouraged. Although the Kaputiei model devoted some attention to the positive asptects of the project for the people, its major thrust aimed at a rapid tranformation of subsistence pastoralism into commercial ranching. The irony of the situation is that one of the limiting factors in the transformation process is the behavior of the indigenous people. It has been shown in many other development projects that the challenge is not simply to meet physical production targets, but to alter behavioral charactristics. These characteristics are not merely irrationally bound up with traditionalism, but rather with the "social security" of households.

It may be noted that as long as the Masai continue to accept development inputs which must be purchased with foreign exchange, they cannot avoid the market exchange system. While such an economic linkage is a welcome trend, it must be pointed out, that the replacement of traditional social security or subsistence risk control measures is likely that household production units will be exposed to greater environmental and market risks.

One eventuality of such an undesirable trend would be a greater segment of pastoral communities at the mercy of famine relief from the central government. After studying the problem of hunger in a subsistence sector in the semi arid area in Eastern Kenya, Wisner and Mbithi concluded (1976): "a relatively low cost and high benefit approach for the government in dealing with drought problems is to build upon the local patterns of adjustment to drought which have grown up in the different ecological zones of the country, fostering those which seem to be effective, discouraging some which seem to be wasteful, introducing new ones."

There are two items which need to be introduced in similar development projects. First, the importance of establishing an enquiry system to monitor the impacts of the development inputs as the project is being implemented should be taken more seriously in future projects. Every development project is a field experiment for learning. The setting aside of a fraction of the development fund for a monitoring research program would yield great dividends for the Masai and the whole country. The project implementation would therefore be altered in light of feedback information from the monitoring system.

The second concern is the choice of performance criteria and the time frame for carrying out an evaluative study. Variables should be selected which are sensitive indicators of trends, positive and negative resulting from development programs. In livestock subsistence projects, sufficient time for project implementation and subsequent operation usually exceeds the five year period set by international donors. In addition the time frame selected for evaluation should account for weather cycles and the logistic of project implementation and operation.

At this point in the history of the Kaputiei Project, some observers may pronounce that, as a sound development strategy in Masailand, the group ranch model is doomed. From my viewpoint, given the protracted drought, even a period of ten years may not be a justified time frame to pass ultimate judgment on the future of the group ranch development strategy in Masailand. The Kaputiei Group Ranch scheme has been successful in many respects but it can be improved, or at least the problems not repeated in other areas.

Bibliography

Africa. September 1975, Published by African Journal Ltd., London.

African Land Development Board (ALDB), 1962. African Land Development in Kenya: 1945-1962.

Aldington, T.J. and Wilson, F.A., 1968. The Marketing of Beef in Kenya. I.D.S. University of Nairobi Occassional Paper No. 53.

Baker, B.H., 1954. Geology of the Southern Machakos District. Report No. 27, Geology Survey, Kenya.

Barth, F., 1962. Nomadism in the Mountain and Plateau Areas of Southwest Asia.

Brown, L.H., 1971. The Biology of Pastoral Man as a Factor in Conservation. Biological Conservation, Vol. 3, No. 2. pp. 93-100.

Cameron, R.D.A., 1970. A Study of the Reproductive Efficiency of Some Masai Herds in the Kaputiei Section, Kajiado District, University of Nairobi, Faculty of Veterinary Science.

Casebeer, R.L. and Mbai, H.T.M., 1964. Animal Mortality Report. Kajiado District. FAO/Ken: 71/526.

Chambers, R.J.H., 1969. Report on Social Administrative Aspects of Range Management Development in Northeastern Province of Kenya. (Typed manuscript).

Chamrad, A.D. and Box, T.W., 1965. Drought Associated Mortality of Range Grasses in South Texas. Ecology 46(6): 780-785.

Clements, F.E., 1928. Plant Succession and Indicators. Wilson Company, N.Y.

Columbia Dictionary 1975. Columbia University Press.

Coupland, R.T., 1958. The effects of Fluctuations in Weather upon the Grasslands of the Great Plains. Br. Rev. 24(5): 273-317.

Davies, H.R.J., 1966. Nomadism in the Sudan. Aspects of the Problem and Suggested Lines for its Solution. Tijdschr. Economic Soliale Geogra., S. Gravenhage 57:193-202.

Davies, R.K., 1972. Some Issues in the Evolution, Organization and operation of Group Ranches in Kenya, East Africa, Journal of Rural Development Vol. 4, No. 1, 1971, pp. 22-33.

Davies, R.K., 1970. A Proposal for a Socio-Economic Analysis of Group Ranching Development in Kenya Masailand, IDS, Nairobi, Staff Paper No.63.

Deming, M.H., 1954. A Guide for Judging Range Condition and Trend.

Development Plan, (Kenya), 1966-1970.

Dyksterhuist, E.J., 1949. Condition and Management of Rangeland Based on Quantitative Ecology. J. Range Management 2:104-115.

Dyson-Hudson, N., 1966. Karimojong Politics.

Dyson-Hudson, N., 1974. The Structure of East African Herds and the Future of East African Herders. SSRC Symposium on "The Future of Traditional 'Primitive' Societies".

Dyson-Hudson, R., 1972. Pastoralism: Self-Image and Behavioral Reality. Journal of Asian African Studies 7(1-2) 30-47.

Ellison, L. Woolfolk, E.J., 1937. Effects of Drought on Vegetation Near Miles City, Montana. Ecology 18(3):329-336.

Encyclopedia Britannica, 1973. Vol. 4.

Estes, R.D., 1968. Territorial Behavior of Wildebeest (connochaetes taurinus) Ph.D. Thesis, Cornell University.

*A Glossary of Terms Used in Range Management, 1974. Published by Society for Range Management.

Governor's Advisory Committee on African Land Development, 1945.

Grieg-Smith, P., 1964. Quantitative Plant Ecology.

Griffiths, J.F., 1968. Climatic Zones of East Africa. East African Journal 23:179-185.

Gulliver, P.H., 1955. The Family Herds.

Gulliver, P.H., 1978. "Nomadic Movements: Causes and Implications" in The Nomadic Alternative: Modes and Models of Interaction in the African-Asian Desert and Steppes.

Halderman, J.M., 1972. An Analysis of Continued Semi-Nomadism on the Kaputiei Masai Group Ranches: Sociological and Ecological Factors. Discussion Paper No. 152. Institute for Development Studies, University of Nairobi, Kenya.

Halderman, J.M., 1970. A Comparison of two Maasai Group Ranches in the Kaputiei Area. Unpublished Report, Nairobi.

Hailey, Lord, 1950. Nature Administration in the British African Territories. Part 1, East Africa.

*On separate sheet at end of Bibliography.

Hall, D., 1929. Agriculture Commission (Kenya).

Hall, D., 1936. The Improvement of Native Agriculture in Relation to Population and Public Health.

Heady, H.F., 1960. Range Management in East Africa. Government Printer,Nairobi.

Heady, H.F., 1966. Influence of Grazing on the Composition of Themeda triandra Grassland, East Africa. Journal of Ecology 54:705-727.

Heady, H.F., 1975. Range Condition and Range Trend. ILCA Conference, Bamako, Mali.

Hedlund, H.G.B., 1971. The Impact of Group Ranches on a Pastoral Society. Staff Paper No. 100. Institute for Development Studies, University of Nairobi, Kenya.

Hoben, A., 1979. Lessons from a Critical Examination of Livestock Projects in Africa. I.A.D. Program Evaluation Working Paper No. 26.

Hollis, C., 1904. The Masai, Their Language and Folklore.

Horowitz, M.M., 1979. The Sociology of Pastoralism and African Livestock Development. (Unpublished paper).

Humphrey, R.R., 1965. Range Condition Analysis - A Practical Ecological Approach to the Classification of Rangelands. Intern. Grassland Cong. Proc. 9:1437-1442.

Hyder, D.N. and Sneva, F.A., 1959. Growth and Carbohydrate Trends in Crested Wheatgrass. J. Range Management 12(6):271-276.

IBRD, 1963. The Economic Development of Kenya.

*
Jacobs, A.H., 1965. The Traditional Political Organization of the Pastoral Masai. Doctor of Philosophy Thesis.

Jacobs, A.H., 1978. "Masai Pastoralism in Historical Perspective" from a reprint.

Jarman, J.P. and M.V. Jarman., 1973. Social Behavior, Population Structure, Reproductive Potential in Impala, East African Wildlife Journal, Vol. 11:329-338.

Julander, O., 1945. Drought Resistance in Range and Pasture Grasses. Plant Physiology 20(4):573-599.

Kajiado Wildlife Management Project 1973.

Kajiado Wildlife Management Project 1976.

*On separate sheet at end of Bibliography.

Kenya Development Plans 1966-1970 and 1970-1974.

Kenya Land Commission 1933.

Kenya Rangeland Ecological Monitoring Unit. 1977.

Lamprey, H.F., 1963. Ecological Separation of the Large Mammal Species in the Tarangire Game Reserve, Tanganyika, East Africa Wildlife 1:63-92.

The Land Adjudication Act., 1968. Kenya Gazette Supplement No. 56.

Langat, R.K., 1970. A Report on Overgrazing and Resting Experiments at Katumani. Range Reserve Report (July), Min. Agr., Nairobi.

Lange, R.T., 1969. The Piosphere, Sheep Track and Dung Patterns. Journal of Range Management 22:396-400.

Lawrence Land Commission 1966. Kenya.

Lewis, R.A., 1965. A Plan for Development of Maasailand.

*Margalef, R., 1968. Perspectives in Ecological Theory.

Matheson, J.F., 1964. Geology of the Kajiado Area. Ministry of Natural Resources and Wildlife. Report No. 70.

Meadows, S.J., 1967. Land Tenure and Ranch Development, Extr Range News. No. 1, July 1967, pp. 8-13, Ministry of Agruculture and Animal Husbandry, Range Management Division, Nairobi.

Naveh, Z., 1965. The Importance of an Integrated Sociology and Ecological Approach to the Development of Semi-Arid Grasslands in East Africa. Int. Grassland Congr. 9:1563-1965.

Naveh, Z., 1966. The Determination of Range Condition and Trend on East African Range Lands. East African Agricultural Journal 32:159-162.

Netting, R.M. ? The Ecological Approach in Cultural Study.

Noveseltsev, P.A., Pasuto, B.T. and Chesepnin, L.S., 1972. Ways of Development of Feudalism. M. 1972, p. 18-19. Quoted from Natsagjorj SH 1975--Main Characters of Feudalism of Nomads. XIV International Congress of Historic Sciences, San Francisco, August 1975.

Parker, K.W., 1951. A Method for Measuring Trends in Range Condition on National Forest Ranges. U.S. Forest Service (Administration Studies).

*On separate sheet at end of Bibliography

Parker, W., 1952. The Role of Plant Ecology in Range Research and Range Management. International Grassland Congress Proc. 6:618-624.

Pase, C.P., Lusigi, W.J. and Mumiukha, P.W., 1975? Vegetation Studies in Selected Areas in Kajiado District, Kenya, for Purposes of Wildlife Management.

Pechanec, J.F., Pickford, G.D., Stewart, G., 1937. Effects of the 1934 Drought on Native Vegetation of the Upper Snake River Plains, Idaho. Ecology 18(4):490-505.

Porter, W.P., 1965. Environmental Potentials and Economic Opportunities--a Background for Cultural Adaptation. American Anthropology 67:409-420.

Pratt, D.J., Greenway, P.J., and Gwynne, M.D., 1966. A Classification of East African Rangeland, with an appendix on Terminology. J. Appl. Ecol. 3:369-382.

Pratt, D.J., 1968. Range Development in Kenya. Annals Arid Zone 7:77-203.

Pre-Investment Survey Report. Kaputiei Section, Kenya Range Management Project UNDP/FAO, 1969.

Prole, J.H.B., 1962. A History of the Cattle Population in Kajiado Masailand During the Last Twenty Years, Leading to the Disastous Losses in 1961-62 with Comments on Past Policy and Future Development. Mimeo Report. Ministry of Agriculture, Nairobi.

Rennie, G.M. et al., 1941. Interim Report of Committee Appointed to Advise as to the Steps to be Taken to Deal with the Problems of Over-Stocking in order to Preserve the Future Welfare of the Native Pastoral Areas.

Reppert, J.N. and Francis, R.E., 1973. Interpretation of Trend in Range Condition From 3-step Data. USDA, Foreign Service Res. Paper RM-103.

Saggerson, E.P., 1959. Geology of the Simba Kibwezi Area. Report No. 58. Geol. Survey. Kenya.

Salzman, P.C., 1972. Multi-resource Nomadism in Iranian Baluchistan. Journal of Asian and African Studies 7(1-2) 60-68.

Sampson, A.W., 1919. Plant Succession in Relation to Range Management. USDA Bulletin No. 791.

Sandford, S., "Opportunism and Conservatism in Dry Areas," 10th ICAES; Jadhpur 19-21 December, 1978; mimeograph.

Searle, D.L., 1954. Geology of the Sultan Hamud Area. Report No. 29 Geology Survey, Kenya.

Simpson, M.C., 1973. Alternative Strategies for Rangeland Development in Kenya. (Rural Development Study No. 2).

Singer, A., 1974. The Politics of Pastoralism in Eastern Iran, SSRC Symposium on "The Future of Traditional 'Primitive' Societies".

Skovlin, J.M., 1971. Range Management Project, Kenya, Ecological Survey and Research. AGP:SF/KEN II, Technical Report 1.

Spinks, G.R., 1966. The Marketing of Livestock and Meat in Kenya. F.A.O. Report, Nairobi.

Swidler, W.W., 1972. Some Demographic Factors Regulating the Formation of Flocks and Camps Among the Brahui of Baluchistan (West Pakistan). Journal of Asian and African Studies VII (1,2) 69-75.

Swift, J., 1974. The Future of Twareg Pastoral Nomadism in the Malian Sahel. SSRC Symposium on the Future of Traditional Societies.

Swynnerton, R.J.M., 1955. A Plan to Intensify the Development of African Agriculture in Kenya. (Report)

Talbot, L.M. and Talbot, M.H., 1963. The Wildebeest in Western Masailand, East African Wildlife Monograph No. 12.

Talbot, L.M., 1968. Ecological Consequences of Rangeland Development in Masailand, East Africa. In M.T. Farvar and Milton, eds., The Careless Technology: Ecology and International Development.

Thomson, J., 1887. Through Masailand. 4th ed.

Touber, L., 1977. Personal Communication.

Touber, L., 1978. Soil Map of Kibwezi-Amboseli Area (unpublished) F.A.O. - Kenya.

"Ch. Toupet., 1972. C.R. Soc. de Rio. Biogeographic, 416-421. Avrill 1972". Quoted from Swift J. 1974.

Trlica, M.J., Jr., Cook, C. Wayne., 1971. Defoliation Effects on Carbohydrate Reserves of Desert Species. Journal of Range Management 25(6):240-435.

UN Statistical Yearbook 1975.

UN Statistical Yearbook 1977.

UNDP. 1967. (Report on the Inter-Regional Studies Tour and Seminar on the Sedentarization of Nomadic Populations in the Soviet Socialist Republics of Kazakhstan and Kirghizia (5 to 30 Sept. 1966). Published by United Nations Development Programme. T.A. Sect., International Labor Office, Geneva, ILO/TAP/INT/R.13.

Wales, M., 1977. ILCA Conference on Pastoralism, Nairobi, Kenya.

Watson, R.M., 1969. Aerial Livestock and Land Use Surveys for Narok, Kajiado and Kitui Districts. Ministry of Agriculture: Range Management Division, Nairobi.

Weaver, J.E. and Clements, F.E., 1929. Plant Ecology.

Weaver, J.E. and Albertson, F.W., 1936. Effects of the Great Drought on the Prairies of Iowa, Nebraska and Kansas. Ecology 17(4):567-369.

Weaver, J.E., Stoddart, L.A. and Noll, W., 1935. Response of the Prairie to the Great Drought of 1934. Ecology 16(4):612-629.

Weaver, J.E. and Albertson, F.W., 1939. Major Changes in Grassland as a Result of Continued Drought. Bot. Gaz. 100(3):576-591.

Weaver, J.E. and Alberson, F.W., 1943. Resurvey of Grasses, Forbs, and Underground Plant Parts at the end of the Great Drought. Ecology Monogr. 13(1):64-117.

Weaver, J.E. and Albertson, F.W., 1944. Nature and Degree of Recovery of Grassland From the Great Drought of 1933 to 1940. Ecology Mong. 14(4):393-479.

Weekly Review, November 30, 1979. Nairobi, Kenya.

Western, D., 1973. The Structure, Dynamics and Changes of the Amboseli Ecosystem. Ph.D. Thesis, University of Nairobi.

Western, D., 1974. The Environment and Ecology of Pastoralists in Arid Savannahs. Paper Presented at the SSRC Symposium of the Future of Traditional "Primitive" Societies.

William, A., 1965. The African Husbandman.

Winick, C., 1958. Dictionary of Anthropology.

Wisner, B. and Mbithi, P.M., 1976. "Drought in Eastern Kenya: Comparative Observation of Nutritional Status and Farmer Activity at 17 Sites." IDS Discussion Paper, 167, Institute for Development Studies, University of Nairobi.

Zadrozny, T.T., 1956. Dictionary of Social Sciences.

Ferguson, D.S., 1977. "A conceptual Framework for the Evaluation of Livestock Production Projects and Programs in Sub-Saharan West Africa." Unpublished manuscript.

Jahnke, H.E. and Ruthenberg, 1973. "Organizational Aspects of Livestock Development in Dry Areas of Africa," Universitat Hohenbeim, Stattgart, Mimeo.

Livingstone, I., 1975. Cowboys in Africa: The Socio-economics of Ranching in Kenya. IDS, Nairobi.

Appendix 1

Changes of Species Frequency in Kaputiei Permanent Vegetation Transects (1969 to 1977)

[1]Perennial Grasses - Frequency Measurements Percentage	[2]Rating	TR 1		TR 2		TR 3		TR 4		TR 5		TR 6		TR 7		TR 8		TR 9		TR 12		TR 13		TR 14	
		1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977
		May 7	May 26	Sept 6	May 26	May 10	May 19	?	May 19	June 10	June 3	June 11	June 3	June 11	May 24	Sept 10	May 18	June 10	May 18	May 9	May 25	May 7	May 31	May 8	May 26
Cenchrus ciliaris	D		7																						
Chloris roxburghiana	D	18	6	23	10	27	6														7				
Chrysopogon aucheri	D			34				1	3											23	27	1			
Cymbopogon pospochilli	U																			25		41	13	32	1
Dicanthium inscupta	D				6			2	3	7	1		1									6			
Digitaria macroblephara	D	95	10	85	14	81	28			42	45	10	27	56		61	56			14	19				
Digitaria scalarum	D							3				7		13	45	14	8	64	44	94	38	80	54	55	
Echinochloa hapoclada	D							1	1										2						
Enteropogon sp.	D																								
Eustachyus paspaloides	D	2		2						14	9		1	1											
Heteropogon contortus	D																					2	4	9	
Ischaemum sp.	D							36																	
Leptochloa sp.	D					4																			
Panicum coloratum	D							14	3			2		34		19									
Panicum poides	D												1												
Panicum maximum	D				2													3							
Pennisetum massaicum	U	22	4	4	1							36													
Pennisetum mezianium	U	5				17		65	70	58	70	27	33	17	24	39	45								
Pennisetum stramineum	U										1		28	50	53	2	19			10				9	2
Eragrostis superba	D																	74	50						
Eragrostis heteromera	D																	20	12						
Setaria sp.	D							6												1					
Sorghum sp.	D								34										4	4	2	50	39		
Sporobolus fimbriatus	U	2								2	1			1	1							9		13	
Themeda triandra	D	4		7	2	1		5	11	89	42	34	30	49	53	86	43	74	49					6	
[4]Total Frequency		148	27	155	35	130	34	133	125	216	174	139	143	246	202	231	176	254	16.8	171	93	189	115	159	5
[5]Total Ephemeral grasses		20	94	25	120	61	75	35	29	114	237	33	79		195	30	220	14	56	6	7	31	66	143	82
[6]Basal Cover %		17.3	1.6	28.8	4.3	10.5	1.5	11.5	22.8	19.3	21	5.8	16.3	8.5	25.5	24.3	32.5	15.5	19.0	18.8	4.0	15.5	12.0	14.0	7
[7]Kg/Hectare (Dry Weight)		1083		1440		567		1273		880		583		803		1129	2200	803		1350		803		385	41

[1]Perennial Grasses - Frequency Measurements Percentage	[2]Rating	TR 15		TR 16		TR 17		TR 21		TR 22		TR 23		TR 24		TR 25		TR 26		TR 27		TR 28		TR 29	
		1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977	1969	1977
		May 8	May 25	May 10	May 12	May 12	May 30	May 12	May 4	May 12	May 4	May 13	May 10	May 10	May 13	May 13	May 11	May 11	May 30	?	May 2	April 19	Oct 13	May 15	April 7
Cenchrus ciliaris	D																								
Chloris roxburghiana	D																								
Chrysopogon aucheri	D			1	9							3	1		1				6	4	4	3	9		4
Cymbopogon pospochilli	U	10														2				19	7			7	4
Dicanthium inscupta	D															3		18	6	2	23	5	22	20	
Digitaria macroblephara	D					18	14	5	6		42			1		22	13	4	2	7	6			10	3
Digitaria scalarum	D	12		36	26					23		8	5	11	3	50	9	36	19	45	32	50	37	59	29
Echinochloa hapoclada	D	4										3	1	5	1										
Enteropogon sp.	D																								
Eustachyus paspaloides	D																								
Heteropogon contortus	D			42	2	18	15	9	2	1		14		27	5	23	1	19	1	30	17	12	10	10	12
Ischaemum sp.	D					2	6	4	6	8	1									13		1	7	23	18
Leptochloa sp.	D																								
Panicum coloratum	D																								
Panicum poides	D							5		15						17	1								
Panicum maximum	D																								
Pennisetum massaicum	U																						2		
Pennisetum mezianium	U	4		1	2							13	17	5	1		46	14	14	1	1			5	6
Pennisetum stramineum	U	1		22	25	44	52	23	33	4	4						3	20	28	1		8	12		
Eragrostis superba	D								2													24	16	6	4
Eragrostis heteromera	D							8	14				10		4		17		9		10	7			
Setaria sp.	D				26																				
Sorghum sp.	D																								
Sporobolus fimbriatus	U			63	10	21		1									3					36	22	14	17
Themeda triandra	D			23	1	54	13	40	22	18	7	2	1	4		1	47		8	9	12	8	2	29	3
[4]Total Frequency		76		189	103	86	105	147	135	149	124	129	90	139	41	125	115	186	97	165	118	171	144	189	100
[5]Total Ephemeral grasses		157	-	67	112	63	189	150	16.5	117	209	79	97	119	142	46	136	78	100	59	98	98	89	102	115
[6]Basal Cover %		1.0		6	58	6.3	27.9	15.5	10.8	13.8	16.0	12.3	29.5	9	7.3	15.2	26.5	16.8	6.0	10.8	5.5	9.3	6.5	9.3	2.5
[7]Kg/Hectare (Dry Weight)				921		171		317		338		580		209		829		799		460	299			34.5	

Notes for Appendix 1

[1]The frequency of perennial grasses is the proportion of plots with the presence of each species in a 100 plots of 0.96 ft^2 or 0.08 m^2.

2Rating: D = Desirable grass species for livestock and high ecological status in the potential grasslands. U = Undesirable grass species - unpalatable for livestock.

[3]TR - Permanent Vegetation Transect.

[4]Total Frequency - is the sum of individual frequency counts of perennial grasses.

[5]Total Ephemeral grasses. The sum of individual species of ephemeral grasses. The species of ephemeral grasses are not listed in this table.

[6]Basal Cover constitutes the percentage of the ground cover by the stems of perennial grasses.

[7]Kg/hectare is the grass standing biomass in kilograms per hectare. The production estimates were not taken during 1977.

Appendix 2

Field Range Condition Form

Group Ranch OLKINOS Technician Theuri Date March 18, 1978

Odometer Reading (km) (Sampling point) from shop to Tarmac	Soil Type (red, black, grey)	Desirable Plants (0-5)	Undesirable Plants (3-0)	Soil Condition (0-3)	Range Condition Classes (E,G,F,P,VP)	Aerial Vegetation Cover %	Remarks
685 km	Black (vertisol)	3	2	3	F	80	Ac dr - Peme
686	"	3	2	3	F	95	"
687	"	3	3	3	G	80	Th tr - Peme
688	"	4	3	3	G	95	Peme - Th tr
Isinya to Athi River 689	"	4	3	3	G	90	Peme Th tr
690	"	3	3	3	F+	95	Peme - Th tr
691	"	4	3	3	G	100	Pem Th tr
692	"						

Appendix 3

Variations in Total Number of Cattle and Mean Herd Size per Family in Kaputiei Ranches in the 1977 Second Livestock Census

Ranch	Total Number Cattle SUM	MEAN	SD	Number of Families N
Arroi	2170	35.0	53.4	62
Emarti	1262	26.3	29.6	48
Empuyankat	2003	43.5	44.3	46
Erankau	1129	20.2	26.8	56
Ilmamen	1151	21.3	29.8	54
Kiboko	1994	48.6	60.3	41
Mbilin	2560	38.8	53.0	66
Mbuko	2768	35.9	48.4	77
Meruishi	1547	46.9	80.8	33
Nkama	3660	23.9	35.1	153
Olkarkar	2119	49.3	64.6	43
Olkinos	1487	20.7	22.8	72
Poka	1966	51.7	75.4	38
Total Kaputiei	25816	32.7	47.9	789

Appendix 4

Variationsin Cattle Losses Due to Drought in Kaputiei Ranches (1976) From 1977 Second Livestock Census

Group Ranch	SUM	MEAN	SD	N
Arroi	3085	49.8	77.2	62
Emarti	9676	201.6	306.0	48
Empuyankat	4915	106.8	204.7	46
Erankau	2532	45.2	83.2	56
Ilmamen	2364	43.8	65.8	54
Kiboko	6304	153.8	158.3	41
Mbilin	12042	182.5	228.6	66
Mbuko	14957	194.2	217.0	77
Merushi	6870	208.2	232.0	33
Nkama	15769	103.1	130.0	153
Olkarkar	6089	141.6	179.6	43
Olkinos	3986	55.4	61.7	72
Poka	3241	85.3	123.2	38
Total for Kaputiei	91830	116.4	175.8	789

Appendix 5

Variations in Number of Sheep and Goats per Ranch and Mean Flock per Family in Kaputiei (1977)

Ranch	SUM	MEAN	SD	N
Arroi	4877	78.7	85.0	62
Emarti	5354	111.5	129.3	48
Empuyankat	9202	200.04	162.1	46
Erankau	4923	87.9	87.3	56
Ilmamen	5000	92.6	100.4	54
Kiboko	4568	111.4	108.9	41
Mbilin	4434	67.2	112.3	66
Mbuko	5815	75.5	81.5	77
Meruishi	2626	79.6	70.2	33
Nkama	6705	43.8	59.3	153
Olkarkar	3333	77.5	80.4	43
Olkinos	5952	82.7	77.3	72
Poka	3207	84.4	107.2	38
Total for Kaputiei	65996	84.6	100.4	789

Appendix 6

Variation in Sheep and Goat Losses in Kaputiei Group Ranches: 1977 Livestock Census

Group Ranch	Total Number of Sheep and Goats	Mean Flock per Family	SD Standard Deviation	(Cases) N Total Number of Families
Arroi	1242	20.0	31.6	62
Emarti	6023	125.5	186.9	48
Empuyankat	3468	75.4	117.5	46
Erankau	2746	49.0	150.3	56
Ilmamen	2241	41.5	86.9	54
Kiboko	3344	81.6	81.8	41
Mbilin	4436	67.2	64.5	66
Mbuko	7384	95.9	103.5	77
Meruishi	2670	80.9	73.9	33
Nkama	5657	37.0	49.8	153
Olkarkar	4612	108.3	302.2	43
Olkinos	4092	56.8	55.1	72
Poka	1286	33.8	40.6	38
Kaputiei Entire	49201	62.4	116.3	789