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THE DEVELOPMENT OF KENYA'S SEMI-ARID LANDS

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THE DEVELOPMENT OF KENYA'S SEMI-ARID LANDS

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OPENING STATEMENTSOpening Remarks by Mr. Y.F.O. Masakhalia, Permanent Secretary Ministry of Economic Planning and Development

The Arid and Semi-Arid Lands cover 82% of Kenya's territory. In these areas live 20% of Kenya's population. It also accounts for a vast amount of unexploited resources including 50% of our livestock herd. The importance of development of these areas has been appreciated for a long time by the Government. However, in recent years the development of these areas has received greater emphasis and concerted efforts are being made to mount effective programmes to develop the arid and semi arid areas. The Fourth National Development Plan highlights the aim of developing these areas. It acknowledges that as a result of a rapid population growth the amount of woods on cultural land in the medium and high potential grade that is capable of producing adequate income using present technology is becoming scarce. Population pressure therefore has gradually been compelling the people to cultivate more marginal land every year. It is therefore Government policy to increase productivity on all types of land. To this end the Government strategy will comprise the following elements:

1. to encourage farmers to use higher levels of purchased imports.
2. drainage and irrigation programmes will be implemented at an expanded level.
3. soil and water conservation programmes will be initiated
4. as the plans phase out a programme will be introduced to intensify the development of the arid and semi arid areas of the country.

I should at this stage recall to you the full basic principles that constituted the basis for the formulation of the 4th Development Plan. The first is wide spread participation in the development effort by the people themselves. This participation takes several forms including sharing in the fulsome progress and by increasing the number of people involved in checking and implementing development programmes. The second principle is diversity of forms. It is recognised that a mixture of organisation forms is desirable.

These include individuals, companies, cooperatives, voluntary agencies and the state. The basic criterion for determining the right organisation for an activity is how effective the organisation is in advancing economic and social goals within the guidelines set by the Government. The third principle is that

the Government should play a leading role in development by direct involvement in certain strategy production sectors and more importantly as the policy making and coordinating agency for public and private efforts. The fourth principle is mutual social responsibility. Such practices as excessive profits, exploitation of workers and concentration of economic powers were to be dealt with promptly. In line with these principles the plan identifies five specific target groups to whom efforts for alleviating poverty must be directed. Using the due criteria of low income and/or lack of access to obtain these the target groups identified were:

1. pastoralists
2. small scale farmers with holdings and income insufficient to support their families
3. landless rural workers
4. the urban poor
5. the handicapped.

The Government's concern for alleviating poverty among the pastoralists and some small farmers with low incomes prompts the redoubling of efforts to develop the arid and semi arid lands. Poverty in these areas is caused by lack of access to employment opportunities, land, water, markets, credit, modern technological innovation, power, social services, such as education and medical care and inadequate infrastructure. The development efforts for these areas must aim to make it possible for the population in these areas to have access to all these things. Provisional basic needs and economic opportunities are central to the success of the development of the drier parts of the country. The Government plans to provide facilities for education, health care and social services to the nomadic people in the arid and semi arid areas. To allocate more resources to the dedication of appropriated technology for the areas and water and power supply. One of the vital things that needs to be done to promote the development in these areas is carrying out some research. To meet technological requirements of the arid and semi arid areas effect of research must proceed to identify technological needs. The identification of these technological needs must be directed particularly to the following:

1. identification of new crops and crop varieties appropriate for arid areas and semi arid areas
2. control of insects and plant diseases
3. methods of farm management that will increase the amount and variety of production

4. low cost mechanical technologies that will increase labour productivity in these areas
5. simple transport technologies to facilitate transportation in these areas.

Now I will make passing remarks on coordination, popular participation, monitoring and evaluation that we consider as crucial for success in the mounting and implementation of development programmes in these areas.

On popular participation - It has been acknowledged for the entire country that it is desirable to involve people in the developmental efforts - I referred to this at an earlier stage. We shall work with people of different areas using their knowledge, their aspiration, their efforts and guidance. We have learned from experience that development will not take place without involving the people in implementing the development programmes. This people-based approach requires decentralisation and quite seriously we have embarked on a decentralisation programme. We now have at district level, district development committees which include in its membership local leaders. The committees have several subcommittees which deal with various services and sectors of the economy. Where these functions are, they reflect the views and aspirations of the people. This institutional arrangement will be used for the development of arid and semi arid lands as well. With regard to monitoring and evaluation, if the arid and semi arid programme is to be continued, and if it is to be improved, the monitoring and evaluation of this programme will be necessary. Monitoring and evaluation is vital if lessons are to be learnt and the experiences gained would be used and information would be readily available. Arid and semi arid lands planning committees will establish the methodology of monitoring and evaluation and I should urge all of you to assist us in these respects I am sure you will also benefit from the experiences gained from this exercise which will be useful to those who will be participating in the programme. The development of arid and semi arid areas will require that we have coordination among ministries, among institutions that will be involved. Recognising the extent of coordination required in implementation of these programmes, an interministerial committee was established last year. This group was requested to consider what approach was to be followed in developing the semi arid and arid areas. The deliberations of the group have been the basis of the report on arid and semi arid land development which I presume all of you have seen. The document sets out objectives, constraints, strategies and procedures for the developing of arid areas that should in fact be given attention by this Workshop. Now, I have indicated that elements of the developmental strategy and policy for the arid and semi arid areas are to be

found in such documents as the Plan I have referred to; the Report of the Coordinating Committee which has already been established for the development of these areas. There is still a lot to be done in the whole area of the development of arid and semi arid areas. We do not have very well formulated programmes and approaches for implementing these programmes. This Workshop is directed to the discussion of those issues pertinent to the development of these areas and I am quite sure that the outcome of the Workshop will be beneficial to us. As the Chairman indicated it is only in the last two or three years that a real concerted effort has been made in evolving developmental strategies, policies and programmes for these areas. And those two or three years have not really given us everything we should like to know about the developmental programmes, approaches and indeed some of the more elusive sociological aspects of the development of these areas which I hope this Workshop will throw light on all these aspects of the development of these areas.

With these remarks, on behalf of my Minister, I now would like to declare this Workshop formally open.

Thank you very much.

INTRODUCTION

GENERAL ISSUES IN THE DEVELOPMENT OF KENYA'S SEMI ARID AREAS

The definition of semi-arid areas can be made on the basis of climatic, ecological or land use characteristics. In terms of rainfall the semi-arid areas receive average annual amounts of between 500 mm and 800 mm, ecologically they lie largely within Ecological Zone IV but extend into Ecological Zone V and in terms of land use they represent areas of interaction between pastoralism and cultivation encompassing the margins of rainfed cultivation and the dry season grazing areas of many pastoral groups.

Each of these attempts at definitions overlap in terms of the areas designated as semi-arid. Ominde provides a more general definition of Kenya's semi-arid areas as 'a wide area around the core region of the Central Highlands and the westward-sloping plateau bordering Lake Victoria'¹ while for the purposes of planning the definition based upon information on ecological characteristics of district units provided by the Interministerial Task Force on Semi Arid Areas may be more appropriate (Map 1, Table 1).² This definition recognises the importance of ecological, social and economic processes in development planning for semi-arid areas.

Kenya's semi-arid areas are characterised by a great heterogeneity in ecological characteristics and production systems. Within this diversity however a number of general processes have been identified as threatening to reduce the viability of socio-economic systems and contributing to environmental degradation.

As the population of semi-arid areas is increasing, both by natural population growth and immigration from higher potential areas, so the viability of the production systems of semi-arid areas has become a vital concern to the Kenyan Government. In addressing the issues however it is inappropriate to identify symptoms of problems such as soil erosion and degradation of the environment as the aspects of semi-arid area development requiring immediate attention. While these processes are important they are but two highly visible

1. Ominde S.H. 1971 'The semi arid and arid lands of Kenya' in S.H. Ominde (ed.) Studies in East African Geography and Development. Heinemann Educational Books, Nairobi, p. 146.

2. See Government of Kenya (1979) Arid and Semi-Arid Lands Development in Kenya: The Framework for Implementation, Programme Planning and Evaluation. Government Printer, Nairobi.



Sources: R.B. Ogendo and F. Ojany (19) KENYA: A Study in Physical and Human Geography.

Table I. Administrative Districts of Kenya With a High Proportion of Semi-Arid Land*

- West Pokot
- Elgeyo Marakwet
- Baringo
- Laikipia
- Meru
- Embu
- Kitui
- Machakos
- Kajiado
- Narok

* Some districts other than those listed above may have semi-arid areas of considerable size but in low proportion to their total area, for example Turkana, Samburu and Isiolo. This illustrates the difficulty of defining the extent of Kenya's semi-arid areas for planning purposes.

aspects of the complex man-environment systems characteristic of semi-arid areas. Planning activities for semi-arid areas should be area-specific to ensure that local variations in cultural and ecological processes are addressed and should develop an approach which assesses the total man-environment system in each area. Prescriptions for improving the situation would then be developed within a holistic view rather than seeking to identify simple and partial cause and effect relationships.

Among the important processes contributing to the problems of the semi-arid areas are:

Population Pressure

Population growth in Kenya as a whole is approaching 4% per annum and is thought to be higher among the sedentary people than among the pastoralists groups which are estimated to have a rate of natural increase between 2.2% p.a. and 2.5% p.a.

Given the limited areas of agricultural land of high and medium potential the rapid rate of population growth is resulting in migration from the densely populated agricultural areas both to the urban centres and to less densely settled rural areas. The latter are often located at the wetter margins of the semi-arid rangelands.

Semi-arid areas therefore are facing a situation of having to support populations which are increasing both through natural population growth and through immigration. Much of this growth has occurred since independence and, although figures as to the rate of increase are scarce, Mbithi has presented evidence of rates of increase in Ukambani of over 30% per annum³.

Land Use Change

The movement of large numbers of people, predominantly farmers, into the wetter margins of the semi-arid areas has altered the land use systems of these areas. Many of the lands which have been settled by immigrant farmers were previously included within the dry season grazing resource base of adjacent pastoral peoples. The land tenure system of Kenya does not promote flexibility of land use and thus the extension of the area under crops has resulted in a decrease in the availability of dry-season pastoral resources.

The latter have, in a number of places, been further reduced by the designation of large areas exclusively for the use of wildlife as National Parks. National Parks in semi-arid areas enclose permanent sources of water and grazing formerly shared by wildlife and pastoralists.

The situation whereby farmers, herders and wildlife compete for scarce resources, particularly in the dry seasons, has created a situation of conflict over resources in semi-arid areas.

Environmental Degradation

Population growth within areas with limited resources has resulted in greater demands being made upon available resources. Farmers migrating into semi-arid areas have often brought with them technologies inappropriate to the more variable climate and less fertile soils often characteristic of

3. Mbithi, Philip M. and Wisner B. 1972 'Drought in Eastern Kenya: Comparative Observations of Nutritional Status and Farmer Activity at 17 Sites.' Discussion Paper No. 167, Institute for Development Studies. University of Nairobi.

semi-arid areas. Forest clearance and insufficient soil conservation measures have contributed to soil erosion and disruption of the hydrological systems while the planting of crops susceptible to water deficits have increased the potential of famine.

Growing pastoral populations finding dry season resources limited by settlement of farmers and the creation of national parks have been forced to concentrate on alternative grazing and water resources. The concentration of large numbers of livestock entails the risk of environmental degradation due to overgrazing and trampling, particularly during periods of drought. There is a need for long term studies to assess the impact on the environment of different livestock stocking rates under different rainfall conditions. The relative importance of different causal agents may then be indicated and appropriate counter measures taken.

While environmental degradation is often the most visible of the problems confronting the development of semi-arid areas it is clearly related to changes in the production systems of these areas. Greater emphasis should be placed on understanding the nature and the consequences of the changing patterns of interaction between the principal land uses of semi-arid areas--farming, herding and wildlife--and to the adaptations which each land use is making to altered patterns of population distribution, resource availability and to changes in environmental conditions.

Appropriate strategies for the development of Kenya's semi-arid areas should therefore be based upon an understanding of the ecosystems of the socio-economic characteristics of the production systems and of the interaction between them. Once the fundamental problems have been identified within this context then appropriate solutions may be developed.

While emphasising the necessity to approach the development of semi-arid areas in a holistic manner through analysis of production and ecological systems, it is recognised that measures to tackle specific problems need to be identified.

The problems of overgrazing and soil erosion should be tackled concurrently through measures for conservation rehabilitation and for reducing the pressure on land resources. The latter is the most important in the long-term and while some have suggested that extensive fallowing may be necessary, most participants emphasised the need to facilitate socio-economic changes which would reduce the pressure on resources.

Among the measures proposed to reduce such pressure were family planning, emigration, settlement schemes, non-farm employment opportunities and changes in the diet. It is evident that for any of these to contribute to the desired objective major changes in the economic environment would be necessary. This further emphasises the need for an integrated approach to the development of semi-arid areas within a national development strategy.

Other suggestions related to specific production systems and concerned methods of increasing this productivity and of reducing land use conflict. Research designed to develop higher yielding or more environmentally suited varieties of food and fodder crops was seen as one important measure for increasing the productivity of the farming and herding sectors as was the promotion of an efficient livestock and grain trading and marketing system. The activities associated with wildlife were seen as requiring greater linkages with adjacent economic systems and strategies such as the Wildlife Utilization Fees were recommended as encouraging local participation in wildlife-related activities. Integrated land use planning was viewed as essential in devising a resource allocation strategy to maximise the productivity of the semi-arid areas and to reduce the degree of conflict over land use between different production systems.

It was noted that the Government of Kenya is placing much of the responsibility for the preparation of plans for the development of semi-arid areas upon the District Development Committees (DDCs). This was seen as an encouraging trend as it was more likely to involve local participation in the decision-making process. Such local participation was seen as essential as the complex interaction between social, economic and environmental factors is best understood by those involved and their contribution to the planning process would promote the preparation of appropriate development strategies.

ISSUES IN THE DEVELOPMENT OF KENYA'S
SEMI ARID AREAS

By

Michael D. Gwynne
Global Environment Monitoring
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As you will no doubt hear again and again at this workshop the combined arid and semi-arid lands of Kenya cover more than 80% of the country's land surface and amount to some 473,000 km.² This large area, however, is occupied by only about one fifth of the country's total human population.

The semi-arid region alone account for about 60% (342,000 km²) of the surface area of Kenya and so constitutes the largest single tract of land in the country. It is with the issues for the development of this tract that we are concerned today.

The first point to make about this region is that it cannot be considered in isolation from the rest of the country. It is connected on the lower side of the aridity gradient to the truly arid zone and on the upper side it merges into the higher potential regions of the wetter zones. Any development schemes proposed for the semi-arid areas must be made in conjunction with similar and related proposals for the country as a whole. The development of marketing and communications infrastructures are two obvious examples of the need for coordinated development planning that spring immediately to mind. There are many others which will become apparent as these discussions proceed.

A second point that needs to be remembered about these semi-arid zones, is that although they are extensive they are not homogenous. The classification that makes them semi-arid is largely one of climate in which prevailing local weather conditions ensure that rainfall is limited in amount and is local and erratic in distribution, both in space and in time.

These climatic and weather effects, however, occur over a substrate that reflects geological and tectonic history and so differs considerably from place to place. Different topography, different soil types, and even different latitude, all combine (with still other factors) to play a part in expressing a similar climate in different ways from one location to another. Thus in one area

the predominant vegetation type may be bushland, in another grassland, and in a third, wooded grassland. Some areas may be regularly seasonally flooded, while others are never inundated at all.

All these differences affect development in the semi-arid region. Long range planning must bear in mind the climatic and ecological limitations imposed upon particular parts of the region and reflect them accordingly. Allowances must be made by planners for the difficulties imposed by these limitations on the routine management of projects within development programmes, no matter whether the projects be range development, dryland farms, irrigation schemes or national park management.

This brings me to my fourth point which is the need for an integrated, or at least a coordinated approach to development. It is very difficult to integrate, or even coordinate, different disciplines unless there are at least a few people at the planning level who have themselves a good working knowledge of a number of disciplines. This is also essential at the research level and is desirable, in management although difficult to attain.

Unfortunately, such people are hard to find and harder still to place in responsible planning positions. The world at large is still suffering from the craze for extreme specialization that went through the universities of the west in the fifties and sixties. This resulted in people knowing more and more about less and less. Fortunately, this trend has been halted, and even reversed, because it soon became obvious that someone had to have an overview in order to focus the activities of the specialists, and good generalists were simply not being produced.

This aside may seem a long way from the problems of semi-arid region, but it is not, for many of those responsible for the development and management of these regions, are themselves the products of the "specialist" university system. How many of those responsible for irrigation scheme implementation, for example, are familiar with the problems of wild-life management in semi-arid region, or could design a sound scheme for livestock production? It is not the fault of those concerned, that they have become so specialised, but rather of the system which produced them and the system which employs them according to their specialist paper qualifications.

My fifth point arises out of the fourth and is perhaps the most important of all. It is the need for flexibility in the approach to development. This need is true for development in any zone but becomes more important as you move down the aridity gradient. At the wetter end of the gradient the relatively larger, more reliable, and better distributed rainfall tends to cushion the effect of the periodic short term changes in local climate and local weather which are a feature of the East African scene. At the dry end of the aridity gradient, however, such short term changes (say 5 year cycles) can have a profound effect. At the moment the effect of these climatic swings in the dry areas is not fully appreciated largely because few people are aware that they exist and, because the paucity of meteorological stations in the region makes their demonstration difficult since there are so few long term data available for analysis. Such analyses that have been done suggest that these climatic fluctuations are normal in the semi-arid region of Kenya. Their effects will become increasingly apparent as development of the region increases in intensity.

One particular area where such short term climatic cycles are of the utmost importance and where flexibility of approach and outlook are essential if disaster is to be avoided, is the interface between the semi-arid regions and those adjacent zones higher up the aridity gradient.

Population pressure and land hunger in high potential areas are pushing people from them into the marginal zones. These people are primarily agriculturalists who wish to cultivate crops. During wetter years this is perfectly feasible and planners and administrators seeing these zones under such favourable conditions are prone to allocate state land for agricultural settlement purposes. When the climate swings back to a dry phase, however, as it always does, the newly settled farmers face almost certain disaster as their crops fail.

The incursion of these agriculturalists into what was traditional pastoral land, on the other hand is viewed by the pastoralists with suspicion and often with resentment, for it usually means that the pastoralists have been deprived of dry season grazing essential to the well being of their herds.

I hope that the finding of suitable development and management strategies for the high potential-low potential interface will be specifically addressed at this workshop. It is a problem that is not unique to

Kenya and occurs in many other regions where the two zones integrate and the climate is variable over the short term. Strategies successfully used in other regions could usefully be considered here, particularly, in my opinion, those that involve the concept of mobility of utilization so that adjacent agricultural and pastoral systems both benefit, no matter what the nature of the prevailing short term climatic cycle currently operating.

One traditional system occurring in other parts of Africa allows the cultivators to expand into the interface during wetter years. The cultivators pull back to more favourable growing regions during dry years, leaving the area to the pastoralists. The manuring of the region during its occupancy by the livestock restores soil fertility and permits the cultivators to obtain better crop yields during their next temporary occupation.

A short term variant of this scheme involves alternate seasonal utilization of the zone by the cultivators and the pastoralists. Here the livestock move in after crop harvest to feed upon the crop residue (e.g. stubble) moving off again later to leave the land free for further cultivation when next suitable.

A modern version of this system might include the production of dry season fodder crops, such as sorghum, by the agriculturalists of the interface, for subsequent sale to the pastoralists.

It is obvious that the questions of land tenure, land occupancy and the social interrelationships between agriculturalists and pastoralists are complex and must loom large in the operation of such schemes. Planning a development programme which involves some such system calls for the flexible approach that I have mentioned earlier. Administrators and planners, however often fight over even considering such an approach for, no matter how biologically sound it might be, it complicates the niceties of legal apportionment of land, and by so doing makes the allocation and management of development funds much more difficult.

The problem is further compounded by additional social factors, for it is often the case that the settlers allocated land in these areas are failed farmers from peoples living in high potential areas. Not only are these people frequently unskilled farmers, who find themselves farming in a very difficult environment, but they also have had little or no previous contact with pastoralists and are culturally out of sympathy with them.

This brings me to my sixth point which is the concept of land tenure. Broadly speaking the hinterland of Africa is occupied by two kinds of people: those who primarily cultivate; and those who primarily keep livestock. Formerly, it was thought that these were two fundamental divisions of mankind but now we realise that there is a cline between the two life styles and that each grades gradually into the other. There is probably not a single pastoral society that is wholly dependent upon its stock. Each such society either cultivates directly or has strong trade links with neighbouring people, often closely related. Nevertheless, the end section of the cline are sufficiently separate to ensure that they each have distinctive concepts of land utilization and land ownership.

Those that primarily cultivate are basically sedentary, and often have distinctive traditional ways of obtaining or buying new land for personal and family use; customary laws of land inheritance are often the rule in such peoples.

Those that keep livestock are basically mobile with no strongly developed tradition of individual land ownership. On the other hand, a variable family and group system of land utilization for livestock management purposes, over extensive areas, is well formed. The land boundaries of such systems are defined in the short term but are fluid in the long term and are determined by the local prevailing climatic and social conditions.

Over the previous 100 years most of Africa was under some form of colonial rule and during this period western education was imposed upon the peoples of Africa. Because of their essentially sedentary way of life, it was the agriculturalists who proved most receptive to education and the new ideas that resulted from it.

Nearly all the colonial regimes found great difficulty in achieving any degree of success with education among the pastoralists. This was due both to the mobility of their way of life, which made attending schools at fixed location for long period very difficult, and, perhaps more importantly, to the periodic but frequent demands for additional manpower for stock management during periods of adversity when it was necessary to send as many herders as possible into the field if the family or group, and its stock, were to survive.

As a result of this difference in educational receptiveness, it was the agriculturalists who tended to be the first to embrace politics, to form the first African political parties, and to demand independence.

With the demise of the colonial regimes, therefore, it was these same educated, politically conscious agriculturalists who formed the first government of independent Africa. With certain notable exceptions, there were few pastoralists involved at decision making levels in these new governments. Most were, therefore, composed of those whose cultural traditions and beliefs were bound firmly to fixed location agriculture - and to land ownership in particular. This was very similar to the general approach of the governments that had been in power before. Such governments were not in favour of the mobility of the pastoralists and their loose approach to land ownership.

As much for strategic reasons as any other (plus the lure of potential oil deposits) it was felt necessary to start to develop the arid and semi-arid pastoral areas. The collective cultural tradition of government, however, reinforced by the opinions of some expatriate advisors, that the pastoralists be resettled, and that title deeds be handed over to individuals, or at least to groups of individuals of limited membership. To this Kenya was no exception.

Only in recent years has it begun to be realised by Government that perhaps this approach is not necessarily the best for obtaining the most efficient form of habitat utilization and the maximization of livestock production in the pastoral areas. That these areas can perhaps be better developed for the good of both the nation and the people of the region adopting a more flexible, ecologically sound approach to the questions of land development, land management and land ownership is still a matter for discussions in administrative circles. It is a matter that I feel should be discussed fully and carefully at this workshop.

I have stressed this at length because I feel that a good meaningful land ownership and land management policy is fundamental to ensuring sound, successful development policies for the semi-arid regions. New concepts of land ownership may have to be developed that are more in keeping with the ecological and sociological realities of these environmentally sensitive areas. The Group Ranch concept was a step in this direction. The choice of social unit upon which it was based, at least in the original ranch

series, left a lot to be desired, while the extent of the individual ranches were founded largely on 'eye-ball' estimates of stock carrying capacity. As it turned out, neither were the best selection, but at least there was a determined attempt to take sociological aspects into consideration when planning pastoral area development - a decided improvement over earlier development schemes for Kenya's rangelands.

I think that these ideas must be taken further. I have already alluded to the need for new land ownership - land development concepts for the agricultural - pastoral complexes of the high potential - low potential interface zone. There is also a similar need for new concepts in the development and land tenure systems for the remainder of the semi-arid pastoral areas.

Most pastoral societies have developed successful adaptive strategies over the centuries which exploit a range of livestock types and take into account the sensitivity and variability of the semi-arid ecosystem. That these strategies have been successful cannot be denied, for if they were not, such societies would have long since disappeared. These then are strengths which can be built upon for development purposes producing a new system that allows the needs of the modern state to be met and at least large part of the secondary production potential of the region to be realized. In some societies, for example, it ought to be possible to base development upon group or family common livestock management ranges. These normally take into account the ecological requirements of the various sex and age groups of each of the users stock types. Such areas are often large, involving a variety of topographic and vegetation types, and a number of different kind of water source. Seasonal stock movements can take place within these ranges. They usually have well recognised boundaries and could serve as development cells to be connected subsequently by a communications infrastructure. Within each, livestock marketing, veterinary, medical, educational and trade facilities would need to be developed. Even here, however, the social obligations between such groups need to be considered carefully and for each pastoral society concerned.

At this point it is perhaps advantageous to consider the reasons for developing the semi-arid regions for there is often an apparent conflict of interest between those planners who view development primarily in terms of benefit to the national economy and national development as a whole, and those who see development in terms of benefit to the people of the region concerned. The farmer consider rangelands mainly in terms of meat production (beef production to be more exact) for sale and use in urban and other centres, and

for export. Traditional livestock use, however, is in terms of milk production and the pastoral herds exhibit what has been called dairy ranching.

If development is to succeed it is necessary to marry these two concepts in such a way that the ecological adaptiveness of the traditional management methods is maintained (or better, improved by using range management techniques which are appropriate to the region). Surplus stock should then be more readily available for near immediate slaughter or transport to higher potential areas for fattening and finishing. This, of course can only be successful if the present national meat price policy is made more rational.

Every effort should be made to prevent the sudden shattering of traditional societies through the over quick introduction of new concepts and new land management policy. Change in society can and will take place but it should be at a pace that can be assimilated and that is most beneficial to the people concerned. Only if the well-being of these people is improved can development be said to have succeeded.

My seventh point arises naturally from the sixth and is concerned with the need for research into the human, and natural resources of the semi-arid regions.

It is a widespread lament of the planners that there is no time to undertake elaborate and time consuming research programmes. Planners must plan for the future now using what information is currently and readily available. This does not in any way lessen the need for careful basic research but it does highlight the additional need for immediate, reliable 'quick-look' data, both biological and sociological, which can quickly be supplied for planning and development purposes. Methods have been developed for obtaining quick-look, quantifiable biological data using Ecological Monitoring unit principles (although I am disconcerted to note the almost non-existent role given to the Kenya Rangeland Ecological Monitoring Unit in the recently proposed framework for Arid and Semi-Arid Lands Development in Kenya.)

Similar, quick-look methods must be developed as a matter of urgency, for making rapid, reliable sociological investigations. A start has been made using questionnaire and field interview techniques such as those developed by the staff of the Kenya Institute for Development Studies. It seems to me that this could very profitably be linked to the systematic Reconnaissance Flights

(SRF) of an Ecological Monitoring Unit. The SRF can be used to obtain data on human population movement over the ranges and when coupled with ground surveys, it should become possible to make, for example very good human population estimates based on settlement and camp, size and structure. Similarly, the SRF can be used to monitor development itself by recording the changes over ever time of such development indicators as tarmac roads, fences, telephone lines, cattle dips, stock marketing points, corrugated iron roofs, and wells. This information should be of great value to development planners provided it reaches them with the minimum of delay.

There are many aspects of basic research that need considering in the semi-arid regions. Some good programmes are underway, but others need starting as a matter of urgency. More emphasis needs to be placed, for example, on research into the adaptive physiology of the domestic plants and animals already used, or intended for use, in these regions.

There is, for example, little doubt that in the semi-arid regions water is the major limiting factor to plant growth. New crop varieties are tolerant to dry conditions but are often not resistant to drought where as good drought resistance was a feature of their progenitors. It is obvious from this that in the yield improvement processes through which basic crosses usually pass, many good qualities have been reduced or lost.

Few plant breeding programmes consider the root system yet an effective root net work is fundamental to plant growth. Those few plant breeding programmes which have examined, inter alia, root systems have often achieved spectacular results. Such was the case of the wheat breeding programme in Australia which quickly discovered a cultivar with a very high root volume/soil volume occupance ratio. The introduction of this cultivar enabled wheat production to be successfully pushed into the drier regions of Australia.

This is not the place to list in detail the plant production problems that need investigation. The difficulties of flowering in some range legumes and seed setting in range grasses are two that spring immediately to mind.

Primary production estimation is of obvious importance in semi-arid regions. The use of spectral reflectance methods for estimating green biomass in the grass and forb layers of the plant community has been a major advance the use of which has helped enormously in understanding rangeland production

and the strategies for utilization used by both traditional pastoralists and by herbivorous wildlife. Its usefulness in the planning and management of intensive beef production ranches remains to be tested.

A similar quick, reliable system is needed for estimating browse production (i.e. the leaves of woody dicotyledonous plants) which constitute an important rangeland resource again used by both wildlife and domestic livestock.

The need for good, updated information on vegetation condition and the trend of its change is important for regions, such as the semi-arid lands, where there is a large economic dependence upon secondary production. In Kenya the provision of such data should be, and very properly is, the role of the various monitoring projects that are operational.

There is, however, a growing tendency to call for the production of very detailed physiognomic and species composition vegetation maps. Such maps are only of practical use if they can be produced quickly for they are little more than historical documents which record the situation seen at a point in time. Vegetation maps of the type produced to accompany the various survey reports of the UNDP/FAO Kenya Range Management Project are useful since they accompany reports, and are produced quickly. What is to be avoided is entering into long term vegetation map production exercises. In Afghanistan I recently came across a bilateral aid project that had taken 14 years to produce a 1:250,000 scale vegetation map of the country. The project staff were the first to point out that the early sheets bore little relation to actuality since many of the regions mapped had subsequently been extensively deforested and cleaved to provide wood fuel. A similar story is seen in the production of the four map sheets showing the vegetation cover of the central high potential areas of Kenya. Began in the late fifties, the project is now nearing completion. In many areas, however, it now takes a trained eye, a map maker's zeal, and a great deal of imagination to use these maps. Indeed for planning purposes most use was made of them as photostats of the rough plots in the period immediately following the initial field work - which is as it should be.

Until recently dry land farming was relatively neglected in Kenya but big strides have been made but more remains to be done both in terms of the development of appropriate techniques, and in the testing of possible new crops. Again it is important to consider dryland farming not just in terms of

the semi-arid regions but also in relation to agricultural development in the country as a whole. Its relationship to various existing and potential livestock production systems must be thought out carefully.

Irrigation is another cause for concern. The world is littered with well meant irrigation schemes which for a variety of reasons, most of which are managerial have gone wrong, often leaving the irrigated area poisoned through salt accumulation. My own view is that irrigation agriculture is a high technology process that should only be introduced with extreme caution into societies with no tradition of irrigation; irrigation can achieve consistently spectacular production results as long as the scheme management is sufficiently firm to ensure that those participating have the social discipline necessary to follow the required management schedules. Any deviation from these schedules is causing potential disaster. Salt accumulation can be removed from soils but it is an expensive and time consuming process.

Again, irrigation schemes, both large and small, must be considered against the development needs of the regions and in relation to other focus of land use. In the case of large schemes, the question of access to water sources for both livestock and wildlife must be carefully thought out as must the whole relationship of the scheme to the wildlife management policy for the region. The provision of fuel for cooking by the participants in the scheme is an aspect that cannot be neglected. The production of irrigated fuel trees or plants has to be considered although the area needed to produce fuel to meet the needs of even a modest sized irrigation scheme is very large. Initially, at least fuel needs can be met in part through selective bush clearance activities for range improvement programmes in adjacent pastoral regions.

Kenya, I feel, will soon have to review its foresting policy for I do not think that a country with so little high potential land and such a rapid rate of population increase can much longer afford the luxury of forest production on what could be good agricultural land. Even the need to continue to maintain forests as the sole vegetation cover permissible on critical high potential area catchments may soon need to be called into question. A large part of the forest industry will almost certainly eventually have to move into the semi-arid regions, and now is the time to undertake research into appropriate dryland forest production methods. Detailed proposals to this effect were made more than ten years ago but unfortunately these were dropped and the research project never got underway.

On the animal side the various options provided by using different combinations of different types of livestock need to be considered. Many

pastoralists already operate production systems that well utilize the physiological and behavioural advantages of their various animal breeds. The systems used by the pastoralists need careful research to see how strategies employed can be improved upon, and adapted for use in different situations, perhaps in association with more conventional livestock production systems. Better knowledge of livestock physiology, nutrition (including diet selection and digestive efficiency) and behaviour can be used to put stocking rate and carrying capacity estimates on a more sound footing.

Milk, blood and meat are proteins of increasing complexity, each requiring more energy to produce than the preceding one. The last requires the death of the animal whereas production of the first two do not. Could milk and blood production become a useful, perhaps economic, aspect of semi-arid rangeland animal production?

As is well known, small stock (sheep and goats) are most important components of the livestock production systems in use in the semi-arid regions. Goats in particular, in addition to some breeds of sheep, are very drought tolerant and highly adaptive with regard to diet, changing happily, and efficiently, from browse to grass to browse with the change of seasons. Much more research is needed into small stock management in the semi-arid region, and particularly with regard to their possible role in the agricultural - pastoral complexes of the high potential - low potential interface. Similarly they should form an important part of dryland farming programmes.

The semi-arid regions are often looked upon in terms of extremes. They are sometimes seen as an area of scenic and ethnic romanticism, or as a backward, unproductive area whose inhabitants are stubbornly conservative. It must be admitted that there is an element of truth in both these views. Their romantic appearance, however, when conceived with the still large wild-life population, makes the tourist potential of the region considerable. If tourism is to succeed in the future, suitable means must be found to ensure that an adequate percentage of the revenue provided by the tourists actually reaches the people of the region to whom money spent in Nairobi or Mombasa is of no immediate interest. Without the support of the local people the wild-life will go and then so will the tourists. This has been said many times before. It still remain true.

My last point is perhaps more a reflection on western education and aid schemes than on development strategies. I nevertheless still think that its mention would be useful.

The western world (at least until a few years ago) is essentially a meat eating society. Livestock production systems have evolved which maximise meat production. Agricultural and range management schools teach methods that are geared largely to the high technology production of meat. Under suitable management regimes, the semi arid regions of the west produce incredible amount of meat at a cost.

Most of those from the third world who are concerned with range management, and associated skills, almost invariably go to be trained in the schools and in universities of the west where they learn their high technology, high production methods. On returning home they try to apply them to their own country and are exasperated and frustrated to find that the systems and methods that they have learned overseas somehow can not quite be made to work at home. Their needs turns out to be different from the needs of the country where they were trained.

Similarly, those expatriates who come with the aid schemes for rangeland development are similarly imbued with concepts that are often inappropriate to the country in which they find themselves. Many fail to realise this and do not make the needed change of concepts. Africa contains many examples of regions that have been improved through well intentioned aid schemes in which, at the end of the improvement process, the secondary production was lower than in the initial unimproved state.

Fortunately, their situation is changing. The difficulties still remaining over the needed changes in attitude are great to which anyone can vouch who took part in some of the discussions at last year's First International Rangeland Congress. These changes in view point. However must eventually reach the syllabus of training establishments. It is important that they do.

I would like to close this section with a quotation from Owen Lattimore (Herdsman, Farmers and Urban cultures). It was written about another continent and very different political philosophy. It nevertheless is equally applicable here:

".....it is an urgent requirement that we should study not the principles of those who offer aid, but the historical and cultural characteristics of those who receive aid."

So far during this address I have done no more than touch briefly, and indirectly, upon two major inter related problems which affect the development of semi-arid regions. These are the population increase and the provision

of fuel (or serve a form of low cost energy) to that population.

Kenya has one of the highest rates of population increase in the world lower perhaps in the drier regions than in the wetter, but still high nevertheless. Those zones at the dry end of the aridity gradient are steadily reaching the limit of their potential human carrying capacity under existing forms of livelihood. New strategies and approaches for their utilization will have to be sought.

The rate of population increase will eventually have to be lowered but at present the need felt for large families is too closely bound up with the traditional and firmly rooted survival strategies used by both agriculturalists and pastoralists for any change to be likely in the immediate future. Planners will probably have to live with this increase rate for some time to come, and indeed future development projection, such as that for meat consumption, suggest that they have accepted this. I am, therefore, not intending to elaborate further on this aspect, simply noting and emphasising the need for development strategies to take such consideration into account.

During this address I have drawn attention to several issues which I think important to semi-arid land development and which I would like to see considered in the working discussion which follow. There are other issues that I could have chosen to stress (such as soil erosion) and I have no doubt that another speaker may well have made a difficult selection altogether. I can only hope that mine proves useful.

KENYA GOVERNMENT POLICY IN SEMI-ARID AREAS:

By
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INTRODUCTION

It is the purpose of this paper to trace the development of Government policy in semi-arid areas in Kenya from the relative neglect of the early years of the colonial period to the more vigorous approach which is currently being formulated. In the past government thought and action was concentrated first in the humid and later in the more arid areas of the country. In consequence dryland agricultural systems have been neglected and the full productive potential of semi-arid areas has not been realised.

A number of attempts were made in the past to promote productive utilization of resources in semi-arid areas but they were sectorally based and thus failed to promote compatibility between the various economic activities in these areas.

The present policy is being developed within the context of intense land use conflict in many semi-arid areas. Land shortage and rapid population growth in the more humid areas is resulting in migration of farmers into the wetter margins of the semi-arid areas causing competition with existing land use systems such as livestock production, wildlife conservation, forestry and water catchment. In the absence of development planning for these areas competition will intensify and the most productive allocation of resources may be prevented by inefficient resolution of conflict between competing land uses.

This paper will adopt an historical approach to the development of policy for Kenya's semi-arid areas. The history of government policy is divided into distinct periods and the dominant themes affecting policy and development strategies in each period and the reasons for policy changes from one period to another are presented. Finally the paper compares and contrasts the present policy with those of the past.

1900 - 1923. The Problem of East African Finances

One of the most important activities undertaken in the early years of colonial rule in Kenya was the construction of the railway from Mombasa to Kisumu. The costs of construction were enormous and these and the costs of operating the line were heavily subsidized by the British Treasury. The primary concern of the government in Kenya at this time was that referred to by Sir Charles Eliot as the 'problem of East African finances' (1,p.3), namely that of

making the railway line a self-financing economic venture. It was argued that the population of Kenya was not only too small to support the railway line but its economy was not oriented to the production of a marketable surplus which could sustain the line.

To resolve these problems the government adopted a policy designed to encourage Europeans to settle in Kenya. It was envisaged that such settlers would be supported to generate the necessary surplus production for export and they would create a demand for goods and services which would be imported via Mombasa and transported upcountry by the railway. The settlers would thus provide sufficient traffic to offset the costs of running the railroad.

To implement the above policy all that was required was the necessary legislation to acquire land in Kenya for prospective European settlers. To this end the 1902 Crown Lands Act was passed and an influx of settlers took place which reached a peak in 1908. The actions of government in supporting the settlers was so successful that by 1909, barely a decade after the start of European settlement in Kenya, grants-in-aid from the British government were no longer required. As the immigration of settlers continued the 1902 Act was strengthened in 1915 by one which gave even more powers to the government to alienate African land for European settlement.

Government policy during this period was clearly focussed upon the issue of European settlement and on the problem of East African finances. Large areas in the more humid parts of the country and in the semi-arid Rift Valley were alienated exclusively for European settlement while development in the unalienated African areas was completely neglected. However, land alienation and the economic policies related to the areas of European settlement resulted in mounting tension as Africans resented the alienation of land and as Asians began to demand rights to land.

1923-1945. The Era Of Dual Policy

As tension mounted the British Government became concerned about the continuing scramble for land in Kenya which was occurring without due respect for African rights and interests. Thus in 1923 the British government issued a declaration aimed at curbing the alienation of African lands. The declaration made it clear that Kenya was an African country and that in all matters affecting the Africans, as the land issue clearly did, African interests should be paramount. It also called for a shift in development policy towards actions designed to develop African areas.

This declaration by the British government caused problems for the Kenyan administration. The Kenyan government was bent on concentrating on European agriculture which was facing new challenges from the 1930's depression, the 1928/32 locust infestations, soil fertility problems brought about by the past grain monoculture and the shortage of infrastructural facilities. Moreover, the settler community, which had formed itself into a powerful pressure group in Kenya, saw the new moves by the London office as an attempt to deny the settler the cheap African labour they were enjoying.

Caught in the dilemma of satisfying both the demands of the British Government and of the settler community in Kenya, the Kenya Government formulated the Dual Policy. The Dual Policy was partially an attempt to appease both sides. The policy was that in order to develop the African areas, all able bodied men must strive to produce a marketable surplus from their holdings. However, those who could not produce such a surplus had to offer their services either in European farms or in the infrastructural construction sector (the port, railway branches, roads, urban centres) for a wage income.

The Dual Policy existed mainly on paper. Apart from opposition from the settlers, there was little on the ground--extension staff, training, facilities, infrastructure, finances, etc. --to support the development of African areas. However, nominal beginnings were made. These included:

- a) Establishment of two Agricultural schools for Africans; one at Kabete, the other at Bukura;
- b) Establishment of Local Authorities to regulate forestry and land use, construct roads and supervise health and educational facilities;
- c) The establishment of District Betterment Funds;
- d) Identification of overstocking and overgrazing as a problem in African Areas and the beginnings of policies designed to deal with these problems through the marketing of surplus livestock, by compulsion if necessary.

In implementing the Dual Policy no attempt was made to differentiate the African areas according to ecological potential. The more humid and the semi-arid areas were considered as one category and development efforts concentrated upon the wetter areas with which the government was more familiar. Actions in the semi-arid areas concentrated upon reducing soil erosion and overgrazing and upon veterinary campaigns to reduce the incidence of disease in native livestock, a measure designed primarily to protect the European livestock economy. The economies of the semi-arid areas were viewed as unproductive, damaging to the environment and as a potential hazard to the European ranching sector. In view of this negative attitude it is not surprising that little

effort was made to develop the economic potential of the African livestock sector.

With the outbreak of World War II the modest beginnings made in the development of African agriculture were interrupted. Faced with the necessity to support the war effort the government again concentrated upon the European areas whose agricultural systems could respond more readily to the new challenge. In the livestock sector however, substantial contributions were made to the war effort by some African producers despite the fact that drought conditions prevailed during much of the war.¹

While some effort was made to stimulate African agriculture during this period it was insufficient to overcome the problems resulting from population increase within the restricted area of the African reserves. Soil erosion and land degradation was widespread and with the end of the war greater attention to the development of African areas was seen as essential to the reconstruction of the economy.

1946-1955. The Ten-Year Plan

One of the first proposals designed to reduce population pressure in the African areas after World War II was that people should be resettled outside of their traditional areas on unoccupied or little used land. This would then have permitted the reconditioning and rehabilitation of traditional African areas. The African Resettlement Board was set up in 1945 to supervise this process but the policy was quickly deemphasized in favour of a more comprehensive plan to develop the African areas. This was the first Ten Year Development Plan covering the period 1946-1955 and it included the first major effort to address the problems of the semi-arid areas of Kenya.

The Ten Year Development Plan called for the total development of African land, crop, livestock and water resources and to implement the Plan two factors were necessary:

- a) Finance: This was to come from two sources:
 - i) District Betterment Funds, raised within Kenya and derived mostly from excesses on produce sold;
 - ii) The Colonial Development and Welfare Fund.
- b) Appropriate organizational set up. Normal Government departments were weak in the African areas. An African Land Development Organization (ALDEV) was therefore

1. Government of Kenya, 1944-1962. Annual Report, 1944, Kajiado District.

established to implement the Plan and it took over the functions of the African Settlement Board established in 1945.

It is important to remember that ALDEV was not a government department, but rather a multi-disciplinary statutory board. Its functions were:

- a) Financial control and planning various development projects;
- b) Coordination of the various activities within any one project area and between various areas;
- c) Carrying out surveys and engineering works where necessary.

Projects for implementation, originated from the field having been prepared by the District Agriculture Committees and forwarded to the Board through the Provincial Agricultural Committee. Projects which were likely to lead to further self-sustaining developments were favoured. Loans rather than grants were encouraged if the project was financially and economically viable and fees for maintenance of projects and schemes were collected from the beneficiaries. Strict stock limitation was enforced--a measure that made the Ministry of Agriculture particularly unpopular.

For the purpose of this discussion, it should be noted that although the Ten Year Plan was supposed to cover all African areas, ALDEV in fact concentrated most of its thought, action and resources in the semi-arid areas. The districts that benefitted most were Samburu, West Pokot, Baringo, Machakos, Kitui, Taita and Kajiado. The projects themselves covered a wide range including: settlement schemes, grazing control and management schemes and afforestation of steep slopes around semi-arid areas. But perhaps the greatest success of ALDEV was in generating useful knowledge on how to rehabilitate and recondition degraded lands.²

By 1954, a substantial part of the African areas had been rehabilitated. Production was increasing due to soil conservation, better land use, grazing control, livestock improvement, rural water supplies and settlement in previously little used or unoccupied lands. The methods used so far were extensive in nature. However, it was evident that resettlements were not a realistic long term solution to the population increase in African areas and policy shifted to emphasise intensification of agriculture in African areas.

2. For a thorough treatment of this subject, see the Board's Report: African Land Development in Kenya: 1946/68, published by the Ministry of Agriculture and Animal Husbandary, Nairobi in 1962.

1955-1960: The Swynnerton Plan

The background to the intensification of agriculture in African areas was a report prepared by the then Deputy Director of Agriculture, Mr. R.J.M. Swynnerton³. In essence, this plan was a follow-up to the Ten Year Plan and was meant to continue the work of ALDEV for a further five years. The policy was to intensify the development of African agriculture in Kenya through land consolidation, an increase in cash crop production, better management and improvement of livestock, development of ranching schemes, improvement of rural water supplies, provision of agricultural inputs and credit and an expansion of extension staff.

A major contribution by the Swynnerton Plan to the development of semi-arid areas was the identification of those areas as requiring specific attention. This was a policy departure from the earlier condemnation of these areas as economically dead, and from the previous treatment of all African areas as a homogeneous category of land potential.

Though intensification of land use in semi-arid areas was recognized as difficult to achieve under the existing technology, it was equally appreciated that these areas could nonetheless produce most of their local food requirements. More importantly, a constant and valuable flow of livestock and their products could be derived from them if only proper livestock management could be achieved, coupled by ready and adequate outlets for excess stock.

The actions to be taken by Government included stock limitation, livestock marketing, water development and tsetse fly eradication. To achieve these objectives some 40 major development schemes were identified and budgeted for. The districts in the semi-arid areas which were to benefit most from this plan were Machakos, Kitui, Taita, South Nyanza, Kwale, Lamu, West Pokot, Baringo, Samburu, Lower Elgeyo Marakwet lower Kiambu, Mukogodo Division of Laikipia, and the Maasai Districts, Kajiado and Narok.

The end of the ALDEV era--and therefore that of the Swynnerton Plan--coincided with the days just preceding independence in Kenya: a period that called for a different set of priorities. There was thus another policy shift to address the new priorities.

3. Swynnerton, R.J.M., 1955. A Plan to intensify the Development of Africa Agriculture in Kenya. Government Printer, Nairobi.

1960-1970. The Land Transfer and Resettlement Era

Up to 1960, the Government had followed two systems of agricultural development in Kenya; one system for the African and the other for the European areas. Although the African areas had begun to receive major attention under ALDEV, there existed an unequal concentration of resources in the European areas. Moreover, the existence of the two systems in the same country was increasingly untenable as independence approached. The two systems had to merge.

Government Policy in the period just before and after independence was to merge the previous two systems in agriculture. Thus Government conceded to the African demands for the transfer and redistribution of land previously reserved for Europeans only to Africans. This was to be achieved through a land transfer and resettlement programme for the Africans. To facilitate the above policy an order in Council reserving parts of Kenya for Europeans only was revoked in 1960. In the following year some 72,000 ha. of formerly European areas was transferred to African ownership. In 1962, the Million Acre scheme was launched. This was to be followed by a fully fledged land transfer and resettlement programme during the next decade.

The above programme, while necessary for political reasons, was very expensive in at least two ways. First it was financially expensive. For example in the 1963/64 Financial year, the programme absorbed about three-quarters of all government expenditure in Agriculture. Even as late as 1968/69, about one-half of the Agricultural budget went into this programme⁴. Secondly, the programme detracted attention from the traditional African areas where the majority of Kenyans live. In the process the semi-arid areas were likely to be de-emphasised. It was absolutely essential that the policy be changed to emphasize rural development instead.

When the need for the land transfer and resettlement programme became evident in 1960, concern was expressed as to the possible consequences of such a policy on the semi-arid areas which were not as suitable for such a programme as the humid areas. The term Rangelands, borrowed from North America literature, was now being used to describe drier areas in Kenya.

Thus, in 1960, Government commissioned a study on the extent, problems and possible corrective action in the Rangelands. The report of this study⁵ contained many recommendations; among them that a separate Department be formed to coordinate action in range areas, of which semi-arid areas are only a part, and to administer a development programme there.

4. Government of Kenya, 1970. Development Plan 1970-1974. Government Printers, Nairobi.

5. Heady, H.F., 1960. Range Management in East Africa. Government Printer, Nairobi.

The above recommendation was not implemented until 1963. The 1961/62 period of drought followed by floods gave a new urgency to the need for an executive authority to develop range areas. It was now Government policy to upgrade the total range economy by conserving, managing and developing those areas. In 1963, the Range Management Division was formed in the Ministry of Agriculture and charged with the above responsibilities under the Agriculture Act.

The Range Management Division, now a Branch of the Ministry of Agriculture, drew up a Range Development Programme covering manpower development, training, pre-investment ranch planning and research. Other institutions of Government have complemented this Programme. They include the Ministry of Water Development and the Agricultural Finance Corporation. In both of these institutions, new sections were established to help in implementing the Range Development Programme. In addition, a Livestock Marketing Division, also now a Branch of the Ministry of Agriculture, was established to handle the marketing of excess livestock in range areas.

The above institutional build-up was facilitated through massive financial allocations into the range areas. These funds have helped particularly in the development of new ranch types. In this regard, the existing legal framework prohibiting the registration of a plot of land to a group of people was recognized. This recognition resulted in the addition of a new chapter to the Laws of Kenya facilitating such an action.

The Range Management Branch and other institutions supporting the above programme have tended to concentrate on livestock development in the arid areas rather than in semi-arid areas. By the early 1970's, it was clear that whereas attention had been focussed on the more humid areas during the colonial period, the Range Management Programme was focussing on the more arid areas where extensive systems of livestock production are possible. The effect of the Range Programme has been to ignore the semi-arid areas where smallholder arable agriculture is possible though risky. This realization has led to a policy shift in favour of the development of dryland farming technology and it forms the basis for the present policy.

PRESENT GOVERNMENT POLICY IN SEMI-ARID AREAS

The 1972 I.L.O. report (10, pp 405-10) argued strongly for a concerted Government effort to develop semi-arid areas. The Report indicated clearly that these areas face problems which cannot be fully addressed to by the on-going Range Development Programme. These problems include land use conflicts between arable agriculture, pastoralism, wildlife use and afforestation; inadequate development of a suitable dryland farming technology; insufficient quantitative information of the developable resources in these areas; population increase--both natural and through migration into these areas; erratic rainfall and under-developed infrastructure. The present policy aims to solve these and other problems including that of coordination of activities in these areas.

The present policy has been developed during the 1974/1978 Development Plan and is further enunciated in the current 1979/83 Plan.

1974/78 Development Plan

Responding to the analysis by the I.L.O. Mission mentioned above, Government proposed in the 1974/78 Plan to 'devise methods of developing the less favoured areas and promote even development among different areas.' The phrase 'less favoured areas' may be taken to mean very much the same thing as Semi-Arid Areas. More specifically, it was intended during the plan to 'promote rapid development of the marginal cropping areas through the development of better crop varieties and improved methods of husbandry' (5, pp. 198). To achieve this, new research and trial programmes were proposed to develop alternative farming systems.

The research and trial programmes proposed in the above plan would take long to prepare, start and obtain useful information from. Anxious to get on with the development of the semi-arid areas, the Government established in 1976 a Marginal/Semi-Arid Lands Pre-investment Study team. The main function of this multi-disciplinary team is to quantify the developable resources in these areas and suggest suitable projects to develop those resources. The team has already completed studies in the Machakos and Kitui Districts and in parts of Embu and Earingo Districts. (8, ten volumes)

Investment projects in those areas are either going on or are at advanced stages of preparation and appraisal. At the same time as the pre-investment studies have been going on a Dryland Farming Research and Development Project has been initiated at the Katumani Research Station near Machakos township.

The two Government activities just discussed will greatly alleviate the information and technological constraints to the development of Semi-Arid Areas. But a lot more remains to be done in shaping the present policy.

1979/83 Plan

The theme of the 1979/83 Development Plan is alleviation of poverty and provision of basic human needs. This theme arose out of the realization that the general theme of rural development in the previous two plans had bypassed some groups in Kenya. Smallholders and pastoralists in Semi-Arid Areas have been identified as some of those groups. The present Plan therefore contains the most detailed statement ever of Government policy in Semi-Arid Areas. The statement reinforces the ideas contained in the 1974/78 Plan.

In the 1979/83 Plan, the development of semi-arid areas is described as a new high priority of Government (6, p.253). Having identified the basic problem as increasing population pressure on a fragile ecology, and noting the significant degradation and the declining and riskier income opportunities, Government has made it the policy to 'urgently develop these areas by means and techniques that will preserve and make more productive the basic environment.' (6), p.253) Therefore Government policy during the next five years will be to 'deal with the twin problem of poverty alleviation and land rehabilitation in semi-arid areas.'

The enabling actions that Government intends to take to implement the above policy will be partly the continuation and expansion of on-going activities and partly the initiation of new ones. As regards on-going activities, the Range Development Programme will be rationalized and expanded in a more integrated context to cover more areas and provide more basic human needs particularly in the more arid parts of the semi-arid areas. The Pre-investment studies will be continued in other Districts. To implement projects emanating from these studies, the various Government institutions involved are being requested to establish special units charged with projects in the semi-arid areas. Thus, while the development of these areas has been mostly the business of only a few Ministries, it will be extended to involve many more others.

Regarding the proposed new initiatives, action has already been initiated to facilitate the mounting of a broader action for the development of semi-arid areas including:

1. Plans have been completed for the Ministry of Agriculture to expand its research and development efforts at both the Kiboko Range Research and the Katumani Dryland Research Stations.
2. The Ministry of Economic Planning and Community Affairs has established three River Valley Basin Development Authorities in order to be able to develop lands traversed by those Basins. Two of these, the Kerio Valley and the Tana/Athi Rivers Development Authorities cover mainly semi-arid areas.
3. The Ministry of Water Development has completed the first phase of a National Master Plan for Kenyan Waters. Again this study is expected to help in the development of semi-arid areas.
4. The Ministry of Tourism and Wildlife has established a Rangeland Ecological Monitoring Unit to advise on trends in livestock and wildlife numbers, and cultivation in semi-arid lands. Further, a study of the conflicts in land use brought about by the presence of very large herbivores is being undertaken for this Ministry so as to provide guidelines on policy for the resolution of the conflicts.
5. A Land Use Commission has been established in the Ministry of Lands and Settlement to adjudicate on proper land use where conflicts occur.
6. The Ministry of Natural Resources, Forestry Department, is mounting a Dryland Re-afforestation Research programme to develop suitable and early maturing tree species for semi-arid areas.
7. In recognition of the nomadic or semi-nomadic mode of life in some of these areas, the Ministry of Education has initiated a project to construct Arid Zone Educational Centres. The first phase will develop 14 such centres to provide both formal and informal residential education.

The above activities will be complemented by the development of both physical and economic infrastructure, call for an integrated framework for planning, implementation, monitoring and evaluation. In recognition of this, Government appointed an Inter-Ministerial Committee in 1978 to define such

a framework. A draft report by the Task Force is ready⁶. The report, which has been accepted by Government proposes an Inter-Ministerial Coordinating Committee at the level of Permanent Secretaries of all Ministries involved. In a way, this committee will be similar to the ALDEV Board as far as policy matters are concerned.

Since the above Committee can only meet occasionally, a second one, the Planning and Coordinating Committee, is proposed to handle the day-to-day interministerial programme coordination and planning. Finally, some Government Ministries/Departments will be more involved in the development of semi-arid lands than others. These core Ministries will be able to exchange ideas through a technical coordinating committee. The three-tier coordinating structure may at first appear cumbersome. But it is meant to diffuse the development of semi-arid areas as widely as possible within Government. It is also meant to get action taken as fast as possible and to avoid unnecessary delays.

COMPARISON AND CONTRAST BETWEEN PRESENT AND PAST GOVERNMENT POLICY IN SEMI-ARID AREAS (SAA)

There are some features of the present policy towards these areas which are interesting when compared and contrasted with the past ones. To start with, the present policy has evolved from the recognition of the inadequacies of previous ones in addressing the needs of the semi-arid lands.

First, during the era of the East African financial problem, they were summarily dismissed as economically dead. The present policy realizes the tremendous regional and national benefits-- economic, social and ecological--which can accrue from their development. These include marketable surplus production, development of the human resources and halting the process of desertification.

Secondly, the half-hearted Dual Policy of the 1930's could not have achieved much success due to the meager resources allocated to the African areas in general and to semi-arid areas in particular.

The present policy calls for a massive infusion of development resources into these areas to alleviate the existing constraints to their development. The constraints include: limited and erratic rainfall, soil infertility, scarcity of the land resource taking into account the productivity

6. Government of Kenya, 1979. Arid and Semi-Arid Lands Development in Kenya: The Framework for Implementation, Programme Planning and Evaluation. Government Printer, Nairobi.

at present technology, lack of research-tested information on better management of more arid areas, and increasing population pressure (7, pp 13-14).

Thirdly, while the interruption of the Second World War shifted Government attention away from them in favour of the humid areas, the subsequent Ten Year Plan was a major effort at addressing the previous neglect of the semi-arid areas. To a large extent, the present policy attempts to build on the lessons learned during this and the Swynnerton Plan periods. Four such useful lessons are:-

- a) That even the worst degraded tropical semi-arid lands can be rehabilitated within a reasonable period of time under proper management;
- b) That the consultation of and cooperation with target groups are vital to the long-term success of projects in these areas;
- c) That pastoral people would be willing to sell off livestock provided the proper price incentives are offered;
- d) That most of the semi-arid regions will have to be developed with present populations remaining in them as opportunities for large scale settlement schemes outside them are extremely limited.

Fourthly the narrow focus of the Range Management policy on livestock and welfare of people in less densely populated areas will be broadened to specifically address the problems of poverty and environmental degradation in semi-arid areas under the present policy. Thus increasing attention will be focussed on mixed farming small-holdings in addition to the pastoral economy.

Fifthly, a major effort will be concentrated on achieving the technological breakthrough necessary for intensified production in these areas, particularly regarding crop agriculture. This has not been effectively addressed in past policies.

Finally, whereas only a few Ministries, notably the Ministry of Agriculture, have been involved fully in the development of semi-arid areas in the past, the present policy calls for a more integrated approach which will involve many more Government and statutory organizations.

In conclusion, there seems to be sufficient evidence that the developmental problems peculiar to semi-arid areas have been recognized by Government in the past. Indeed, the activities of ALDEV under the Ten Year Plan and under the subsequent Swynnerton Plan appear to have been major and honest efforts to develop semi-arid areas. What seems to have happened all along was the failure by policy-makers to conceive approaches to rural development different from those proved successful in the humid areas. If the present policy thrust is maintained in the future, however, Kenya will be in a position to develop one of the most consistent policies in this regard in Africa. The greatest advantage those concerned with semi-arid areas have to-day that they lacked in the past is the political will to be less centralist and paternalistic in developing these areas.

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SETTLEMENT POLICY AND ITS IMPLICATIONS TO THE
DEVELOPMENT OF KENYA'S SEMI-ARID LANDS

S.E. Migot-Adholla

INTRODUCTION

To make the economy as a whole grow as fast as possible, development money should be invested where it will yield the largest increase in net output. This approach will clearly favour the development of areas having abundant natural resources, good land and rainfall, transport and power facilities, and people receptive to and active in development.

Republic of Kenya (1965)

African Socialism and Its Application to Planning in Kenya.

para. 133.

There is no doubt that by adopting the strategy summarised above Kenya realised an admirable rate of economic growth. Yet not surprisingly, this achievement has been accompanied by increasing disparities in incomes and social welfare. Among the rural populations, farmers and pastoral peoples in the marginal land areas have particularly been underprivileged. It is therefore not surprising that the parlous state of the economy in Kenya's semi-arid lands is often dramatised only during times of acute drought and famine. At the peak of such times, nearly one quarter of Kenya's population, living in an area more than 70 per cent of Kenya's total land area may be affected. Crop failures are sometimes total and livestock losses may reach 50 per cent or more.

Mbithi and Wisner have estimated that the most severe and widespread droughts occur about once a decade and may cost the government up to 20 million shillings in famine relief alone.¹ But less serious droughts or drought-like conditions, regional famines and localized livestock losses do occur with greater regularity with varying effects. Until recently, the general response by previous governments has been 'the substitution of economic rationality by welfare conscious specialists and politicians (which) has led to half-hearted searching for economic alternatives which include large scale irrigation, ranching projects and land settlement schemes.'²

For a long time the dilemma of development in Kenya's marginal areas has been characterized by 'export crop fixation' among economic planners on the one hand and competition over land use between agriculture, pastoralism and wild life conservation on the other. The land areas often referred to as marginal are characterized by a wide range of vegetational, soil and climatic relationship. Generally, these areas comprise Kenya's rangelands, defined as 'land carrying natural or semi-natural vegetation which provides a habitat suitable for herds of wild or domestic ungulates..... Some of the present range area has a potential for agriculture or other developments but most is destined in the present state of technical knowledge to remain under range-use because its rainfall is scanty and erratic.'³ Yet because of the land distribution and settlement policy (or the lack of it) developed during colonialism and continued thereafter, the process of competition over land use in the marginal areas is already widespread, as an authoritative government report illustrates.⁴ But the complexity of the issue arising from such competition

1. Benjamin Wisner and Philip M. Mbithi (1972), "Drought in Eastern Kenya: Comparative Observations of Nutritional Status and Farmer Activity at 17 Sites" Discussion Paper No. 167, Institute for Development Studies, University of Nairobi.

2. *ibid.*, p. 22.

3. Pratt, D.J., Greenway, P.J. and Gwynne, M.D., (1966), 'A Classification of East African Rangeland, with an appendix on terminology'. Journal of Applied Ecology, (3) pp. 369-382.

4. Republic of Kenya (1976), Kenya's National Report to the United Nations Conference on Human Settlements, Office of the President.

have been subjected to piece-meal treatment, the general result of which would appear to aggravate the deterioration of human condition in these areas.

Realizing the deleterious effects of previous official neglect of the marginal lands, the Kenya government has now given a very welcome emphasis to the development of the Arid and Semi-Arid Lands. But given the complexity of environmental, social and economic problems in these areas, there is need for more careful consideration of aspects of settlement, particularly in the pastoral areas, as they relate to the provision of basic social services and production inputs. This paper attempts to review the existing settlement policy (or its absence) in the Semi-Arid Lands in order to provoke discussion about alternative settlement policies and their socio-economic implications.

Background: Evolution of Settlement Policy in Kenya

Very broadly defined, rural settlement implies the spontaneous or planned movement of people to occupy areas of under-utilized economic potential. As this definition suggests most often settlement takes place in virgin or unused land. Sometimes, however, it includes land used by nomadic pastoralists or shifting cultivators. The objectives of planned settlement often vary very widely, and may include such elements as famine relief, mass relocation, tse-tse fly eradication, swamp drainage, consolidation of national boundaries or the furtherance of ideological goals. But generally, settlements include as their goal the creation of income earning opportunities through the utilization of relatively more productive methods. This applies to both rainfed and irrigated agriculture whether spontaneous or planned.

Historically, Kenya's experience with planned settlement of the indigenous population remained very modest until the years just before Independence and immediately thereafter. But these movements of

of population, largely accounted for by large scale settlement in the former White Highlands have tended to mask some historically more salient patterns of rural migration and settlement in Kenya. The first major movement of people in search of land was sparked off by the process of land alienation and the establishment of farms for exclusive occupation of white settlers. One immediate effect of this was that it precipitated land pressure in the areas into which those whose land had been alienated were squeezed. In the pastoral areas the impact of land alienation was not immediately felt as their herds had been considerably reduced in the rinderpest epidemics between 1880 and 1900.

Spontaneous Settlement

Although the agricultural people were most severely affected by land alienation, the pastoral people lost the largest proportion of the land, and even more important was the loss of dry season grazing in the relatively well watered and higher grounds. In the ensuing adjustments to the combined effect of land alienation and population pressure in the agricultural areas one category of migrants settled in other African reserves or in areas legally designated as Crown Land. Settlement of this nature tended to assume the nature of tribal expansion into less populated adjacent areas. Mbithi and Barnes have outlined the major patterns of these.⁵

Along the coast, for example, some of the Miji Kenda people effectively became tenants-at-will on the land previously alienated from them. Efforts to control squatter settlements on coastal land had not been successful - By the early 1920's such settlement was beginning to cause excessive soil erosion, whose alleviation eventually led to the establishment of planned settlement at Gedi for the "Wanyika".

5. Philip M. Mbithi and Caroline Barnes, (1973) Spontaneous Settlement Problem in Kenya, Nairobi, East African Literature Bureau.

Further inland, a significant proportion of the Kamba people had been evicted from the area surrounding Chyulu Hills to create game conservation areas. It is likely that some of the pockets of Kamba settlements in the Coast Province, Maasailand and in Kilimanjaro and Tanga regions in Tanzania may have originated from these evictions. However, migration and settlement back to the relatively fertile areas in the Tsavo National Park, especially Chyulu Hills, has continued sporadically.

But more imperceptible, although probably the most numerous, have been migrations within the tribal reserves which have involved settlement in relatively less fertile areas. During the 1920s, for instance, Luo people from the densely populated and fertile areas started to occupy some of the sparsely populated areas of South Nyanza District. These destinations, relatively empty at the time, having earlier been depopulated due to successive sleeping sickness epidemics were occupied by wild animals, and had no effective claimants. More recently this type of settlement within Kenya's agricultural areas has significantly increased. But because census enumerations do not give migration data for units smaller than the district, it is difficult to measure the magnitude of such spontaneous settlement except very crudely. It is instructive though that the most attractive districts are also those with significant proportions of land that can be categorized as semi-arid: Narok, Kajiado, South Nyanza, Samburu, Baringo, Tana River, Kilifi and Embu. In Narok, Kajiado and Baringo for instance, Kikuyu migrants constitute 53.6, 44.9 and 26.8 percent of all migrants.⁶

Characteristically, agricultural settlers in these marginal areas occupied the relatively more fertile areas in the higher grounds, on the river valleys and in the low-lying seasonal swamps. Yet as several studies have shown, continuous farming in these areas cannot provide a secure source of livelihood given the existing technology.

6. These calculations are based on the figures given in Henry Rempel (1974) 'An Analysis of the Information on Inter-District Migration Provided in the 1969 Kenya Census.' Working Paper No. 142, Institute for Development Studies, University of Nairobi.

Farming in these areas should thus rightly be seen only as part of the strategy for diversifying family economies.⁷ But unfortunately official fixation over increasing crop production has gone unabated as is evident, for instance, in the District Development Plans for Kitui, Kajiado and Garissa during the last plan period. The long run consequence of such policies encouraging agricultural settlement and crop production in semi-arid lands (either actively or by default) has been ecological deterioration and acute economic stress among the pastoralists.

Until the mid 1940's the predominant attitude of successive governments towards the pastoralists in the marginal areas was largely governed by the need to maintain law and order, and control animal diseases. Earlier attempts to deal with these problems through punitive quarantines and compulsory destocking provoked so much political dissent that they were immediately abandoned. Official attitude towards pastoralists was then characterised largely by benign neglect. But as population pressure led to increased deterioration of the land both in the agricultural and pastoral areas the problems of African agriculture could not be ignored much longer. The malaise of rural economy in the African reserves was diagnosed to arise from overcrowding, over-stocking and poor agronomic practices. Accordingly, solutions were seen in soil conservation measures and the removal of excess population and livestock from the badly degraded land. Thus started several planned settlement schemes under a new agency: The African Settlement Board, which later became popularly known by its acronym, ALDEV.⁸

7. Philip Mbithi (1971) 'Non-farm Occupation and Farm Innovation in Marginal, Medium and High Potential Regions of Kenya and Buganda.' Discussion Paper No. 114, Institute for Development Studies, University of Nairobi. See also Gudrun Dahl and Stephen Sandford (1978) "Which way to Go? A Study of People and Pastoralism in Isiolo District in Kenya." Nairobi, International Livestock Centre for Africa.

8. Although its initial focus was settlement, the Board gradually realized that the root of the problems it was charged with solving was the mismanagement of the ecology and soil resources. This is illustrated by the changes in its title from African Settlement Board (1945), African Settlement and Land Utilization Board (1946), African Land Utilization and Settlement Board (1947) to African Land Development Board - ALDEV - (1953). Later it became Land Development Board-Non-Scheduled Areas - (1957), and Board of Agriculture-Non-Scheduled Areas - (1960).

Planned Settlement

Although some attempts had earlier been made to resettle squatters, for instance at Gedi (1937) and Olenguruone (1940), the major efforts at planned settlement came in the post-war years, and more decidedly in the aftermath of the Mau Mau revolt and the advent of Independence. Generally, the earlier colonial attempts at planned settlement were a failure. Most of the settlements were on land considered "waste" or in areas infested with tse-tse and simulium flies. Such schemes were thus primarily aimed at controlling the flies, since cultivation would ensure the bush not regenerating.

As a strategy for settlement there was a clear misconception in these early projects. There was no serious land pressure in the areas where such 'waste' was available; consequently it became very difficult to attract settlers. Many of these earlier schemes were also on land with marginal potential and very doubtful prospects for profitable crop production. It is not surprising then that the ALDEV settlement schemes attracted a very small number of people and many of them were abandoned; only to be 'colonized' later by people from other areas far afield where land pressure was more acute.⁹ For instance, the Kerio Valley scheme started in 1947 failed to attract any settlers and was shelved 'until such time as pressure on the land enforces development'.¹⁰ In later years the Land Development Board had some success on some schemes. Generally, however, unless a high priced commercial crop was established and market accessibility assured, the schemes often collapsed.¹¹ Of all the people settled by ALDEV on rainfed schemes by 1961, about 79% were settled on marginal lands in Machakos, South Nyanza, Kilifi, Kwale, Meru and Baringo districts.

9. African Land Development in Kenya, 1946-1962, (1962) Nairobi: Ministry of Agriculture, Animal Husbandry and Water Resources; passim.

10. *ibid.* p. 149.

11. Among the rainfed settlement schemes only Shimba Hills met some measure of success because of the high income from sugar, and its close proximity to the Mombasa market which contributed to profitable vegetable production. But even here by 1961, nearly 70% of the settlers were Kamba. All the people from the Coast Province constituted only 11%.

But perhaps a little more successful even though more expensive were irrigation settlement schemes. Minor irrigation projects were operated locally through the District authorities. Many of these were very small, settling on the average not more than 250 families drawn mainly from the local populations. By 1961 only 1,500 families had been settled on some 6,388 acres in Embu, Baringo, Machakos, Elgeyo, Taita and Tana River districts. But of the major irrigation projects Mwea Tabere, Galole (Hola) and Perkerra which started by utilizing the labour of Mau Mau detainees, only Mwea-Tabere was successful. This scheme was very closely supervised from the beginning. Settlers were genuinely landless peasants who held their land on the scheme only as temporary tenants and were liable to be evicted if they did not comply with requirements laid down by the management. But the Mwea-Tabere scheme was also in a very favourable position with respect to water availability and management. Thus by 1961 it had been expanded to accommodate a total of more than 1230 families. At the same time Hola and Perkerra accounted for only 100 and 117 families. In the case of Hola the number of tenants, comprising mainly Kikuyu Mau Mau detainees had been declining very sharply since 1959. As a result 'the question of introducing Pokomo riverine cultivators was proposed for the first time. This was still under discussion at the end of 1961.'¹²

But in spite of the efforts of ALDEV at settlement in rainfed and irrigation schemes throughout the country, the deteriorating economic and social conditions in the African reserves remained, in the words of the governor then 'complex and recalcitrant..... a result of the increase in population, inefficient systems of tenure and slow rate of industrialization.....'¹³: Typical of the government at that time, major policy formulations has to be justified by commissions of experts. The Mau Mau

12. African Land Development..... p. 216.

13. Dispartch to Colonial Office by Governor, Sir Philip Mitchel, quoted by Leonard Joy (1956) 'Some Agricultural Aspects of the Report (Comment on the East African Royal Commission, 1953-1955 Report)', East African Economic Review 2, 2: 11-118.

era thus witnessed a barrage of reports focussing on Kenya's political economy: the Troup Report (1954) the Carpenter Report (1954) the Swynnerton Plan (1954) and the Royal East Africa Commission Report (1955), the last two being particularly relevant to the subject of our discussion.

Land Tenure Reforms and Its Impact

The Swynnerton Plan dealt with problems of agriculture in the African areas and embodied a series of proposals immediately designed as counter-revolutionary to Mau Mau.¹⁴ In the long run the plan aimed at revolutionizing African agriculture through the introduction of individual tenure and the production of profitable export crops hitherto prohibited to Africans. Arguing for the eventual concentration of land resources in the hands of the most efficient producers, it anticipated an exodus of surplus labour from the land into urban based industries. The Royal Commission having the broadest terms of reference, endorsed the need to promote commercial agriculture and private enterprise among Africans. But perhaps as most important recommendation was the abolition of racial distinctions in land holding. It can therefore be seen as the official rejection of the White Settlers' hope for economic and political domination.

In purely productive terms, the combined effects of land-tenure reform, provision of agricultural credit, expanded extension service, and the benefits of experience accumulated in the settler farms started what may be justifiably seen as a "green revolution" in the limited sense that it led to higher crop yields and better quality.¹⁵ But these develop-

14. See M.P.K. Sorrensen (1963) 'Counter Revolution to Mau Mau: Land Consolidation in Kikuyu land 1952-1960', Kampala, Makerere Institute of Social Research (mimeographed).

15. Evaluation of the programme show that production per acre is much higher in the small holder plots for coffee, tea, maize and dairy products than it is in the larger mixed farms or plantation. Some statistical analysis also demonstrates that the profit margin is higher for smaller than for larger farms, thus in our area the optimal farm size is between 4 and 7 hectares. But considering that the average size of land holdings in the area is only 0.4 hectares, it becomes obvious that it is the wealthier smallholder farmers with relatively larger holdings who are in a position to maximize profits. See Rodney Wilson (1972) 'Land Control in Kenya's Small-holder Farming Areas' East African Journal of Rural Development, 5, nos. 1/2: 123-40.

ments have so far been restricted to areas of high potential land. In the rest of the country, comprising the majority of the marginal lands agriculture has continued to stagnate despite the extension of the land tenure reform campaign. Indeed, it may be argued that as a result of accelerated dispossession in the high potential areas resulting from tenure reform, significant numbers of "squatters" have settled in the marginal areas on land unsuitable for continuous cultivation, thus making the economy of such areas even more precarious.

Within the high-potential areas, the land question was increasingly politicized during the late 1950s and early 1960s partly as a result of rising productivity and profitability of small holder farming under the Swynnerton Plan and rising unemployment in the urban areas. To preempt the land grabs advocated by the underground Land Freedom Army and Kiama Kia Muingi, and to avoid possible revolt against the new government, portions of the former White Highlands were added to the African reserves beginning in 1961 and subdivided for occupation by the landless and unemployed, and by progressive African farmers. This programme, known as the Million Acre Settlement Scheme, although popularized as a measure to Africanize the Highlands, affected only a small fraction of the large scale farms, leaving from three-quarters to four-fifths of the former White Highlands intact. It is important that this policy did not change even after Independence. By 1968 the subdivision of large farms was effectively abandoned. Since then no sizeable settlements have been established on rainfed lands, except the Lake Kenyatta Scheme at Mpeketoni in Lamu District where landless people, mainly from Central Province, are settled. Other sizeable post-Independence settlement projects are the Bunyala, Ahero and West Kano Irrigation Schemes all of which have settled indigenous people from the immediately surrounding areas. These schemes also appear to have been predicated upon the need to regulate periodic flooding and/or drain the swamps in the area which otherwise could still produce food crops without irrigation. But the more promising post-independence irrigation schemes, even though small in size have been the minor irrigation projects in the arid and semi-arid areas.

Minor Irrigation Schemes

Since 1967 a number of irrigation schemes have been started in the arid Northern regions of the country. Many of these schemes were initiated and financed by various church organizations, but a few such as Rapsu and Gafansa started on local initiatives. The primary aim of these schemes was to provide settlement opportunities, particularly to destitute pastoralists who had lost their herds during the Shifta disturbances and later during the famine of 1974-75. Many of the schemes may thus be seen as a continuation of the famine relief effort. Because of their different origins, the schemes vary in their organization and management although there has been a somewhat uniform allocation of about 0.5 hectares per family. While the emphasis was initially on food production some cash crops, mainly cotton, have recently been introduced. But because of the small size of these plots the income from them is not sufficient to meet the basic needs of an average sized family. Not surprising, therefore, settlement on these schemes has not been very stable and there is a tendency for the settlers to invest their income from agriculture into livestock. And while only few people have been able to revert to pastoralism completely, farming on these schemes serves as a strategy for diversification and should ideally be integrated with pastoralism.

Recently all these minor irrigation schemes have been brought under the Arid Region Irrigation Development (ARID) Programme of the Ministry of Agriculture which will in future develop new schemes, expand some existing projects and co-ordinate the activities of the various donor agencies. Although the major objective of the ARID Programme will still be the provision of settlement opportunities it is now realized the plot sizes of 0.5 hectare can hardly provide adequate income and plot sizes are now to be increased to one hectare.¹⁶ But it may be argued that even one hectare is still too small if the settlers on the schemes are expected to rely entirely on farming. It is expected that based on the new policy the ARID Programme will have a settlement capacity of only 15,000 families.

16. Sadik Toksoz, (1979) 'Irrigation and Drainage Development in Kenya: Some Policy Issues' Nairobi: Development Planning Division, Ministry of Agriculture. (mimeographed).

So far it would appear that minor irrigations in the arid regions of Kenya offers only an insignificant opportunity for livelihood. Nor given the emerging policy of recruiting settlers from all over the country on the basis of provincial quotas, would it appear that the larger projects like Bura in Tana River District offer any significant settlement opportunities for the indigeneous populations in the semi-arid areas.¹⁷ It is clear then that a more useful settlement policy would be one that was aimed at making the pastoral economy in these areas more secure, by guaranteeing access to improved pasture, water and other basic social services.

Future Trends

From this broad review of experience with settlement in Kenya it is clear that there has so far been no coherent policy with respect to the semi-arid areas and particularly pastoralist peoples. If anything the tendency appears to have been biased toward sedentizing or stabilizing the pastoral peoples. But given the limited possibilities for an expanded irrigation programme in the semi-arid lands, any significant stabilization of the population in these areas can only be achieved through a livestock based economy. But this calls for a clear land use policy which may necessitate zoning of certain parts of the country for extensive livestock production. This may necessitate that people who are exclusively farmers may have to be excluded from such areas.

17. An analysis of the quotas proposed for each province shows that they were arbitrarily estimated and bore no relationship to population densities, land carrying capacities or levels of unemployment. The proposals were North Eastern 2.5%, Rift Valley 4.7% , Western 13.6%, Nyanza 15.5%, Eastern 19.4%, Central 22.9% and Coast 22.9%. A more objective ranking of provinces based on population density and carrying capacity gives Coast 25%, Eastern 25%, Central 13%, Nyanza 14%, Western 14%, Rift Valley 5% and North Eastern 2%. T.B. Kabwegyere, S.E. Migot-Adholla, D. Kayongo-Male (1977) "Report on the Study of Selection of Tenant Farmers for the Bura Irrigation and Settlement Project" (mimeographed).

It should be emphasised though that in advocating the setting apart of some land areas for the exclusive use of pastoralist one is not proposing the creation of modern-day human zoos. The logic of this suggestion is that adequate land be made available to enable the inhabitants of the semi-arid areas to earn an acceptable means of livelihood. To do this, in keeping with the declared objectives of the current development plan which seeks to alleviate poverty and satisfy basic needs, it is imperative that basic social services must be provided. It is in fact the difficulty of providing services such as education, health and clean water to pastoralists that is often used as a pretext to sedentize pastoralists. But experience elsewhere indicates that with more imaginative planning these services could be delivered without having to settle pastoralists. With respect to education, for instance, it is planned to establish 12 centres where boarding facilities will be provided to primary school children whose parents lead a nomadic life. It is regrettable though that even with the disillusionment with the content of primary education in the farming areas, the curriculum in these centres is expected to be the same as in the rest of Kenya. A basic question however still remains over whether education and other social services in the pastoral areas should not be mobile.

Concluding Remark

This paper does not pretend to provide any solutions to some of the problems I have posed. Its objective as I stated at the beginning was to provoke discussion focussing on appropriate settlement policy to be adopted in the semi-arid lands. It is perhaps worth reminding ourselves that ultimately the major justification of a settlement policy will be the extent to which such policy contributes to the improvement of the living condition of the populations in the semi-arid lands. For that is the challenge of development.

DRYLAND FARMING IN KENYA: PROBLEMS AND PROSPECTS

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INTRODUCTION

The term 'dryland' Farming' was coined to describe a new technology for crop production in marginal and semi-arid areas where rainfall was previously considered too low and limited for profitable crop production. The widespread use of the term is a reflection of the success of the new technology and represents hope for the people living in the marginal and semi-arid regions of the world. The dryland farming technology therefore aims at careful management of the chief limiting resources, viz. rainfall to ensure that as much of rain water as possible becomes available for crop production. The soils and fertility and crops themselves are managed so as to ensure maximum efficiency of utilization by crops.

In recent years attempts have been made to delineate areas where the dryland farming technology could be used with success. Since the semi-arid zones extended from the tropics to the temperate zones, with temperatures varying according to latitude, rainfall was used as the major criterion. Within the temperate and subtropical regions it was found possible to grow crops with as little as 500 mm per annum for summer crops but could be as low as 250-300 mm for winter cropping. (Arnon, 1972; ElBaradi, 1974). Within the tropics the minimum amount of rainfall has not been worked out but in Kenya it has been suggested that areas receiving less than 30 in (750mm) are of marginal agricultural potential and cropping becomes hazardous as 20 in. (500 mm) isohyet is approached, (Peberdy, J.R. 1979). For this reason, the dryland farming technology is being developed and tried in those areas of Kenya receiving between 500 mm and 850 mm of rainfall per annum, loosely termed as marginal or semi-arid zones.

THE NATURE AND SCOPE OF THE ANTICIPATED PROBLEMS

1. The Physical Environment

Although rainfall has been singled out as the main factor limiting production in the marginal and semi-arid areas, other meteorological factors like temperature and wind, and land factors like soil type, fertility and topography act variously to modify the effectiveness of rainfall to a greater or lesser extent. This is best appreciated from the water balance equation, thus

$$AW = P + S - E - R - D$$

where AW = available water, being that water held in soil between permanent wilting point and field capacity.

P = precipitation (rainfall)

S = moisture already stored in the soil before it rains. It can have a negative value if the moisture content is below permanent wilting point.

E = Evapotranspiration, representing water lost through direct evaporation from the soil and/or vegetation surface and transpiration from crops.

R = runoff or surface drainage and

D = Deep drainage beyond the effective rooting depth.

It follows from the equation that evapotranspiration, E, is a direct consequence of meteorological factors while runoff, R and deep drainage, E are affected by the rainfall and soil characteristics. The degree to which these factors influence the effectiveness of rainfall in turn depends on rainfall characteristics themselves. The rainfall characteristics which are important in this respect include

- (a) rainfall amount received during a growing season,
- (b) rainfall duration, (c) rainfall distribution within and
- (d) between the seasons.

(a) Total Rainfall: It has already been mentioned that dryland farming technology can be applied in summer rainfall areas with as low as 500 mm with success. The main problem prevalent in Kenya semi-arid areas is that the total rainfall within the growing season can be considerably below this, especially the bimodal rainfall areas. The areas to the east of Rift Valley and excluding

the coastal hinterland have two rainy seasons of roughly equal duration and thus sharing the total annual rainfall by half. Hence the actual rainfall expected in these areas reduces to between 250 mm and 400 mm in a growing season. However, the agrometeorologists have estimated that if rainfall equals or exceeds two thirds of potential evaporation totaled over the growing period, then crops can reach maturity. For most of the semiarid areas, especially in Ecological zone IV (Survey of Kenya, 1970) the potential evaporation (Woodhead 1968) totalled over three growing months ranges between 400-500mm giving a two-thirds minimum rainfall requirement of 260 - 330 mm. This explains why with 250-300mm rainfall those farmers practising good management are able to obtain good harvests, while others obtain poor or no harvest.

Studies from other semiarid regions of the world also indicate that the lower the rainfall totals the poorer the distribution within the growing season and the greater the variation from season to season. This variation suggests there should be expected alternation of drought with wet years. The recent drought years (1974-1976) followed by the wet years (1977-79) in the semiarid areas of eastern Kenya supports this observation and more accounts of droughts alternating with wet years covering a longer period can be found in the Machakos Gazetteer, (Peberdy, 1958).

(b) When the total rainfall received in a growing season looks roughly adequate then examination of its duration helps to determine whether the wet period is sufficiently long to cover the maturity period of the existing crops. Under normal agricultural conditions, when rainfall duration equals or exceeds the maturity period of the main crops, rainfall is unlikely to limit crop production and is usually taken for granted. Conversely, when the duration is shorter than the maturity period crops suffer from drought and yields are depressed depending on the length of the period between the on-set of drought and crops' maturity. If drought sets in before pollination and fertilization are complete the yields could be reduced to very low levels. For example, maize yields were reduced by 25% when soil moisture was depleted to wilting point for two days during tasselling period and by 50% when the period of stress was increased to 6-8 days, (Robins and Domingo, 1953). The corollary to this is that rainfall duration should be sufficiently long for the available crops to reach at least beyond the most sensitive stages, viz, flowering, pollination, fertilization and early grain filling stages, (Salter and Goode, 1967). For root and tuber crops the tubers expansion should be advanced when the rain stops so that the process can be completed with residual

moisture. Looking at semiarid areas of eastern Kenya the reliable duration of the rainy period has been shown to be about two months for both seasons (Dowker, 1961) and this seems to be true whether rainfall is low (less than 200 mm) or high (Marimi, 1977). The available crops on the other hand take more than three months to reach maturity e.g. Katumani maize 110-120 days and Mwezi moja beans take 90-100 days. It can be appreciated therefore that the available crops experience drought before reaching maturity.

(c) Rainfall distribution within a growing season forms the basis for determining whether a given crop experienced any drought at any stage of growth. The water requirement for a growing crop and hence the ideal method of supplying a crop with water has been shown to be low at germination and accelerating rapidly during the establishment phase and reaching a maximal broad peak during the mid - season phase and thereafter decreasing rapidly as the crop reaches maturity.

However, rainfall distribution does not follow that pattern and in the bimodal rainfall semiarid areas of Kenya there is a heavy preponderance of high intensity storms during the first thirty days from the start of rainy season, (Fisher, 1977). Up to 70% of the storms greater than 50 mm per day are received during this period at Kitui and much less received during the next thirty days when the water demand by crops is highest, while the third month is virtually dry. This distribution has an advantage as well as a disadvantage.

The high rainfall at the beginning of the season following a dry season ensures there is excess rain water which could percolate into deeper soil layers, thereby contributing to storage. Unfortunately, most of the rain water is lost as runoff since at this time the soil has little or no protective cover and hence forms surface cap rapidly which cuts down infiltration rate to very low levels. Simulation studies in Machakos area indicate that with rainfall intensities of 50 mm or more per hour runoff forms in 15-20 minutes and infiltration rate falls down rapidly so that by the end of the hour very high runoff - in excess of 60% of applied water was measured, (Barber, Moore & Thomas, 1978; Moore, Thomas and Barber, 1978). Due to this high proportion of runoff when rainfall exceeds 25 mm/hr, records might show rainfall was adequate for producing a crop while in fact there was widespread crop failure.

In areas with one distinct main season as in the semiarid areas within the Rift valley the tendency is to have short periods of heavy rainfall separated by drought periods, sometimes of considerable duration. When such droughts are too long they may impair the crops permanently so that such crops do not recover fully when favourable weather returns.

(d) The variation of total rainfall from one season to another is a major cause of frustration to the farmers and agricultural planners of the semiarid areas because prediction of yields is not easy. Exactly how much rainfall would be available for cropping is only known at the end of the rainy season. The farmers may react to this uncertainty in a number of ways, but two extremes will be illustrated. The easiest action a pessimistic farmer could take is to grow his crop at low plant densities in anticipation of a drought. However, if the rainfall happened to be high then such a farmer loses a chance of getting a high yield. An optimistic farmer on the other hand would plant high density stands hoping the season would be favourable and therefore get a high yield. If the season turns out to be average or below a complete crop failure results. Such a situation could be saved by thinning out excess plants when adverse conditions set in but unfortunately the farmer tends to allow the crop to hang on in anticipation of good rainfall in the next few days. Faced with such uncertain weather conditions the wisest decision appears to be to plan to accommodate a mild drought through the application of the various cultural methods that are available, for example planting adapted crops early and at medium densities which save rain water early in the season following to conserve moisture in one season to augment the rainfall of the following season may also be considered.

2. The Effect of Temperatures and Wind

The effect of meteorological factors on the effectiveness of water supply to crops is well documented, (Denmead & Shaw, 1962) High temperatures, wind or both combined increase the atmospheric evaporative demand and hence potential evapotranspiration. It follows that a given amount of reserve moisture becomes exhausted in a shorter period. Taking the semiarid areas where temperatures remain high and winds dry after blowing over the drier lands to the east and north, and soils of medium to low water holding capacity, capable of storing about 120mm available water at field capacity within a profile depth of 150 cm, it can be shown that the available water can be depleted to permanent wilting point in 15 days

when the demand is high (8mm/day) but could take up to thirty days when the demand is low (3-4 mm/day). In eastern Kenya the evaporative demand is particularly high at the end of the rainy season because the skies remain clear for most days and the winds become drier every day so that with a high canopy cover, the moisture reserves in the soil are depleted rapidly and crops begin showing signs of water stress during the second week after the rains have stopped. This period to develop water stress is much shorter with shallow soils or when the profile was not full of water (field capacity) on the day of last rain. In order to minimise the water loss through evapotranspiration then all weeds should be removed as they are known to be more efficient in extracting moisture than most crops, (Pereira, et.al., 1958), and crops should be grown at low densities to cut on actual evapotranspiration rates, especially during the mid-season phase.

3. The Effect of Land Characteristics on Rainfall

The land characteristics which are of importance are the soil texture, structure, level of organic matter and depth as they affect the rate of rainfall acceptance at the surface and soil water storage. Topography influences the ease of runoff formation. Runoff represents rain water lost from a field and hence to the crop growing in that field.

In the semiarid areas of Kenya agricultural land is made up of rolling uplands or plateau and the slope depends on whether the field in question is located at the fairly flat tops or valley bottoms or slopy sides. The soils have weak surface structure mainly due to low organic matter and high sand content, which disintegrates under rain drop impact resulting in surface sealing (Muchena, 1975) leading to high runoff (Barber, et. al. 1978; Moore, et al. 1978). In fact it has been shown 10-20 minutes of high intensity storm is enough to reduce infiltration rates to about 10 mm per hour (Barber et al. 1978). The soil depth is also variable from very deep to very shallow in places due to the presence of murrum (petroplinthite) layers (Muchena, 1975). On account of medium clay content the water holding capacity is medium, storing about 120 mm water at field capacity in 150 cm depth. Hence with such soils limited amount of water can be stored even if higher rainfall were received.

Soil fertility influences the effectiveness of rainfall indirectly. Impoverished soils can only support a poor crop stand with a poorly developed root system. Such a root system will not be able to extract water from deeper levels of the soil profile and hence the crops will develop extreme

water stress even with a mild drought. The soil survey reports show that the soils found in the semiarid areas of Kenya have low or are deficient in organic matter, nitrogen, phosphates and sulphur. Hence unless these are added the crops may not utilize the available water efficiently.

4. Traditional and Migrant Farmer and Resources Utilization

From the foregoing it follows the farming activities should centre around intensive management of the limiting natural resources - mainly rainfall, the soil and its fertility - to maintain crop and animal production at economic levels. The marginal and semiarid areas of Kenya are occupied by people who depend solely on livestock for their livelihood or are mixed subsistence farmers who cultivate limited areas of crops and keep animals. The latter group of farmers keep livestock as a bank or insurance to assist in times of extended drought and food shortage. Alongside these are migrant farmers who have moved from the high potential areas to ease land pressure. The main problem these farmers face is the poorly developed dry farming methods which can enable the farmer to sustain production in an intensified condition. The migrant farmer in particular has brought with him the technology-traditional or modern-developed for the high potential areas where rainfall and the soil are taken for granted and not as manageable resources. Hence, the crops grown are usually not adapted for the harsh environment and, until recently, soil and water conservation was not considered necessary as farmers could move and open up new fields. With the changed circumstances the farmer has inevitably found that the traditional or the imported technologies are either obsolete or inapplicable.

Animal production is similarly facing similar problems. As more and more land is taken for cropping seasonal rotational grazing is no longer possible in some areas and grazing land has diminished. With the same livestock numbers overstocking with consequent overgrazing are prevalent, leading to high quantities of runoff and hence serious soil erosion. The grazing lands are in places held communally and thus relief grazing cannot be organised to allow revegetation. Therefore, when the rains are below average, grazing becomes extremely short and a large number of animals die or are sold off at throw-away prices.

3. FARMING SYSTEMS

The ultimate aim of developing the dryland farming technology is to enable the evolution of stable farming systems, which are less vulnerable to the fluctuations in the physical environment. In Kenya the priority areas requiring attention include soil and water conservation so as to maintain or increase the yields of crops or forages, the development of adapted crop varieties and the development of suitable cropping and cultural methods which aim at achieving high water nutrient use efficiency by the crops. For a farming system to be stable the basic resources need to be exploited without degrading them. For the resources which are used up in the production process like plant nutrients and soil water methods of replenishing them should be found. These could be either through direct addition as in the case with rainfall and fertilizers or be generated within the system as in the fixation of atmospheric nitrogen by Rhizobia or recycling of crop residue and animal refuse to the yields. For this reason dryland farming is a whole farm undertaking and does not simply cover only some of the farming components.

1. Soil and Water Conservation

The soil and water conservation is seen as the first step which should be taken towards stabilizing production in our semiarid areas. In its widest sense the term covers such practices as terracing tillage systems, cropping patterns, establishment of permanent vegetation cover in specially vulnerable areas, establishing wind belts and dam construction. In Kenya however, the term has been interpreted by many people to mean terracing of sloping land and construction of dams. This narrow use of the term is regrettable because farmers do not appreciate these are other less expensive and time consuming but equally effective methods of soil conservation. Thus, contour tillage, tied ridges, planting grass or crop strips, minimum (zero) tillage, stubble mulch tillage are some of the methods which have been used with success in other semiarid areas of the world for both soil and water conservation, (Arnon 1972). The use of water conservation to mean dam construction has similarly lead to the exclusion of any farm practices which would restrict rain water where it falls so as to enter the soil and later become available for crop growth. In order to achieve effective conservation it is necessary to draw whole farm plans so that all aspects ranging from terracing to cultural practices are integrated. Since terracing is accepted at farm level, greater attention should be directed towards the development and promotion of tillage and cultural methods which are effective in rainfall conservation at

farm (field) level. Evidence available from the tropics shows the tillage methods which are promising include field ridging, contour ridging, zero tillage as these have resulted in increased yields of maize, sorghum, cotton, millet and groundnuts when rainfall was limiting, but had no effect in seasons when rainfall was adequate, (Lawes, 1965, LeMare, 1953; Peat and Brown, 1960 Walton, 1962). Zero tillage and contour tillage do not control runoff completely but soil erosion is controlled so that in the long run fields where conservation tillage has been practised high yields are maintained whereas yields decline steadily to uneconomic levels with conventional tillage.

2. Use of Adapted Crops

It has already been mentioned that the rainy seasons in the semiarid areas of eastern Kenya average about two months while the available crops reach maturity in three or more months. It follows therefore, the most important objective while developing crops for these areas is to aim at adapted varieties with a high probability of reaching maturity for most seasons (say 8 out of 10). To achieve this breeders have two approaches open to them -

- (a) developing quick maturing varieties which escape drought;
- (b) developing varieties with drought tolerance/resistance and suitable maturity length.

Whatever the approach the plant breeders have to tailor the maturity length of the crop to the prevalent moisture regime. However, there is evidence that some crops respond better to the drought escape approach and Katumani Maize was developed this way, while others are drought tolerant, like sorghum, cotton or pigeon pea. It has also been demonstrated by the Katumani Maize improvement programme that the maturity period could be shortened even further, but the farmers would have to be satisfied with lower yields. This is why questions are being asked whether maize is the crop for our semiarid areas because drought tolerant crops have a better chance of stretching the season out a bit longer and hence give higher yields. One analysis of yield shows that when rainfall is less than 275 mm then sorghum yields are higher than those of maize, (Dowker, 1961). Sorghum, millets pigeon peas and cow peas are thus being developed for the drylands.

3. Cropping Systems

Crops can be grown in sole stands, in mixtures, in relays or in certain sequences or rotations. Each one of these constitutes a cropping system. However, the different systems have been developed under different climatic conditions and scale of production and thus tend to be more productive under those conditions.

Thus sole stands and rotations are mostly practised under large scale farming while the others are commonly practised by small scale peasant farmers and developed under humid conditions.

In an area where production, is limited by moisture shortage even with maximum conservation, the cropping system finally adopted should maximise water use efficiency. With adapted crops a farmer may choose whether to grow his crops as sole stands or in mixture provided in the latter case the combined water requirements of the constituent crops is met by available moisture. This is normally achieved by adjusting plant population - the higher densities require more water than the low densities.

The water use efficiency of a crop is generally reduced if soil fertility is low. It is thus necessary that the cropping system adopted should as far as possible help maintain soil fertility by at least minimising loss through erosional water, or by direct addition through biological fixation of atmospheric nitrogen, recycling of crop residue or animal refuse and possibly topping up with mineral fertilizers. For this purpose the inclusion of nitrogen fixing legumes in crop mixtures or rotations would make valuable contribution, while pasture legumes are known to contribute greater amounts of nitrogen than pulse legumes. Nevertheless, phosphatic fertilizers will need to be added to support a vigorous stand of both legumes and cereals.

Other cultural practices like early planting, clean weeding and pest control should be watched as they can reduce water use efficiency considerably even when other practices are done as required.

The cropping sequences in semiarid areas need special mention, especially in relation to moisture availability every season. In order for the farmer to accommodate a mild drought in any season, a cropping sequence should be designed which will ensure that all or part of the farm under crops carried some residual moisture into the following season. This is possible by alternating very short maturity (and unfortunately low yielding) crops with relatively longer and high yielding crops. A bare fallow replaces the short maturity crop when the latter fails to leave useful residual moisture. This is a common practice in the semiarid areas of other parts of the world and what result can be expected in Kenya is given by Bennison and Evans (1968). In a crop rotation experiment involving different sequences, it was shown that the yield of maize (test crop) increased as preceding crops were ranked in the

order: local maize (5 months to reach maturity) short term maize (3 months) silage maize) (harvested at 2½ months) beans and fallow. (maize yields after local maize were lowest and yields after fallow were highest). Residual nitrates, besides moisture were also shown to contribute to the observed trend.

4. CONCLUSION

From the evidence presented on the situation regarding the rainfall (distribution, duration and the total amounts) received in a growing season, the possibility of developing short maturing or drought resistant crop varieties, the presence of soils with manageable qualities, the prospects of developing a stable farming system for the dry areas of Kenya are good. Problems are many but can be solved and the success already achieved in other countries with semi-arid lands gives encouragement. Whole farm development as opposed to improving components of the farm is considered more effective in ensuring stable farming systems.

SUMMARY

The paper enumerates the main problems which would be encountered when developing the marginal and semiarid areas of Kenya. These include the short rainy season with poorly distributed rainfall. Soils with a high tendency for surface sealing and causing runoff and erosion, and high temperatures and winds which increase water loss through evapotranspiration. These have a combined effect of reducing the amount of water which ultimately becomes available for crop growth.

The suggested solutions include the management of soil and rainfall so as to reduce runoff as much as possible through terracing and tillage. The maturity period of crops should also be reduced to fit in the rainfall duration while the cropping systems should be developed which utilize the available water and plant nutrients as efficiently as possible. The inclusion of legumes in rotations, the recycling of crop residue or animal refuse to maintain soil fertility and addition of phosphatic fertilizers are all suggested.

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The history of irrigation in Kenya can be divided into three periods, the first of which is the indigenous phase. This lasted until the 1920's and was a time in which only a few isolated groups practiced the technology. One of these was the Masai, living on the western wall of the Rift Valley. Here they diverted water from the steep, fast-running streams, and channelled it over large distances to land suitably for irrigated cultivation. This form of irrigation continues in the area today.

Another group which traditionally practiced irrigation were the Kikuyu of the Lake Baringo region. A Masai group, they settled here in the 1800's after sustaining complete defeat in the Masai wars. They lost most of their animals, which formed their subsistence base, and were forced to seek alternative means of survival. They began to grow irrigated crops and were so successful that the Arab caravans travelling from the coast to the court of the Kabaka of Uganda stopped at Lake Baringo to buy fresh food. But in 1818 flooding altered the course of the river and the irrigation channels became useless. By this time, much of the profit from farming had been invested in livestock, and so rather than build new irrigation structures the Kikuyu reverted to pastoralism. Their technology passed to another group in the area, the Luo, who today still grow maize using irrigation water from the Nyan River.

By the end of the indigenous phase, in the 1920's, the total area of land traditionally irrigated was not more than a few hundred hectares, in a country where the estimated potential was some 250,000 ha. There had been virtually no attempts to develop commercial irrigation, although the project worthy of

IRRIGATION IN KENYA WITH SPECIAL REFERENCE TO THE DRY AREAS.

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THE HISTORY OF IRRIGATION IN KENYA

Irrigation in Kenya has always been an exceptional technology. Its history stretches back over more than a century, but until the last twenty or thirty years it cannot have been employed on more than a few hundred hectares of land. Even today, irrigation projects are not integrated into the agricultural economy of the country, but are an alternative method of exploitation existing largely in isolation.

The history of irrigation in Kenya can be divided into three periods, the first of which is the Indigenous Phase. This lasted until the 1950's and was a time in which only a few isolated groups practised the technology. One of these was the Marakwet, living on the western wall of the Kerio Valley. Here they diverted water from the steep, fast-running streams, and channelled it often over large distances to land sufficiently flat for irrigated cultivation. This form of irrigation continues in the area today.

Another group which traditionally practised irrigation were the Il Chamus of the Lake Baringo region. A Maasai group, they settled here in the 1800's after sustaining complete defeat in the Maasai wars. They lost most of their animals, which formed their subsistence base, and were forced to seek alternative means of survival. They began to grow irrigated crops, and were so successful that the Arab caravans travelling from the coast to the court of the Kabaka of Buganda stopped at Lake Baringo to buy fresh food. But in 1918 flooding altered the course of the river and the irrigation channels became useless. By this time, much of the profit from farming had been invested in livestock, and so rather than build new irrigation structures the Il Chamus reverted to pastoralism. Their technology passed to another group in the area, the Tugen, who today still grow maize using irrigation water from the Ndau River.

By the end of the Indigenous Phase, in the 1950's, the total area of land traditionally irrigated was not more than a few hundred hectares, in a country where the estimated potential area is some 260,000 ha. There had been virtually no attempts to develop commercial irrigation, although one project worthy of

mention is that by Colonel Grogan in the Taveta region during the 1940's (Hughes, 1942). The reason for this lack of interest would seem to be that in the past there was no need for irrigated agriculture, apart from the exceptional cases such as the Il Chamus. There was sufficient land for everyone, whether they practised intensive agriculture in the high potential areas, or extensive pastoralism in the drier regions. But the incentive for intensive exploitation of the arid and semi-arid areas just did not exist.

The second phase in the development of irrigation in Kenya may be termed the Colonial Phase. Although it did not begin until the 1950's, the motives behind the investment in irrigation projects during this decade were strictly colonialist in philosophy. The early fifties were the years of Mau Mau, when those Kikuyu who had been forced off their land into the overcrowded Tribal Reserves to make way for the White Settlers began to rebel. Two aspects of the uprising led the Colonial Administration to the idea of building large-scale irrigation schemes. First, many able-bodied men were taken into detention, and employment had to be found for them. Second, the Administration evicted those Kikuyu who had emigrated to the Rift Valley, and returned them to the homeland in Central Province. There they formed a disaffected landless group, ripe for recruitment to Mau Mau. Irrigation projects could solve both these problems: first, the detainees would supply the labour force to build the channels and bunds, and to level the fields; then the landless would become the tenant farmers. And so out of this policy three irrigation schemes were created in Kenya in the 1950's: Mwea, Perkerra, and Hola (Chambers and Moris, 1973).

Of the three, Perkerra and Hola are in the drier area of Kenya, having mean annual rainfalls of 645 mm. and 475 mm respectively. At Mwea the climate is wetter, with a mean of 890 mm. However, all were located in relatively 'empty' parts of the country. This was deliberate, to keep the number of displaced people to a minimum. In this respect, the relationship between population density and aridity may work to advantage, in that the low atmospheric humidities reduce pest and disease outbreaks, so increasing crop yields.

The farmers are tenants, and can be evicted if they fail to obey the instructions of the governing authority, which up to the time of Independence was African Land Development Organization (ALDEV.) These instructions cover all aspects of cultivation, including the crop to be grown, dates of planting and harvesting, and the amount and timing of the application of fertilizer and

irrigation water. The tenant is supplied with seed and fertilizer, but after harvest the crop is collected for him and sold through one of the government parastatal marketing boards. Thus the tenant on these organized Government schemes is far removed from the ordinary Kenyan small-holder farmer, even though he will most likely have come from such a background. In the type of work he does he is much closer to an industrial factory worker.

Of the three schemes, Mwea has been from the very beginning by far the most successful. It opened in 1956, growing rice, and the yields have consistently ranked amongst the highest in the world (Carruthers and Weir, 1976). The regular profits from this scheme are in stark contrast to the equally regular losses at Perkerra and Hola. These two are both too small in area ever to be economic. In particular, management costs, which are large on these highly-organized schemes and remain almost constant irrespective of size, cannot be offset where the cultivated area is small. Perkerra in the first Government scheme in Kenya: it opened in 1954 growing onions and maize, although today the maize has been replaced by chillies. Hola opened in 1957 and grows cotton.

By Independence the total area under organized irrigation was 3381 ha. This represents virtually the whole irrigated area in Kenya at that time, since the amount of land under other forms of irrigation was negligible. This 3381 ha. was divided between the three schemes as follows:

Mwea	2244 ha.
Hola	578 ha.
Perkerra	559 ha.

It is estimated that this provided direct employment for some 30,000 people (Development Plan, 1966-70).

At the time of Independence the role of irrigation, particularly through the development of large-scale organized Government schemes, was seen in a very favourable light. The 1966-70 Development Plan stated 'even if irrigation is not a panacea for Kenya's agriculture, it can make a significant contribution to production, income, foreign exchange earnings and employment' (p. 137). The role was to be primarily an economic rather than a social one: 'there is no room for inefficient producers on irrigation schemes, and a scheme must be able to expel any settler who fails to meet his obligations' (p. 139). The years since Independence have seen a gradual disillusionment with this viewpoint, and a diversification away from organized schemes. This is the third period in the history of irrigation in Kenya, which we may term the Diversification Phase.

The disillusionment arises in part from the feeling that successful irrigation schemes create a rural elite. The Government schemes are now administered by the National Irrigation Board, and their target income for tenants is £150 per annum. This is set on the assumption that families will have to buy a higher proportion of their food requirements than the ordinary Kenyan smallholder growing a mixture of cash and subsistence crops. To meet the target income, each tenant on the older schemes has 1.4 hectares of irrigated land. However, under pressure from the tenants the N.I.B. has been forced to allocate a rain-fed subsistence plot to each family. A farmer who can grow an irrigated cash-crop with a net value of £150 per annum and his own food crops is rich compared to his smallholder cousin. And of course an efficient tenant can earn three or four times this amount in a good year.

A second reason for the disillusionment is the high construction costs of organized schemes. It is estimated that the cost per hectare for the Lower Tana Irrigation Scheme at Bura, which is at present being built for the cultivation of cotton, will be Kf8000! Nor is this the most expensive form of construction: cotton is grown under furrow irrigation for which the engineering works are relatively cheap; for the flood irrigation of rice the costs are even higher. But Kf8000 per hectare is now seen by the Government as an unacceptably high price to pay, particularly if the primary role of these organized schemes is seen as that of job creation. At a land allocation of 1.4 ha., the cost per family will be Kf11,200. There is no doubt that the Lower Tana scheme will go forward, since cotton is needed for import substitution and to provide the raw material for new Kenyan industries. But in future, unless the crop is vital for the economy and can only be grown successfully under intensive irrigated agriculture, the Government is likely to seek cheaper alternatives to organized irrigation schemes for job creation.

The disillusionment of the Government has led to diversification in public sector investment in irrigation since Independence, as a result of the search for a higher return both in terms of job creation and crop value. Investment by the private sector has also increased substantially. We can now look at the types of irrigation to be found in Kenya today.

PRESENT-DAY IRRIGATION SYSTEMS IN KENYA

The types of project to be found may be classified as follows:

- Government - large-scale
- small-scale
- Private - commercial
- charitable
- small-scale independent

These are examined below in turn.

Government large-scale schemes. Today there are six large-scale Government schemes, all administered by the National Irrigation Board.¹ Three entirely new projects have been added since Independence, all of them in the Lake Victoria Basin. The area of the Mwea and Hola schemes has been increased. At Perkerra the irrigable area has dropped due to irregularities in the river flow caused by forest clearance in the upper catchment. In 1977/8 the position at the six schemes was as follows:

	<u>Area (ha)</u>	<u>No. of tenants</u>
Mwea	5616	2,974
Lower Tana - Hola	864	592
Perkerra	198	329
Ahero	840	519
Bunyala	212	131
West Kano	610	520
TOTAL	8,340	5,065

To answer the charge that large scale irrigation schemes create a rural elite, it has been suggested that the target income for each tenant be reduced to Kf100 per annum (World Bank, 1975). This would be achieved by cutting the plot size by a quarter or even a half. Since the primary aim of the current Development Plan is the alleviation of poverty (Government of Kenya, 1979) it would ostensibly be in accordance with the aims of the Plan to increase the number of tenants per unit area. Irrigation schemes could then provide a living for an increased number of the rural poor who are at present landless.

However, the indirect employment opportunities in service occupations created by N.I.B. schemes are supported by the surplus cash of the tenants. Cutting tenant incomes will decrease the number of indirect jobs, to the point where the total number of people supported by the schemes may become smaller than at present. Furthermore, overall production levels may drop. It is the belief of the N.I.B. that highest yields are achieved where the number of tenants is kept to a minimum. This is probably correct although impossible to prove statistically given the large number of other variables. Thus smaller plot sizes would lead to a decrease in the amount of produce supplied to the national market economy, and might even drop tenant income below subsistence level. The argument for reducing tenant holdings is therefore far from proven.

Government small-scale schemes. Government expenditure in this sector is at

1. This figure has recently undergone an upward revision.

present very small: only Kf0.5 million in 1978/9 for both small-scale irrigation and drainage. It is planned to increase this figure to Kf1.9 million p.a. by 1982/3 (Development Plan, 1979-83).

Three Government organizations are responsible for the development and administration of small-scale schemes, two of which are within the Ministry of Agriculture. The Minor Irrigation Programme for Arid Areas has ten projects covering 920 ha, which provide a living for 1,795 families. These are mostly destitute ex-nomads who lost their animals either in a drought or to raiders. Very often the head of the household is a woman. The irrigated plot, being on average less than 0.5 ha, can do little more than supply the subsistence needs of the family. No levies are raised, and the scheme costs for administration, diesel and maintenance are met by the Government. Therefore this is essentially a relief programme, and adds little to the economic development either of the arid areas or of the nation.

The Small Scale Irrigation Unit of the Ministry of Agriculture was formed in 1977. Its activities so far have been confined mainly to the setting up of Provincial Irrigation Units, and to the implementation of the Kibirigwa Scheme in Central Province. This is a co-operative in the Upper Tana whose members are already small-holders in the area. They will each irrigate a part of their land to grow out-of-season vegetables. At present there are some 250 members with about 100 ha of land irrigated by a sprinkler system. Plans are also in hand for the development of new schemes and the rehabilitation of old ones in Coastal, Eastern, Nyanza and Rift Valley Provinces. Clearly much of the thrust of Government activity in irrigation will be through this organization in future. The advantages of the type of scheme organized by the SSIU are several: it minimizes disruption and benefits established land-owning farmers; Government involvement is small and ultimately largely advisory; the farmers are responsible to a much greater extent than on NIB schemes for making the projects succeed.

Finally, the Ministry for Water Development is also technically responsible for small-scale irrigation. At the present time, however, their involvement is confined mainly to engineering works for the improvement of catchment basins. If these works then make irrigation a feasible proposition, the implementation is left to the Ministry of Agriculture. Ministry of Water Development officials will also advise private individuals on the engineering and technical aspects of their irrigation proposals.

Private commercial schemes. This has been until recently a very rapidly growing sector of the agricultural economy in Kenya, particularly the supplementary irrigation of high-value cash-crops such as coffee. During the recent 'coffee boom' estate growers invested in sprinkler systems for use in the dry months. It is estimated (W..., private communication) that 90% of the coffee on holding of more than 50 hectares now receives supplementary irrigation. Since the boom ended this investment has largely ceased but probably installed systems will continue to be used. The total area for all cash crops in the high potential areas receiving supplementary irrigation is estimated to be about 20,000 ha.

In the drier areas of Kenya there has recently been the development of commercial schemes of the 'plantation' type. They use sprinkler systems to distribute pumped water over large fields of market garden produce. Such schemes can be found at Lake Naivasha, using lake water, and at Kibwezi using the local river. These locations share the common characteristics of large tracts of cheap land, a good water supply and relative proximity to Nairobi. The produce is trucked to Nairobi Airport and flown to the European markets. There are no accurate data on the area under this form of irrigation, but at a rough estimate it is probably about 2,000 ha and increasing.

The impact upon the environment of these schemes is substantial, and may be demaging. For example, over the last few years at Lake Naivasha there has been an explosive growth of water weed, choking the shore and considerably reducing the tourist amenities. It would seem reasonable to relate this to the runoff from the irrigation schemes which, bearing fertilizer, must add considerably to the nutrient supply of the Lake. Equally, projects using ground reserves usually extract the water at a much higher rate than it accumulates. Such projects have a finite lifespan, but it can take decades to raise the groundwater levels back to their original height.

Private charitable schemes. These small-scale schemes function mainly in the arid areas, and are the private sector counterpart of the M.I.P. schemes. Typically they provide very small plots of land per family, less than 0.5 ha, to grow maize and vegetables. The underlying philosophy varies: for example at Songa in Marsabit District the farmers are encouraged to sell their produce, whereas at the P.C.E.A. scheme west of the Ngong Hills the subsistence aspect is emphasised. But because these schemes are in isolated regions having poor communications with the high potential areas, very often good markets exist. The farmers are usually destitute nomadic pastoralists who have lost their animals through famine or raiding. The methods of irrigation are seldom to be found in any textbook: at Songa the farmers get the water from taps and

carry it to the plots in watering cans or Kimbo tins.

There are probably twenty to thirty such schemes in Kenya, covering a total area of not more than two or three hundred hectares. The degree of success is very variable and seems to depend largely on single individuals. There is no cohesive central plan: a missionary will simply decide there is a need for a scheme in a certain place. Everything then depends on that man his choice of location, his engineering ability, administrative and organizational flair, and how well he gets on with people.

Success brings its own problems. Where the farmers are able to sell a part of their produce they invest their profits in livestock, in the absence of alternatives. Their time is then divided between the two interests, the small-holding and livestock, and yields may suffer. Although it is too early to say yet with any certainty, it appears as if the farmers are unwilling to give up their plots entirely to return to the pastoral way-of-life, but try to juggle the two by bringing in other family members to help look after the fields. A further problem is that because the farmers are sedentary, increased livestock numbers cause overgrazing around the scheme. This has been noted at Gafarsa in Isiolo District (Dahl and Sandford, 1978).

Private small-scale independent schemes. These are estimated to cover some 800 ha by the Ministry of Agriculture, but this figure is probably too low. It includes the indigenous schemes already mentioned earlier in this paper. But there has also been a transfer of technology from the N.I.B. schemes, particularly in Nyanza Province where valley-bottom rice has become an important crop. Statistically, the area will decline in future, since the Ministry of Agriculture intends to provide extension services and where necessary engineering assistance. The schemes will then be included in the S.S.I.U. figures. But in actual terms the area will undoubtedly increase rapidly as ordinary people become more aware of the benefits of irrigation, and as the technological transfer continues.

THE FUTURE OF IRRIGATION IN KENYA

Table 1 shows the estimated irrigated area in Kenya for 1978/9, and the projected estimates for 1983. It is likely now that the actual 1983 figures will be lower, owing to cuts in Government spending. The figures are arrived at from numerous sources, mostly either personal communications or unpublished reports. The author takes full responsibility for their accuracy or otherwise.

As already pointed out, in the public sector there will be a shift in investment from large-scale to small-scale schemes, in line with the aims of the current Development Plan. The bulk of the increase in irrigated area comes from S.S.I.U. projects, but 3000 ha of this is accounted for by valley-

Table 1. Estimated Irrigated Area of Kenya (ha)

Scheme Type	1978/9	1983	% inc.
<u>Public</u>			
N.I.B.	8,340	17,315	107.61
S.S.I.U.	112	7,500	6596.43
M.I.P.A.A.	920	2,485	170.11
Total	9,372	27,300	191.29
<u>Private</u>			
Commercial	22,000	30,000	36.36
Charitable	200	300	50.00
Indep. small-scale	800	1,000	25.00
Total	23,000	31,300	36.09
TOTAL	32,372	58,600	81.02

Source: Own compilation.

bottom rice irrigation in Nyanza. Much of this is rehabilitation work.

The 17,315 ha of N.I.B. land is distributed as follows:

Mwea	6,233	ha
Ahero	840	ha
Bunyala	212	ha
West Kano	1,610	ha
Perkerra	250	ha
Hola	870	ha
Bura	6,700	ha
Yala	600	ha

The figures for the private sector are more tentative. It is envisaged that, in line with the current economic situation, the growth will be slower than in the past five years, and also slower than the Government projects which are in part funded by foreign loans. However, private commercial

schemes will remain the most important type of irrigation project in Kenya.

Overall, it is estimated that the irrigated area of Kenya will approximately double in the next five years. But the 1983 figure still only represents 22.54% of the estimated potential irrigatable area of the country.

IRRIGATION IN THE DRY AREAS

So far we have only looked at irrigation in the country as a whole. However, this disguises a fundamental dichotomy: the role of irrigation in the rural economics of the developed humid highland regions is quite different from that in the dry lands. In the former, irrigation has two uses: first, to produce out-of-season horticultural crops to sell at high price in the expanding urban markets nearby; second, to prevent water stress in perennial crops, such as coffee, in the dry season, so as to increase yields. Irrigation is therefore an essential adjunct to the existing agricultural economy which can be used to increase profits.

But in the arid areas, irrigation is used to radically alter the land use and the rural economy. The large-scale schemes at Bura and Hola turn land previously used for grazing the livestock of the Pokomo and Orma tribesmen into highly-productive, intensively-farmed cotton fields. The small-scale projects of the N.C.C.K. and the M.I.P.A.A. create sedentary farmers from pastoral nomads. Irrigation is not integrated into the existing economy, but usually displaces it, being imposed by an outside agency.

This section of the paper examines the present characteristics of irrigation schemes in dry areas. It attempts to evaluate their contribution to the national and to the local economy. A comparison is made with alternative forms of irrigation development.

Table 2 shows the estimated current irrigated area of the dry regions, and the projected figures for 1983. Dry regions are defined as those places receiving less than 900 mm mean annual rainfall. This is admittedly a crude definition¹, but quite adequate given the level of precision of the data in Table 2.

1. Some readers may also feel that 900mm is too high a value to separate the semi-arid from the humid regions. In selecting it the N.I.B. schemes were used as a yardstick: Mwea, Perkerra, Hola and Bura are thus defined as semi-arid; Ahero, Bunyala and West Kano are humid. Mwea receives a mean annual rainfall of 890mm yet has the clear environmental characteristics of a semi-arid region.

At the present time only about 30% of Kenya's irrigated area is in the dry parts of the country. This is expected to rise to nearly 40% by 1983. The change in the balance comes from the private sector. Given the current prices for the traditional cash crops of the high potential regions, there is unlikely to be much further expansion of supplementary irrigation. The growth in this sector will be contributed by the large irrigated holdings of the dry areas, growing horticultural crops. There is also an estimated increase in the proportion of the independent small-scale schemes which are in the arid areas. This is because it is thought likely that the Ministry of Agriculture will take over those schemes in the wet areas earlier than those in the drylands.

Table 2. Irrigation in the Dry Areas of Kenya.

Scheme Type	1978/9		1983		% increase
	Area (ha)	% Table 1 figure	Area (ha)	% Table 1 figure	
<u>Public.</u>					
N.I.B.	6,678	80.07	14,053	81.16	110.44
S.S.I.U.	nil	nil	1,460	19.47	-
M.I.P.A.A.	920	100.00	2,485	100.00	170.11
Total	7,598	81.07	17,998	65.92	136.88
<u>Private</u>					
Commercial	2,000	9.09	4,000	13.33	100.00
Charitable	200	100.00	300	100.00	50.00
Indep. small-scale	200	25.00	400	40.00	100.00
Total	2,400	10.43	4,700	15.02	95.83
TOTAL	9,998	30.88	22,698	38.73	127.03

Source: Own compilations.

In the public sector there is a slight decrease from 1978/9 to 1983 in the proportion of the total irrigated area which is in the arid regions. This is caused by the concentration of the S.S.I.U. on valley-bottom irrigation in Nyanza Province. In the N.I.B. there is small increase from 80.07% to 81.16%, accounted for by the development of the Bura Scheme.

Physically, the arid and semi-arid areas of Kenya are well-suited to the development of irrigation schemes. The atmospheric humidities are low, which limits the spread of plant diseases. An irrigated crop in the dry areas watered on the ground by a furrow or drip system is well protected against

disease attack. By comparison, the Kano Plains schemes of the N.I.B. are notorious for catastrophic outbreaks of rice blast.

Generally, the rivers in the dry areas are in their mature stage, and the flood plains are wide and gently undulating. This is ideal for the construction of flood and furrow projects since it reduces the engineering work to a minimum. Because the river gradient is low, there is no competition with water use for H.E.P. generation. This is, of course, part of the reasoning behind the location of the major Tana River schemes at Bura - that they will not compete for water with the Seven H.E.P. project.

In social and economic terms the dry areas are not so favourable. The distances are large and the communications poor. At Perkerra, for example, the choice of crop was decided not simply on the basis of agronomy, but on the grounds of what could survive the 100 km. journey over unmade roads to the nearest tarmac. Thus although tomatoes or citrus might well be the most profitable crop at this scheme if they could be delivered to market whole, it is in fact onions and chillies which are grown. There is no doubt that the proposed tarmac road between Nakuru and Marigat will make a great difference to this scheme. The cotton projects at Hola and Bura have similar communication problems. The crop is moved by lorry to Lamu along roads made in black-cotton soils which frequently become impassable in the wet season.

The social amenities in the dry areas are very poor, particularly for those with families needing schools and hospitals. Many of the administrative staff on the irrigation schemes leave their families behind, despite the fact that poor communications and large distances mean they can seldom travel home. They are unsettled, and will seek a transfer as soon as possible. The rapid turnover does not assist in the efficient running of the schemes, and it is a compliment to the field staff of the N.I.B. that schemes such as Perkerra and Hola operate as well as they do. However, large Government investment in the infrastructure of the arid and semi-arid areas is needed before such schemes can attract and hold the number of competent senior staff they require for optimal working.

Perhaps the only social advantage of locating an irrigation scheme in the dry areas is that the population density is low, and therefore few people are displaced. At Bura, for example, it is only a small number of pastoralists who must find alternative grazing and watering for their live-stock. By contrast the Ahero scheme displaced about one thousand families, of which only five hundred could be re-instated on the scheme. At the time this caused much ill-feeling towards the N.I.B. in the area.

The potential irrigable area in the arid and semi-arid lands is large. Table 3 shows for the whole of Kenya and for the dry regions alone the total irrigation potential as estimated by the Ministry of Agriculture. (The figures have recently undergone an upward revision in the Kenya Master Water Plan, 1979. However, this revision is based upon what is feasible from an engineering rather than an economic point-of-view). At the present time, some 7.87% of the potential of the dry regions is irrigated. By 1983, according to Table 2, this will have risen to 17.87%. Therefore although the irrigated area of the drylands will have more than doubled in these five years it will still be only a small proportion of the potential total.

Table 3. Irrigation Potential of Kenya. (ha).

<u>Catchment area</u>	<u>Total Potential</u>	<u>Potential in Dry Areas</u>	<u>%</u>
Tana	180,000	110,000	61.11
Athi	10,000	7,000	70.00
Lake Victoria	56,000	-	-
Northern Kenya	5,000	5,000	100.00
Rift Valley Lakes	5,000	5,000	100.00
TOTAL	256,000	127,000	49.61

Source: Own Compilations.

Given that the potential for expansion is so large, it is important that we consider carefully the purpose of irrigation in dry areas. The possible goals may be summarized as follows:

i) To provide employment, The schemes most obviously dedicated to this sole end are those of the M.I.P.A.A. and the private charities. Owing to the small plots and the types of tenants (often elderly women), these schemes generate little if any cash surplus. Thus for a plot size of 0.5 ha the employment levels must be about two families per hectare. At the other end of the scale are the private commercial schemes, dedicated to the aim of providing a few people with the maximum possible income.

Between these two extremes lie the N.I.B. and S.S.I.U. projects. The N.I.B. Calculates that the indirect employment in service occupations such as shopkeepers, matatu drivers and fund is generated by their schemes is as follows:

No. of indirectly employed

per tenant at Mwea	0.7	
per tenant at other schemes	0.5	
per senior staff member	1.0	
per subordinate staff member	0.5	
per casual labourer	0.2	

on this basis the number of people employed by the N.I.B. on operational schemes is as follows:

	1978/9
Tenants	70
Senior staff	440
Subordinate staff	355
Casual labourers	1960
Indirect employment	4100
TOTAL	11925

This works out at 1.43 persons employed per hectare. With an estimated family size of 7.5, the total number of people dependent upon the N.I.B. for a livelihood must be about 90,000. Figures for the S.S.I.U. are not yet available. However, since these schemes are more loosely organized than the N.I.B. projects, the level of employment will probably be between 1.23 and 2 persons per hectare.

Table 4 estimates the total number of people employed in the arid and semi-arid areas of Kenya through the activities of irrigation schemes. The figures for the commercial sector schemes were particularly difficult to arrive at. Direct employment is higher than expected relative to the public schemes. This is because hidden employment, where members of a tenant's family working in the fields are not included in the employment totals, does not exist in commercial projects. However, indirect employment is estimated to be lower, since the wages of the workers are lower than those of tenants on a successful N.I.B. scheme.

Assuming a family of 7.5, irrigation schemes in 1978/9 are estimated to support some 109,000 people in the dry areas. By 1983 this figure will have more than doubled to 251,000.

Table 4. Estimated Employment Creation by Irrigation Schemes in the Dry Areas.

Scheme Type	Persons per ha	1978/9	1983
<u>Public,</u>			
N.I.B.	1.43	9,550	20,096
S.S.I.U.	1.62	-	2,365
M.I.P.A.A.	2.00	1,840	4,970
TOTAL		11,390	27,431
<u>Private</u>			
Commercial	1.20	2,400	4,800
Charitable	2.00	400	600
Indep. small-scale	1.62	324	648
TOTAL		3,124	6,048
TOTAL		14,514	33,479

Source: Own Compilations.

The cost of job creation, measured in terms of the cost of setting up a scheme, depends on the type of irrigation system installed and the location. Where labour is cheap and plentiful, and the topography is suitable, furrow systems are the least expensive to build. Even so, the cost per hectare of the Bura Scheme is currently estimated at Kf8,000. This very high figure is caused primarily by locational factors: to create all weather roads on the local black-cotton soils is expensive; building materials for staff housing must be carried long distances; the main supply canal is 40 km in length. Because this scheme is pump-fed, the running costs in terms of diesel fuel will also be extremely high.

The equipment for a sprinkler irrigation system-pumps, piping and sprinklers, costs between Kf250 and Kf1000 per hectare. This depends on the crop type, the plot shape, location and topography, and whether or not the irrigation is supplementary.

ii). To provide a high-value crop. If an irrigation scheme is to run at a profit, it must produce a crop which has a scarcity value. Otherwise, the revenue from that crop will be insufficient to offset the high capital investment and running costs of the project.

In the private sector, the commercial schemes must clearly make a gain. If we examine their distribution we see that they are always located on or very near to a tarmac road. Essentially, they depend on rapid easy transport for perishable vegetables or flowers for their success.

The N.I.B. also seeks to run at a profit, at least on behalf of the tenants. The crop grown should fulfill two purposes: first, it should be of high commercial value, to benefit the tenants; second, it should replace a previously imported crop, to benefit the Government by reducing foreign exchange expenditure. Thus the two principal crops of the Board are rice and cotton. Sugar has been introduced at Ahero and West Kano, but this is largely an attempt to reduce the work loads of the tenants who previously were growing two rice crops per year.

iii). To contribute towards local development. So far we have looked at irrigation schemes as units largely independent of the environment in which they operate. Indeed, until very recently this was the attitude of those responsible for scheme planning and administration. And no doubt in Kenya there will always be a need for intensive 'factory' schemes producing crops such as rice or cotton which otherwise would have to be imported. But irrigation schemes can never make a substantial contribution to local development until they are seen as a part of their surroundings, and an effort is made to integrate them into the local economy.

At present, the creation of an irrigation scheme can be economically and socially disruptive to a region. In a heavily-populated area it may well throw people out of work, as at Ahero. The subsequent growth of service occupations is not necessarily sufficient to counteract this. In areas of low population job creation by such schemes as Bura does not benefit the local people, but draws in people from elsewhere.

In the semi-arid areas occupied by small-holder agriculture irrigation systems can make a real improvement in the standard of living of the local farmers. The risk of drought is ever-present in the lives of the people, and irrigation can remove that risk. The development of flexible sprinkler systems, either privately or with Government assistance, could be of major importance in areas within reach of a suitable water supply. The S.S.I.U. was created as recently as 1977 to foster this kind of development.

In the arid pastoral areas it is more difficult to see how irrigation schemes can contribute to the local economy. However, irrigated alfalfa pastures already exist in some places: at the commercial end of the spectrum the Rumuruti ranch of Sir Arthur Cole; at the subsistence end the Ngong P.C.E.A. schemes. The alfalfa is cut and used as hay in the dry season. This may well be the most rational approach to benefit the largest numbers of people in the arid areas, in that it seeks to upgrade the indigenous economy rather than imposing an alien one. The scale would be wide, from the largest commercial ranches using irrigated pastures for fattening before slaughter, to the nomadic pastoralist storing hay against a drought. Not only is this possibly the most satisfactory method of integrating irrigation into the local economy, but it may well be the most rational use of the scarce water resources of the arid areas in terms of the national economy. Meat at present commands a very high price on the world market, particularly in the Middle East, and Kenya barely produces enough for her own needs.

It is clear from the above that some re-thinking is necessary if irrigation schemes are to contribute fully to the local and national economies. There must be more integration: first, to fit the schemes into their environment; second, to fit them into a rational national irrigation plan which will ensure the most efficient use of the Republic's water resource. Because at present there is no single authority, there is a risk that schemes being built today will use water that could have been used to supply a more efficient scheme elsewhere. A central planning authority is vital if Kenya is to obtain the maximum benefit from irrigation.

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SOIL AND WATER CONSERVATION IN SEMI-ARID AREAS

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INTRODUCTION

In establishing a framework for integrated rural development in the arid and semi-arid lands of Kenya, an Interministerial Task Force (1) equated "semi-arid" areas with ecological zone IV (2,3) in the absence of a more appropriate agroclimatological classification. This corresponds broadly with the zone lying between the 500 and 800 mm isohyets of mean annual rainfall and represents between 10 and 20 per cent of the land area of Kenya depending on whether ecological zones or isohyets are used as basis for delineation.

However defined, the semi-arid areas are a significant proportion of the land which can be said to have a potential for sustained agricultural development. They are characterized however, by having a highly variable mean annual rainfall which often falls in short-duration storms of great intensity. It is normally sufficient in quantity only for the production of short-season or drought-resistant crops on a low-risk basis and some authorities consider the land having less than 800 mm per annum to be marginal for agriculture and that having less than 700 mm to be land basically unsuitable for arable agriculture (4). On the other hand, these areas have a high potential for livestock production under good management, i.e. with stock numbers related to the climatically-varying carrying capacity of the land, and they also contain a substantial proportion of those areas identified as having potential for irrigation (5).

In the Fourth Development Plan (6), the Government of Kenya has pledged a special emphasis on alleviating poverty and in developing agriculture in the arid and semi-arid lands. It is recognized that such development will lean heavily on the provision of adequate water supplies and on the rehabilitation of degraded areas. The current situation is that accelerated soil erosion has reached alarming proportions in many parts of the semi-arid areas and poses a threat not only to agricultural development in general but also to the ability of the Government to make the necessary strides in water development. In these areas of fragile ecosystems, and in the context of increasing pressure on the land through high rates of population growth, soil

and water conservation become an indivisible task assuming an ever-greater priority for concerted and effective action. This paper discusses the current strategy for soil and water conservation in the semi-arid areas and the special problems which will be associated with implementing the development programme.

WATER DEVELOPMENT IN THE SEMI-ARID AREAS

In October 1974, the Ministry of Water Development (M.O.W.D.) was established by Presidential decree and took over from the Ministry of Agriculture all responsibility for the development of the country's water resources with the exception of major irrigation which remained under the National Irrigation Board (NIB). In 1978, the NIB also transferred under the umbrella of the MOWD and now forms one of the semi-autonomous units within the Ministry together with the Tana River Development Authority, the Mombasa Pipeline Board and the Water Apportionment Board.

As a result of recommendations made by the WHO Sectorial Study and National Programme for Community and Rural Water Supply, Sewerage and Pollution Control, provision was made for the preparation of a National Master Plan which would guide future policy. Stage I of the Plan has now been completed and the report deals with water resources, water demands (with particular emphasis of irrigation potential) and manpower and training requirements. Stage II should now follow, aiming to produce a detailed Master Plan for each major drainage basin including strategy for development, priorities and individual project identification up to the pre-feasibility level.

In the meantime, targets have been established as part of the long-term Government policy for the provision of water supplies to both urban and rural areas. The overall target of "bringing to the entire population, the benefits of a safe water supply sufficient for their requirements for domestic and livestock consumption by the year 2000" has been well publicised and the attainment of this target will only be possible if the Stage II of the NMWP is carried out rapidly and effectively and the programme of development is adhered to. Water development targets for the semi-arid areas, as outlined in the Fourth Development Plan, are for the most part concerned with the rural water supply programme, the self-help schemes, the water conservation programme, water development for livestock and in minor irrigation. Other activities of the Ministry which have a direct bearing on the development of the semi-arid areas are the research, resource assessment and monitoring programmes of the Resources Branch which provide the basic data on which all the rural water supply schemes are based. Each of these programmes is discussed briefly below.

a) Rural Water Supply Programme

The present rural water supply programme began in 1970 and has been financed in a number of stages, designated RWS I, RWS II, RWS III and currently RWS IV. Working through the Provisional and District Development Committees, the Ministry carries out pre-development studies on approved schemes and eventually submits to the PDC's a revised priority list for a number of schemes to be included in the current annual estimates. The projects are either executed by the Ministry through its Design and Direct Labour Sections or by consulting Engineers and contractors.

b) Rural Self-Help Schemes

A unit exists within the Ministry which carries out surveys and designs to assist with the construction of communal self-help or "harambee" water schemes. The distinction between rural water supply and self-help schemes lies in the degree of government financing. The latter being expected to involve a greater contribution by the community. In the drier areas, however, where population is more scattered and the levels of income are low, there has been little self-help involvement in water supplies as yet.

c) Water Conservation Programme

In the context of the operations of the Ministry, water conservation implies the impoundment of surface water in order to prevent excessive and wasteful storm runoff. Although recognizing the need for careful planning of land use as a prerequisite of water conservation, the Ministry only has direct responsibility for the construction of conservation works. It can invoke Section 14 of the Water Act (7), however, in order to protect water catchment areas from land use malpractice.

The types of structures which are proposed range from "gully stops" in the headwaters of a catchment to concrete or masonry storage dams on the major streams. Less well-known techniques for water conservation which have been used successfully in Kenya include sub-surface dams, i.e. masonry weirs in sand rivers which store water within the interstices of the sand matrix and reduce surface evaporation, and rock catchments, where masonry walls are used on exposed rock to increase the surface area and hence, runoff into small dams. In the very dry areas, pans, tanks, hafirs and cisterns can be used for seasonal storage although their capacity is strictly limited due to high evaporation and high infiltration rates.

d) Water Development for Livestock Programme

Although mainly concerned with the drier parts of the semi-arid areas which are only suitable for livestock production, the Range and Ranch Sections do aim at making optimum use of these areas by the development of available water resources and their activities are very relevant to an overall strategy for the semi-arid lands.

In the rangeland areas of North Eastern Province a Phase One Project resulted in the construction of facilities with a total water production of $2555\text{m}^3 \text{ day}^{-1}$ on 48 ranches and 76 reservoirs with a total storage of about $950,000\text{m}^3$. In addition, 19 production boreholes producing about 200m^3 of water per day were drilled.

The Two Project has concentrated on 181 ranches in the Rift Valley and Coast Provinces together with an additional 7 million hectares of rangeland in the North Eastern and Eastern Provinces. The overall objective is to encourage increased beef production and, by employment or involvement in the beef marketing schemes, bring benefits to about 90,000 pastoralist.

e) Irrigation

Responsibility for implementing public irrigation schemes is split between the National Irrigation Board which deals mainly with large-scale projects and the Small Scale Irrigation Branch of the Land Development Division of the Ministry of Agriculture. Both the Irrigation Section of the Ministry of Water Development and the Tana River Development Authority initiate feasibility and planning studies for irrigation, and various donors including the Ministry of Economic Planning and Community Affairs provide cash grants for small schemes in the drier areas. The Irrigation Section of M.O.W.D. provides a technical service for the farming community in general and will survey or give technical advice on both private and public small-scale schemes.

f) Resource Monitoring and Research

The Resources Branch of M.O.W.D. maintains hydrometeorological networks over the whole country and also investigates the occurrence of groundwater through its Geology and Drilling Sections. Table 1 gives an indication of the size of the hydrometeorological network but it does not show how the majority of river gauging stations are clustered around the zones of high agricultural

Table 1. Hydrometeorological Networks in Kenya.

	Drainage Area					Total
	1	2	3	4	5	
<u>River Gauging Stations</u>						
a) Staff Gauges	99	70	85	87	50	391
b) Water Level Recorders	18	4	12	18	6	58
<u>Rainfall Stations</u>						
a) Standard Daily Gauges	421	227	310	240	205	1,403
b) Storage Gauges	-	-	1	22	20	43
c) Autographic Recorders	24	3	7	14	5	53
<u>Climatological Station</u>						
a) Full Stations	26	14	19	23	10	93
b) Evaporation Pans	26	14	19	23	10	93
c) Automatic Weather Stations	-	-	3	2	2	7

Drainage Basins are:-

1. Lake Victoria
2. Rift Valley
3. Athi River
4. Tana River
5. Ewaso Ngiro

potential. As a result, although a considerable amount is known about the water resources of the high potential region (8), very little is known about the semi-arid areas.

To remedy this defect, the Resources Branch has embarked upon a programme of establishing representative and experimental basins in the drier areas, initially in the "medium potential" zone of Kitui, Embu and Machakos Districts. By selecting small drainage basins which are representative of the hydrology of the whole region, instrumenting them carefully and investigating the relationship

between different component processes of the hydrological cycle, it will be possible to draw general conclusions about the availability of water resources to aid in water development of the region. In addition, specific design information required for dams, water supplies, culverts and bridges, such as the peak discharges, average water yield and probable sediment yield, will also be forthcoming from the detailed studies.

At the same time, the Hydrology Section is seeking to expand the national networks in the drier areas. A prerequisite for this is the establishment of more regional offices from which closer supervision and maintenance of the monitoring equipment can be ensured. Otherwise, the maintenance of river water level recording equipment in seasonal streams with high sediment loads becomes an almost impossible task.

Groundwater exploitation offers an alternative solution to water development in the drier areas. Unfortunately, Kenya does not have abundant groundwater resources and of the 4,000 boreholes for which measurements are available, the average yield is only 117 litre min^{-1} and half of the boreholes have produced less than 80 litre min^{-1} (9). The Ministry of Water Development continues to explore the groundwater resource by means of exploratory and production boreholes. Through the Ministry's own drilling rigs and a number of private contractors about 100 boreholes are constructed every year.

Much of the semi-arid zone falls on the metamorphic rocks of the Pre-Cambrian basement-complex which have a significantly lower yield than either the sediments or volcanics. The general conclusion to be drawn from this is that while small supplies in the semi-arid areas may be provided from boreholes, it is unlikely that they will support more than village water schemes and stock watering points.

The likelihood of irrigation schemes based on groundwater supplies is very low indeed except in certain parts of Coast Province where high yielding boreholes have been located on the Tertiary and Quaternary Sediments.

SOIL CONSERVATION IN THE SEMI-ARID AREAS

Responsibility for conservation of the soil resource rests primarily with the Ministry of Agriculture although it is recognised that inputs from the Ministries of Water Development, Lands and Settlement, Natural Resources and Finance are needed to accelerate the programme of soil conservation. At present the Ministry of Agriculture has a Soil Conservation

Unit concerned with the training of extension workers, the preparation of a soil conservation master plan and the coordination of provincial and district programmes of soil conservation. The Soil Conservation Service which was formerly concerned mainly with the large farms of the high potential zones has been amalgamated with the Tractor Hire Service which operated in high-and medium-potential small-holder areas. The intention is to increase the Government's capacity to implement resource conservation measures in smallholder areas by offering mechanised services for communal soil and water conservation projects during the off-ploughing season.

At the provincial and district level, Land and Farm Management Officers are expected to organise training courses, field days and demonstration plots for the dissemination of soil and water conservation techniques, to organise the supply of subsidised planting material to farmers and to liaise with the District Development Committees concerning minor projects and communal activities. Bearing in mind that the ASAL Report (1, op.cit) recommends that the District should be the focal point for the planning and implementation of projects in the arid and semi-arid lands, it is clear that the provision of adequate funds, manpower, technical training and guidelines for conservation by Central Government to the officers operating at the district level is one of the first priorities in the national programme.

Also at the district level are the special district programmes undertaken by the E.E.C. in Machakos (Machakos Integrated Development Programme) and U.S.A.I.D. in Baringo and Kitui. In view of the concern expressed about the heterogeneity of the administrative units and the way in which district boundaries cut across accepted ecological and geographical units, an alternative strategy of planning on a river catchment basis is being tested in the Kerio Valley Regional Development Project. In each of these programmes, resource conservation will play a major part.

One of the policy statements of the Ministry of Agriculture is implicit in the amendments to the Basic Land Use Rules of the 1965 Agriculture Act (10). It is the intention that by modifying the Basic Land Use Rules to relax the limit of cultivation from 35% slope to 55%, to allow cultivation on slopes between 35% and 55% only when bench terraces are constructed, and to retain the requirement to provide adequate conservation works on slopes between 12% and 35%, the Act will now be enforceable.

THE STRATEGY FOR CONSERVATION AND PROBLEMS OF IMPLEMENTATION

The above paragraphs have outlined some of the programmes being implemented at present by Central Government to effect soil and water conservation measures and to provide water supplies for domestic and agricultural purposes in the semi-arid areas. The problem to be addressed now is, "How can these interrelated programmes be coordinated into effective action?" No amount of master planning by a "think tank" based in Nairobi is going to produce the desired action at the farmer level without a degree of communication of technical ideas which has been unknown upto the present. At the same time, individual farmers and extension workers working in isolation, however inspired and willing to innovate, will not begin to scratch the surface of the problem without efficient backing from the Central Government in the field of technical advice, incentives, subsidised seed and plant material, mechanised assistance where necessary and firm adherence to the Agriculture Act when all else fails.

To give some idea of the scope of the problem, an example can be chosen from the Kalama Location of Machakos District. One of the MOWD Hydrology Project's representative basins is an 12km² catchment of the Iiuni River. Within this catchment, 43% of the areas is cultivated and of this 36% has been terraced in the past. Some innovative farmers are busy extending and improving terraces while others have abandoned the old terraces, allowing them to breach, and are making no further effort to prevent soil loss. The present situation is that the catchment suffers an extremely high surface runoff and the estimated mean sediment yield of the catchment is 6 tonnes ha⁻¹ annum⁻¹. Individual losses from fields and uncultivated grazing land may be as much as 12 tonnes ha⁻¹ per storm. This catchment is fairly typical of a large part of Machakos District and presents a microcosm of the whole problem of agricultural development. Where does one start to prevent the wholesale loss of soil and water from the catchment?

In the first place, a catchment is a good unit to chose. In terms of river rehabilitation, velocity reducing works must begin in the headwaters and where cutoff drains are required to reduce overland flow or surface runoff on uncultivated areas, these can be led into the minor streams where the gully stops and retaining weirs can be used to control discharge. On the steepest slopes (55%), conservation forestry is the only answer on the fragile soils of the Basement Complex. Where such land has been adjudicated, there might have to be compulsory purchase, compensation or provision of alternative livelihoods for farmers who have to discontinue cultivation. All these measures require government-funded action backed by the organisational infrastructure capable

of putting small well-trained teams with adequate resources into the field.

Turning to the cultivated land, this is clearly the responsibility of the individual farmers to rehabilitate but it is equally clear that the good farmers have already started and that a very real problem of motivation exists for the remainder. At this point it is as well to be reminded that terrace building is back-breaking labour even with the help of ox-ploughs. The most that a small-holder could be expected to achieve would be one new terrace per year and at this rate of progress it would take at least ten years to complete the task within this particular catchment. Is there any way of speeding this process up and motivating the indifferent farmers? One solution would be to provide incentives for those farmers who construct new terraces or rehabilitate old ones, in the form of subsidised seed, fertiliser, agricultural credit, technical advice on farming systems and water supplies for completed sub-catchments. In the case of genuine hardship where resources for terrace building do not exist but the will to improve the land management does, either communal labour such as the "Mwethya" groups or small-scale mechanised assistance could be organised. Otherwise, the power of successful farming serving as an example to others should be exploited to the full.

In passing, it should be noted that the increase in terracing in Machakos District is due both to the increase in awareness of the benefits of bench terracing and to the spread of land adjudication which has reassured farmers that their efforts will not go to waste. In this context it can be seen that the criticism of land tenure reform by Okoth-Ogendo (11) ignores this aspect of land adjudication which, in spite of its faults, may have the single largest impact of all the recent changes on agricultural development in the semi-arid areas. Both the implementation of effective soil and water conservation measures and the innovation of more-productive farming systems are dependent upon individualisation of title.

In the case of grazing land, much of which is suffering from severe soil erosion, the problem of finding a workable system is more acute. It is well-known from earlier work by ALDEV (12) and Percira et.al. (13) that the powers of recovery of degraded rangeland are far greater than expected given that stock can be completely excluded for a period of two years or so and some reseeding of the worst degraded areas can be accomplished. In the practical situation of the catchment chosen as an example, however, it is difficult if not impossible to exclude stock completely from the grazing areas because of the general shortage of good grazing land. In recent years, there have been some reductions in live-

stock numbers as a result of both stock losses in the drier-than-average years in the early seventies and the growing awareness of farmers of the poverty of the grazing areas and the extent of the accelerating erosion. A few farmers have gone over to keeping a smaller number of stall-fed grade cattle which would seem to be one excellent alternative system to be adopted more widely. On the other hand, there seems to be little or no overall reduction of livestock numbers in individual districts (Table 2) except where the drought of 1972-6 affected the rangeland plant growth and stock were lost.

Table 2. Livestock Population of Eastern Province

District	1970		1975	
	Cattle	Sheep & Goats	Cattle	Sheep & Goats
Embu	87	111	80	113
Isiolo	180	200	140	670
Kitui	430	505	950	700
Machakos	350	616	450	666
Marsabit	200	508	140	530
Meru	223	375	43	400
Total	1,470	2,315	1,803	3,079

Source: Livestock Development Report (14).

Clearly, cosmetic rehabilitation of the grazing lands is a total waste without the introduction of a controlled grazing programme which is acceptable to the small farmers. This requires a socio-economic solution rather than a technical one and perhaps a different solution in the rangelands from the densely-settled parts of the medium potential zone. In a study of the local attitudes to soil conservation in Machakos District Mbithi and Kayongo-Male (15) show convincingly how reluctant farmers are to destock until they begin to lose livestock and how many of the older farmers believe that grassland should be reclaimed in order to increase grazing i.e. increase the carrying capacity of the land. Any farming-system package which does not take into account the strong adherence of farmers to pastoralism, in spite of the observed consequences of overgrazing, will have a minimal impact.

Within the Iiuni catchment, therefore, it can be seen that a combination of government initiative coupled with a drive to motivate all the members of the community to develop good husbandry is required. Furthermore, such progress towards better land management should precede the implementation of water supply schemes although they can be developed up to the technical design stage with the full knowledge of the District Development Committees as added incentive.

In the areas where only a small percentage of the land is cultivated it is generally agreed (16, 17) that the productivity of the rangelands can be increased. One of the constraints on such development is seen as the provision of an adequate number of stock-watering points to prevent the all too common overgrazing in their vicinity where they are insufficient in number or badly distributed. Once again the technical problem of providing such water supplies is small in comparison with the social problem of persuading pastoralists that the potential of an area to produce an adequate quantity of edible herbage is the true limiting factor of stocking density. Furthermore, this potential is largely climatically controlled in that a run of drier than average years will necessitate drastic stock reduction in order to avoid soil erosion by laying bare and trampling the soil surface. The effects of such denudation on storm runoff and on lack of infiltration of rainfall to the root zone has been demonstrated in the Atumatak experiment (17) in a potentially rich rangeland area of north-east Uganda. Ironically, following the controlled experiment of bush clearing, exclusion of stock and grazing within the carrying capacity, a renewal of widespread stock theft in this region has left the area virtually depopulated and regeneration of the degraded areas has accelerated rapidly.

Although it has been demonstrated at Makaveti, Atumatak and elsewhere that vegetative cover has remarkable powers of recovery, it is by no means certain how long it takes for soils to recover their former infiltration capacity. It has been reported, for example, that springs which dried up in the 1972 drought in Northeastern Province had not started to flow in spite of adequate rainfall upto 1976 (19). The changes in surface soil structure consequent from overgrazing, such as increases in bulk density and capping, reduce the infiltration capacity of soils and increase surface runoff. Certain areas where the soils are low in clay content may take many years to recover.

CONSTRAINTS IN DEVELOPMENT

It has been stated above that the technical problems of soil and water conservation are not as serious as the socio-economic problems of motivating small farmers to improve their husbandry. There are, however, a number of technical organisational problems which nevertheless will act as constraints on development if they are ignored. The following paragraphs outline some of the more urgent points.

a) Lack of an adequate resource data base

As the emphasis on development moves into the drier areas, the lack of basic hydrological information will become more acute. There is a tendency for data collection to be given low priority until it is too late to obtain the right kind or quantity of data for specific projects. More often than not large sums of money are then gambled on insufficient scientific fact bolstered by evidence extrapolation from other parts of the world or sheer guesses. Being conservative and safety-minded, engineers usually opt for the "safe" solution although it may necessitate a large overexpenditure through "over-design". As an example, Table 3 shows the cost of drainage structures in roads in Kenya as a percentage of the total road costs (20). It can be seen that the combined costs of each type of drainage structure represents a significant proportion of the total and each structure has to be constructed to pass a design flood based on flood prediction techniques or historical records or both. The second part of the table shows how the costs for the two culvert sizes increase as the design flood is increased by 20% and 50%.

When we consider that every road, water conservation structure, soil conservation structure, water supply project and surface water dam is going to require calculations based on hydrological data, it can be seen as a comparatively small expenditure in networks which could prevent either under-or over design will be more than justified.

b) Administrative separation of soil and water conservation

The present division of responsibility for soil and water conservation between the Ministries of Agriculture and Water Development leads to neither being fully effective in what is essentially a single field. There is little point in constructing surface water dams without the accompanying soil conservation in the catchment above. Similarly, the proliferation of cut-off drains as an anti-erosion measure without the necessary velocity reducing structures on the

Table 3 Cost of Drainage Structure as a Percentage of Total Road Cost

	<u>Percentage of total road cost</u>		
	<u>Average</u>	<u>Lowest</u>	<u>Highest</u>
Small culverts	7.2	5.0	14.0
Large culverts	5.4	1.4	12.0
Bridges	8.7	Nil	26.0

Average cost of Culverts as a percentage of Total Road Cost

	<u>As built</u>	<u>Plus 20%</u>	<u>Plus 50%</u>
Small culverts	7.2	9.3	11.4
Large culverts	5.4	6.6	7.7

Culvert capacity:-
 Small = up to 0.75 m²
 Large = 0.75 m² to 10m²

(after : Truran, 1975)

main streams will lead to more rapid runoff than before and an increase in stream-bank erosion and scouring.

One technical problem is that of education; educating the children in primary and secondary schools, educating sub-professional technicians as extension workers, educating farmers and local administrators and, finally, educating politicians and civil servants not only on the economic value of soil and water conservation but on the principles and methods of conservation practice so that the innovative farmer can use his own initiative and take some of the burden off the extension services.

A really effective soil conservation service should have the technical ability and executive authority to carry out schemes on a catchment basis (including reafforestation). It should also provide unequivocal technical guidance in the form of regional handbooks on appropriate soil and water conservation techniques. Where there is doubt on the relative efficiency of different systems of conservation management, research programmes should be started immediately to provide the necessary evidence.

c) The water balance and conflicts of interest.

In assessing the feasibility of water supply schemes, one of the important criteria is the water yield of the catchment area. This is the residual streamflow from a given rainfall input after the "losses" due to infiltration, evaporation and transpiration have been subtracted. It can be seen that in this context, infiltration to the root zone is regarded as a loss since most of it is returned to the atmosphere via evaporation and transpiration. It also follows that soil and water conservation schemes will increase this "loss" by maximising infiltration, encouraging greater water use by crops and, perhaps, substituting deep rooted trees which transpire the whole year around in the place of annual crops or short-rooted grass with a lower overall water use.

In the semi-arid areas where potential evaporation is more than double the rainfall, streamflow is only a small percentage in the water balance equation. The feasibility of a given water supply scheme may hinge on the capital cost per family served with water. Since major capital costs in the scheme are the water supply reservoir and treatment works, for a given reticulation system, two small schemes are more expensive than one large scheme although there may be barely enough water in a single catchment. Clearly any reduction in the water yield of that catchment will threaten the whole scheme and at the present time it is just not possible to put realistic figures in the water balance equation to predict how serious the conflict of interest in any particular scheme might be.

On the other hand, the reduction in water yield has to be balanced against the very positive advantages of a significant reduction in the rate of sedimentation of a reservoir and the reduction in magnitude of peak flows which have to be dealt with by expensive spillways. The extension of the period of flow in a river may also help the reservoir to cope more easily with dry season demand.

The above example serves to show how important it is to quantify the individual components of the water balance so that the effects of changes in land use, both destructive and beneficial can be taken into account. A considerable body of knowledge now exists for the high potential regions (21). It is now important to extend this knowledge to the drier areas.

d) Irrigation

Irrigation schemes are frequently regarded as the universal panacea for developing the drier areas. There are three basic requirements, however, without which irrigation can be ruled out of any development plans:-

- i) Sufficient water
- ii) Suitable soils and topography
- iii) People willing to adopt to the tight discipline of a successful scheme.

The first two are self-evident and the potential for irrigation has been estimated recently to be as high as 600,000 ha (22).

There is growing criticism, however, of the slow growth and high cost of the major schemes and the Fourth Development Plan states that the major emphasis will be on small scale irrigation (6, Section 6.149p 256) and supplementary irrigation in medium rainfall areas. For such schemes, however, the comments made in the previous section have particular relevance. The efficiency of small scale schemes is generally low and water demands are high compared with domestic water supply schemes. It is much more difficult, therefore, to arrive at economic solutions for irrigation schemes away from the major rivers (Tana, Athi-Sabaki, Ewaso Ngiro). Under the existing conditions of soil erosion depleting the dry season flow, very few of the rivers will have sufficient water to support abstraction for irrigation at the time of maximum demand.

The third factor is frequently ignored completely with the result that many irrigation projects fail to fulfil the promise of their pilot schemes. Within the drier areas where pastoralism predominates the difficulties of persuading herders to change their life style completely by running irrigated farms should not be underestimated. The alternative strategy of bringing people from areas where intensive and careful cultivation is common practice pressure on the land through high rates of population growth is excessive, may give an irrigation scheme a better chance of success but in the long run will be a source of social discontent.

Higher technology systems, such as drip irrigation, require a standard of management and maintenance which will be difficult to provide or even justify in terms of national priorities in manpower training. These systems can be highly efficient, make use of poorer quality water and help with the general problem of water conservation. They offer a possible solution for

the long-term future, but more likely in the private sector where motivation is higher, and only when the cost-benefit ratio has been considerably reduced.

CONCLUSION

The way in which the Kenya Government is able to confront the problems of soil and water conservation have been outlined above. There is clearly a need for more integration between programmes in each Ministry and, given the enormity of the task of soil and water conservation in the semi-arid areas together with the lengthy period required for such a rehabilitation programme before soils stabilise again, there is a case for urgent and effective action.

It is to be hoped that the Integrated Agricultural Development Programme and the Arid and Semi-Arid Lands Development Programme of the Ministry of Agriculture will form the spearhead of the attack on the soil and water conservation problem areas. At the same time, by building up the monitoring networks and resources research programmes in the Resources Branch, the Ministry of Water Development could make a vital contribution to the development of these areas.

There is a tendency for development programmes to attract more priority than research programmes because of the inherently slow nature of investigations into the hydrological cycle. As emphasis shifts towards the more delicate ecosystems, however, it becomes more important to understand the nature and consequences of the sometimes imperceptively slow but, nevertheless, vital changes in the balance between input and output brought about by man's misuse of the land.

It is particularly important to monitor the effects of development programmes on the hydrological cycle in order to compare the efficiency of different farming or streamflow and sediment yield. It is also important to build up the monitoring networks and representative basins in the drier areas to assess the precise status of the water resource and to measure the impact of soil and water conservation measures on the water balance. At the present time development plans are running far ahead of our ability to provide sufficient data for project design. If the Government targets are to be achieved the resource base must not be neglected.

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THE PRESENT AND FUTURE PATTERNS OF CONSUMPTION
AND PRODUCTION OF WOOD ENERGY IN KENYA

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INTRODUCTION

A number of studies have been undertaken to evaluate the potential supply and demand for charcoal in Kenya (Arnold et al, 1962; Chlala, 1972; Uhart, 1975; Kabagambe, 1976). In general these have only assessed the demand in urban areas and a satisfactory country-wide survey has yet to be undertaken. An even larger gap exists in our information on fuelwood demands, even though this is appreciably higher than charcoal requirements on a national scale. However a number of studies on the per capita consumption of wood amongst rural populations have been made in Kenya and elsewhere in East Africa (Arnold et al, 1962; Oppenshaw, 1976) but these did not calculate the country wide demand relative to supply. There is therefore an urgent need to assess the total requirements and supply of wood fuels in Kenya, to calculate what role they presently play in national energy consumption and how the pattern is likely to change in future. It is frequently argued that a greater dependence on locally produced energy sources will lessen Kenya's dependence on imported fuels, will save on foreign exchange and will create a large rural employment (Githinji, 1978). However, the extent to which internal self-sufficiency in energy can be achieved will depend substantially on the potential production of the various energy sources.

Our intention here is to examine the consumption of wood fuels in the various sectors. These include large and small farms and rural subsistence and urban domestic use. We provide an estimate of the contribution of wood fuels to the total energy consumption in Kenya, examine consumption patterns by province and project the growth in demand over the next two decades, and for the purpose of illustrating future prospects, to the year 2050. To look at the potential of wood energy to meet the existing and projected demand, we have calculated the production of wood biomass on a national and regional basis. Finally from an analysis of the patterns of supply and demand we have deduced the status of each province in terms of its surplus and deficit of wood

energy, now and in the coming few decades. The factors which contribute to the patterns of imbalance are identified and pointers are made for increasing the efficiency of wood utility.

METHODS

In calculating the balance of wood energy we have had to make various assumptions about existing and future demand and supply of all wood fuels. We adopt two ways of examining the energy balance. The first involves calculating when the sustained yield of wood production is exceeded, the second how long the existing standing stocks will last. To calculate the existing wood consumption, we have, by province, stratified the population into various sectors which have different patterns of consumption; large farmers, small farmers, subsistence agriculturalists and urban dwellers. The wood consumption amongst each sector has been calculated on the assumptions given in the Appendix. For large and small farmers consumption is derived from Earl's (1975) data which relate both total energy use and the fraction used as wood to GNP per capita. The population figures and projections we have used have been drawn from Central Bureau of Statistics (1971, 1972).

By far the largest proportion of the population in Kenya comprises subsistence, rural agriculturalists. To estimate their wood consumption we have drawn on a variety of surveys that have estimated the present use and future demand (Table 5). By far the major proportion of the wood consumed by this sector is used as energy. This amounts to some 94% (Table 5). In our calculations we have therefore used the per capita wood fuel consumed as the basis of projecting wood demand. The actual total will therefore be slightly higher than we have projected, but will fall within the upper ($2m^3$) and lower ($1m^3$) range of consumption that we have based our projections on.

The bulk of wood fuels used in Kenya are consumed in the form of fuel-wood. However, a substantial proportion is used in the form of charcoal. Because of the low conversion efficiency of traditional charcoal kilns (about 9kg. of wood are needed to produce 1 kg. charcoal (Oppenshaw, 1976), the amount of wood wasted as insensible heat is extremely high. We have therefore tried to express the amount of wood consumed per capita for that proportion of the population dependent largely on charcoal. This is confined predominantly to the urban areas (Chlala, 1972; Kabagambe, 1976). To estimate the urban demand we have relied on the only source of data that apparently estimated charcoal use from direct observations. In doing so Chlala (1972) estimated that urban use ranged between 100 and 165 kg per capita per annum. Almost all publications since 1972 have relied directly or indirectly on Chlala's data, underscoring

the urgent need for more refined information. We have further assumed that 20% of the urban population are earning sufficient income that they rely almost exclusively on energy other than that from wood fuels. The urban consumption is therefore calculated on the basis that 80% rely predominantly on charcoal, as Kabagambe (1976) has suggested.

The present population and future growth in each of the provinces and sectors that we have included are derived from the Statistical Abstracts (1977).

To derive estimates of the present and future yield of wood biomass and of the standing crop biomass, we have had to use various sources of data in the literature. There exist a number of relationships that have related both of these parameters to climatic variables. We have examined three different models which predict the yield of wood from rainfall and evapotranspiration and found that the variation amongst them is less than 40%.

The figures produced by this method only give the potential wood yield. To gain a better estimate of the actual yield and standing crop we have discounted all the land under national parks and reserves in each province, and the land under arable agriculture, Table 7. We have used two scenarios to predict wood production. The high forecast assumes that all fallow land in agricultural areas produces wood fuels and that elsewhere the potential supply is achieved. The low forecast assumes that fallow land is not used for fuelwood production. It also assumes that 25% of the remaining land produces little wood fuel or has already been heavily depleted.

We have used a variety of scenarios of production and consumption to evaluate the balance of wood biomass and production at both the provincial and national level. The assumptions are given fully in the Appendix.

RESULTS

It is estimated that the present consumption of energy other than wood fuels amounted in 1975 to 1,658,000 tons oil equivalent (Singh, 1978). From our own analysis (Table 8) we estimate that the consumption of wood fuel in 1975 amounted to 4,487,000 tons oil equivalent on a low scenario and 8,447,000 on a high scenario, which amounts to 73% and 84% of the total energy consumption. Wood fuels are and will therefore, continue to be a major source of Kenya's energy supply well into the next century (Table 8).

Looked at from a national perspective (Fig. 1) the future of wood energy as an alternative to other sources does not however look promising. Based on a low consumption-high production scenario it is likely that the annual consumption will exceed annual production of wood within 25 years. Based on the low demand-low production forecast the annual yield of wood is exceeded in 1979. If we assume that the population consumes wood at the rate of our high forecast, the annual production of wood was exceeded in the early 70's based on the low production scenario, and will be exceeded in the mid 1990's on the basis of a high wood-production forecast.

These figures indicate that the sustainable supply of wood fuel has either been exceeded or will almost certainly be exceeded over the coming two decades. This need not be immediately obvious in looking at the available wood in the rural areas, largely because of the enormous standing mass of woody material that has been accumulated over the preceding years. However, the stored mass is being rapidly depleted, whatever forecast we assume (Fig.1). If we use the higher demand rate for wood, half of the remaining woody cover would be stripped over the coming decade; while assuming the lower demand rate, half of the remaining woody cover would be stripped over the next three decades (Fig. 1).

On a provincial basis there is a wide variation in the balance of available wood energy amongst the provinces and in the rates at which it will be consumed in the future (Table 7). The relatively sparsely cultivated Coast and Eastern Provinces which receive a reasonably high rainfall have substantial wood reserves, while the densely populated and cultivated Central and Nyanza provinces have been consuming the standing crop of wood at a dramatic rate over the last decade. North-Eastern Province which has virtually no agricultural potential is unlikely to exceed the available wood supply in the foreseeable future. However, the extent of depletion in each province will depend largely on the patterns of wood exploitation in relation to the urban and rural centres and is therefore difficult to predict in detail.

What is most obvious in the regional picture of wood supply is the role that is still played by the high rainfall areas. The amount of wood production per annum increases with rainfall and most of the potential production is confined to the higher rainfall zones. The amount of wood production, discounted for land placed under agriculture is shown in Table 7. Despite the amount of land already placed under agriculture in the higher

rainfall zones, most of the existing production still occurs here. Even though the non-arable areas, which we have assumed to be below the 450 mm isohyete, cover some 67% of the country, they produce less than 12% of the present estimated annual production of wood fuel, Table 6. The potential energy production per unit area is here so low that the remote arid and semi-arid areas of Kenya are unlikely to offer a significant source of wood fuel once the arable zones are overutilized.

It is also evident that the existing and planned production of fuel wood from forests is entirely inadequate to meet present and future demand. With a present annual consumption in the region of 15 million m³ of wood per annum on our low forecast (Table 4b) and a production of approximately 700,000m³ of wood from forest reserves (Statistical Abstract 1977) the 4.7% contribution to the national level of consumption is minor. Presently only 6% of the forest area is allocated to fuel production and it is unlikely that this figure will change sufficiently in future to the extent that it will be a major source of supply.

DISCUSSION

Three factors apparently contribute substantially to the depletion of wood production and to the reduction of standing biomass. These are:

1. An increase in the population at the projected rate of 3.6% per annum.
2. A change from traditional use of fuel wood to charcoal in urban and high density agricultural areas.
3. Land demand for agricultural production.

We need to consider how sensitive the projections are to changes in the values of each of the variables of demand and supply before placing too much confidence in them. Having done so we will consider which factors contribute most to the observed trends, and how likely it is that these factors will change in time.

The consumption of wood fuel is dependent largely on the amount that is used by the subsistence agriculturalists and to a lesser extent the urban populations. The large and small scale farmers only contribute between 4.5 and 8.2% of the annual demand, so irrespective of whether one uses a high growth forecast of 6% in GNP per annum or a low forecast of 3%, the outcome changes the national quantity of wood used by a relatively small amount.

The subsistence demand is assumed as 1m^3 on a low forecast. Some figures indicate a higher demand in the order of 1.2 to 1.3m^3 per capita per annum (Arnold et al, 1962; IBRD, 1977). To this must be added the amount of wood used in building, which amounts to 6% (Table 5). The per capita consumption of wood in urban populations is perhaps as high as 2m^3 per capita per annum, and with the present estimated figure of 2 million people in towns and cities, their contribution to the national use of wood may be as high as 24%. This may be expected to increase substantially over the coming two decades (Table 9) as the percentage of people in urban areas rises from the present 13% to around 25% at the turn of the century (Central Bureau of Statistics, 1972).

It is unlikely that the rate of population increase will fall substantially below its present level before the year 2000 or that the urban population will be much lower than the anticipated 6 to 8 million. The combined growth in subsistence and urban demand for wood fuels will therefore continue to grow at least as fast as the population. Given the amount of information available on per capita wood utilization, it is unlikely that there is a very large bias in the values we have adopted. We consider that the national per capita use is probably substantially higher than our lower assumption of 1m^3 but has yet to reach the higher assumption of 2m^3 per annum. As a larger percentage of the population come to depend on charcoal it is possible that the upper value will be reached. Although we have here assumed a conversion efficiency of 11% in producing charcoal from wood, the value may be somewhat lower since the volume of woody mass cut down but not fed into the kiln is quite substantial. In examining kilns close to Nairobi we found that most of the scrub vegetation consisting of branches and twigs less than 4 cm was discarded. This accounts for a considerable proportion of the wood chopped down for charcoal production.

The extent to which the non-subsistence sector of the population changes from wood fuel to charcoal and eventually to commercial fuels will depend largely on the growth in GNP. If we assume a rapid growth of 6% per annum in GNP then a greater proportion of the population will be in a position to purchase commercial fuels by the year 2000 and the demand for wood will therefore be somewhat lower than a low growth rate in GNP. We caution however that these assumptions are based on past relationships of purchasing power and patterns of energy consumption. The extent to which wood fuels are replaced by say fossil, fuels in future will depend on price rises which cannot presently be anticipated. The faster the increases in the price of oil fuels, the greater will be the dependence on wood fuels in future.

The most uncertain component in our projections is the rate at which new land is placed under agriculture. With the present and projected growth in population, additional agricultural production will have to be brought into play simply to keep pace with the present per capita food demand. To increase the per capita food wealth will necessitate increasing agricultural production at a faster rate than population growth. While this can be achieved in part by intensifying agricultural production, a large amount will presumably be met, as is the case now, by increasing the area of land under agriculture. We have set out our assumption of the way in which the remaining arable land will be used over the coming two decades (Table 7). This is based on prevailing data and the assumption that the pattern of agricultural settlement will precede from the wettest to driest areas. Some provinces such as Nyanza have more or less used the available agricultural areas (which we assume extend to the 450mm isohyte) while others such as Coast Province offer prospects for expansion well into next century. Land that is placed under agriculture will inevitably be stripped of woody cover, though the fallow areas could produce fuel woods. Land which could be used for agriculture is unlikely to be used for fuel wood production on any scale simply because the opportunity cost is too high.

Land placed under agriculture will, according to our calculations, account for the reduction of annual wood production that is evident in Fig. 1. Its effect will be to advance the imbalance between supply and demand by approximately a decade on most of the forecasts. It will also accelerate the depletion of standing mass of wood by close to 50%.

On the demand side we tentatively conclude that the most significant component is the demand for agricultural land, which will depress the potential wood supply by almost a half over the coming two decades, due in large part to removing, for arable farming, the land areas which make the largest contribution to the present wood production in Kenya. Land demand for agriculture will also reduce the standing mass of wood by a similar proportion, although it will also serve to fuel the increase in demand resulting from population growth. The increase in demand due to population growth will, irrespective of that due to agricultural land, depress the standing crop of wood by roughly a half over the coming two decades, but will not reduce the annual production to any large extent. The extent to which the change from subsistence to consumer economies will accelerate the use of wood could by the year 2000 exceed 30% on our most pessimistic forecast and 23% on our optimistic scenario (Table 9).

On the supply side the figures are more speculative. We consider however that the estimated production figures probably err on the high side. Data sources on total above ground production indicate that at least on a

large scale in Kenya the production figures are similar to those estimated in our model (Cassady, 1973 Phillipson, 1975). The portion of total production channeled into wood mass has been derived largely from other studies and the values for a given level of rainfall are summarised in Table 7b. The only local data which we have to compare with these projected values are drawn from unpublished data in Amboseli. Here, in relatively dense bush areas, the standing mass of wood amounts to some 60% of the total biomass. Our theoretical value at the same 300mm isohyete gives 66% which is in good agreement. However, most of the climax woody vegetation has long been reduced by a combination of grazing, burning and cutting and average woody mass only contributes 10 to 15% of the biomass over much of the area.

Actual production and standing mass of wood is therefore likely to be somewhat below our theoretical computation. This is all the more likely when it is considered that extensive areas such as the Athi-Kapiti plains support little wood due to soil constraints such as waterlogging, alkalinity and salinity.

In general we consider that the patterns of surplus and deficit that we have outlined for wood fuels in Kenya indicate the main trends on a national basis. The picture we have portrayed may be more optimistic than situation is in reality. Even so, the rate of depletion to date and the future potential for unmanaged fuel wood production looks bleak.

There are in addition various factors which will limit the extent to which the available production and standing mass of wood can be consumed. The cost of transport is particularly crucial. Earl (1975) has noted that the transport costs incurred in collecting wood fuels from natural forests in East Africa is so high that at distances greater than 80km from markets it is only profitable to carry charcoal. As local sources of fuel wood are used up around the main urban and agricultural areas it is inevitable that there will be a progressive switch to charcoal, and consequently, to a higher absolute consumption of wood per capita. Moreover, with a sharp rise in the price of oil fuels the distance within which it is profitable to transport wood will be reduced, thus further escalating the per capita consumption of wood through a switch to charcoal.

Given the large labour costs involved in making charcoal we expect that the standing mass of wood required to sustain the trade is much greater than for fuel wood. The arid areas (those below the 450mm isohyete) which are

both distant from the main centres of population and which have a low wood mass will not provide much wood fuel apart from that used by pastoralists. Further constraints on use include woods that are too soft or have branches and twigs that are too small to make gathering economical. Such constraints will limit the extent to which the available wood source can be utilised as wood fuels and will lead to earlier critical shortages locally and nationally than we have predicted.

Yet a further factor which will undoubtedly limit the availability of wood supplies is the impact that its utility will have on both the environment generally and on other sectors of the economy. An accelerated reduction of vegetation cover will increase the already alarming rate of soil erosion.

The impact of an increased loss of soil can theoretically be calculated in terms of its opportunity costs on ranching, riparian agriculture, hydroelectric supplies and the productivity of marine ecosystems for example. The outcome is not a simple one to predict and would be a major project in itself. A reduction of bush cover can, for example, lead to a greater productivity of grassland pasture (Walker, 1974) and therefore of livestock. Provided the grasslands are well managed the reduction of over-all ground cover need not be great or result in a sharp increase in erosion. We consider therefore, that the optimum offtake of wood fuels should be calculated within a larger framework where the costs and benefits of reducing woody cover can be gauged relative to other sectors of the economy.

Finally, we suggest that there is an urgent need for detailed research into the field of wood fuel production in its broadcast sense. For a fuel which provides over 75% of the country's total energy supply and which has the highest environmental impact, there is a distressing lack of information.

A number of effective measures can be undertaken to alleviate the future drain on wood stocks. Areas within the arable lands which are not immediately under cultivation could be used as fuel lots during fallow periods. The International Council for Research in Agroforestry is one of a number of organisations that are beginning to look at the prospects for increasing domestic fuel supplies grown in arable areas. A variety of multi-purpose trees and rotation systems offer prospects for producing a combination of livestock forage, food, shelter and firewood within the existing agricultural areas which, as we earlier pointed out, have the greatest potential for energy production (Fig. 2).

On the consumer side the most immediate gains could be achieved by increasing the efficiency of charcoal kilns, charcoal and wood stoves.

1.4. High commission on present wood consumption in Kenya
 1.5. The present situation and future prospects of charcoal
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APPENDIX

Data sources and assumptions are given in the following tables.

TABLE 1

KENYA'S PROJECTED POPULATION BY PROVINCE IN '000

	1975	1979	1985	2000	2050*
COAST	1,158	1,333	1,669	2,969	15,436
EASTERN	2,284	2,585	3,158	5,263	19,781
NORTH EASTERN	264	275	290	277	238
NAIROBI	700	863	1,189	2,596	15,075**
CENTRAL	2,029	2,315	2,862	4,924	23,249
RIFT VALLEY	2,666	3,033	3,734	6,354	35,024
NYANZA	2,645	3,076	3,914	7,231	43,524
WESTERN	1,667	1,973	2,493	4,674	29,679
TOTAL	13,413	15,427	19,310	34,288	202,871

SOURCE: Central Bureau of Statistics

The population has been projected up to 2000 using a method described in the Kenya Statistical Digest June 1971, and September 1972.

* For 2050, growth rates in 2000 have been assumed to prevail.

** Nairobi has been projected at 3.6% annual growth rate between 2000 and 2050.

TABLE 2

PER CAPITA INCOME IN 1975 US \$ AND TOTAL FUELWOOD DEMAND IN
'000 TONNES ON LARGE FARMS IN PRIVATE SECTOR BY PROVINCE

	1975		1979		1985		2000		2050	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
COAST										
PER CAPITA INCOME US \$	295	289	297	314	301	375	310	584	345	2559
TOTAL FUEL- WOOD DEMAND	3	3	3	3	4	4	4	6	36	19
EASTERN										
PER CAPITA INCOME	321	271	402	305	563	364	1,306	567	21,582	2,487
TOTAL FUEL- WOOD DEMAND	3	3	3	4	3	4	4	6	8	14
NORTH EASTERN										
PER CAPITA INCOME	-	-	-	-	-	-	-	-	-	-
TOTAL FUEL- WOOD DEMAND	-	-	-	-	-	-	-	-	-	-
CENTRAL										
PER CAPITA INCOME	271	256	332	288	451	344	972	536	12,560	2,350
TOTAL FUEL- WOOD DEMAND	17	18	18	19	20	22	26	32	61	94
RIFT VALLEY										
PER CAPITA INCOME	296	258	379	290	547	347	1,371	540	29,370	2,367
TOTAL FUEL- WOOD DEMAND	29	311	30	33	32	38	40	55	58	190
NYANZA										
PER CAPITA INCOME	324	294	427	331	646	395	1,821	616	57,526	2,701
TOTAL FUEL- WOOD DEMAND	3	3	3	3	3	4	5	6	11	25

TABLE 2 contd.

	1975		1979		1985		2000		2050	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
PER CAPITA INCOME	226	219	285	247	541	295	969	459	17,849	2,012
TOTAL FUEL-WOOD DEMAND	1	1	1	1	1	1	1	1	3	6
PER CAPITA INCOME	273	261	370	294	524	351	1,248	547	22,563	2,398
TOTAL FUEL-WOOD DEMAND	56	59	58	63	63	73	80	116	177	348

Per Capita energy consumption:-

$Y = 1.84X + 125.31$ ($r^2 = 0.87$)

Y=Total energy consumption (Kg CE) per capita
X=GNP per capita (US \$)

2. % Total energy supplied by fuelwood
 $\log Y = 4.44 - 1.25 \log X$ ($r^2 = 0.67$)

3. Y=% total energy supplied by fuelwood
X=GNP per capita (US \$)

Source for Equations Earl (1975)

Total fuelwood use was calculated by finding the per capita fuelwood demand using equations (1) & (2), originally as Kg CE then converted to wood equivalent. This was multiplied by the number of people projected to be employed on the large farms. The projections were based on data published by the Central Bureau of Statistics.

Per Capita income was projected on 2 scenarios high and low which use an observed national annual growth rate of 6.06% Central Bureau of Statistics (1973 - 1978) and an assumed growth rate of 3% respectively.

TABLE 3

PER CAPITA INCOME IN 1975 PRICES US \$ AND TOTAL FUELWOOD DEMAND IN '000 TONNES ON SMALL FARMS BY PROVINCE

	1975		1979		1985		2000		2050	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
COAST										
PER CAPITA INCOME	109	109	168	122	323	146	1,651	227	381,541	997
TOTAL FUELWOOD DEMAND	75	75	68	82	61	90	58	119	78	377
PER CAPITA INCOME	106	106	122	120	151	143	255	223	1,456	976
EASTERN										
TOTAL FUELWOOD DEMAND	151	151	154	156	162	167	192	204	434	490
PER CAPITA INCOME	-	-	-	-	-	-	-	-	-	-
N.EASTERI										
TOTAL FUELWOOD DEMAND	-	-	-	-	-	-	-	-	-	-
PER CAPITA INCOME	116	116	111	130	105	155	91	242	56	1,060
TOTAL FUELWOOD DEMAND	126	126	150	136	187	150	335	194	1,352	563
PER CAPITA INCOME	128	128	153	144	200	172	392	267	3,696	1,172
R.VALLEY										
TOTAL FUELWOOD DEMAND	156	156	165	173	177	190	218	255	590	821
PER CAPITA INCOME	124	124	194	140	378	167	2,002	260	519,728	1,142
TOTAL FUELWOOD DEMAND	158	158	145	168	128	196	134	274	211	1,022
PER CAPITA INCOME	75	75	72	84	67	101	57	157	33	688
WESTERN										
TOTAL FUELWOOD DEMAND	112	112	128	139	156	168	255	228	1,408	1,438
PER CAPITA INCOME	105	105	126	118	167	141	335	220	3,430	963
TOTAL FUELWOOD DEMAND	779	779	809	855	870	961	1,192	1,103	4,072	4,711

The same method as on large farms was used except that per capita income was projected at a 4.7% high scenario based on data published in the Statistical Abstract (1977) and an assumed growth rate of 3% on the low scenario.

TABLE 4(b) *

TOTAL FUELWOOD DEMAND BY PROVINCE IN '000 TONNES OF WOOD
(INCLUDES FUELWOOD DEMAND ON LARGE FARMS AND SMALL FARMS AND SUBSISTENCE AND URBAN)

PROVINCE	1975		1979		1985		2000		2050	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
COAST	807	1,538	911	1,765	1,120	2,205	1,957	3,916	9,842	19,853
EASTERN	1,646	3,046	1,799	3,444	2,180	4,202	3,597	7,011	12,971	25,562
NORTH EASTERN	198	396	206	412	218	436	208	416	179	358
NAIROBI	504	832	621	1,025	856	1,413	1,869	3,084	10,854	17,909
CENTRAL	1,388	2,634	1,588	2,995	1,967	3,693	3,420	6,434	15,677	29,184
RIFT VALLEY	1,799	3,351	2,023	3,862	2,461	4,733	4,104	8,002	21,854	43,422
NYANZA	1,838	3,515	2,098	4,071	2,620	5,177	4,779	9,559	27,818	56,240
WESTERN	1,174	2,236	1,368	2,618	1,748	2,351	3,266	6,249	20,300	39,222
KENYA	9,355	17,613	10,613	20,193	13,169	25,210	23,200	44,419	119,493	231,750

* This is the sum of Tables 2, 3, and 4 (a)

TABLE 5

DATA SOURCES FOR SUBSISTENCE WOOD DEMAND

	m ³ /capital/annum
IBRD TUNISIA/KENYA 1977	1.238
EEAFRO (DYSON 1974) (HIGHLANDS)	1.122
ARNOLD et al (1962)	1.027
FAO (1974)	0.980
HUNTING TECHNICAL SERVICES (1976)	0.619
$\bar{X} =$	<u>0.997</u> + S.D.0.23 SE + 0.10

OF THIS CONSUMPTION % USED AS FUELWOOD:

	BUILDING	FUEL
IBRD (1977)	2%	98%
FAO (1974)	8%	92%
HUNTING TECHNICAL SERVICES (1976)	8%	92% (98% as fuel- wood)
$\bar{X} =$		<u>94%</u> + SE 1.73

TABLE 6
% OF POTENTIAL ANNUAL WOOD PRODUCTION BY RAINFALL ZONE AND PROVINCE

MEAN ANNUAL RAINFALL (mm)	POTENTIAL ANNUAL WOOD PRODUCTION IN TONNE/Km ²	COAST	EASTERN	N. EASTERN	CENTRAL	RIFT VALLEY	NYANZA	WESTERN	KENYA	ANNUAL WOOD '000 TONNE FOR EACH ZONE
200	4					0.1			0.03	13
250	6					0.4			0.2	76
300	10	0.5	9.3	46.8					3.6	1,804
350	16			18.8		2.2			1.6	786
400	25	5.1	1.5			1.0			1.4	707
450	32	8.7	1.6	25.8		6.4			5.0	2,526
550	99	14.7	13.1	8.6		7.3			7.8	3,944
600	124		0.4						0.1	40
650	149		13.1			8.8			7.4	3,707
750	199	13.7	14.1		3.2	10.3			9.0	4,521
800	233		6.7						1.3	652
900	272	20.8	13.0		18.8	15.9			13.2	6,636
1000	297	19.6							4.0	2,019
1100	359		6.0		10.3	12.4	12.9	1.9	9.6	4,826
1200	375	7.6			1.2	8.2	20.1	12.4	4.4	2,220
1300	396		12.0		26.9	15.7	21.9	24.3	14.2	7,144
1400	412					2.4			1.0	494
1500	421				13.4	5.9	31.0	25.3	7.8	3,940
1600	434		5.7			2.6		29.9	4.0	2,014
1800	470				17.0		12.4		2.4	1,222
2000	486		3.4		9.3	0.5	1.7	6.2	2.1	1,049

Potential annual wood production was predicted using Whittaker (1970) giving the relationship between net above ground primary production and mean annual rainfall. This was then used to predict annual wood production from Whittaker and Marks (1975) who give the relationship between net above ground primary production and annual estimate increase in volume.

This was then converted to weight using density of wood; $1m^3 = 750 Kg.$ wood (Earl, 1975).

POTENTIAL ANNUAL WOOD PRODUCTION BY PROVINCE IN '000 TONNES AND WOODY BIOMASS IN '00 TONNES

TABLE 7(a)

	1970		1979		1985		2000		2050	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
COAST										
WOOD PRODUCTION	2,045	6,097	1,424	5,848	1,020	5,591	336	4,682	-	760
WOODY BIOMASS	22,202	61,913	16,787	58,357	9,986	54,699	4,337	42,712	-	8,083
EASTERN										
WOOD PRODUCTION	1,942	7,566	1,289	6,990	1,110	6,561	-	5,127	-	900
WOODY BIOMASS	17,487	71,495	10,908	63,136	8,707	55,114	-	43,365	-	9,003
N.EASTERN										
WOOD PRODUCTION	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689	1,689
WOODY BIOMASS	17,585	17,585	17,585	17,585	17,585	17,585	17,585	17,585	17,585	17,585
CENTRAL										
WOOD PRODUCTION	163	2,031	-	1,740	-	1,028	-	-	-	-
WOODY BIOMASS	2,191	33,449	-	21,428	-	12,316	-	-	-	-
RIFT VALLEY										
WOOD PRODUCTION	8,107	18,027	6,393	17,340	5,060	16,717	4,142	14,405	358	1,873
WOODY BIOMASS	95,694	241,151	85,116	224,911	51,231	211,153	24,752	160,237	4,749	20,095
NYANZA										
WOOD PRODUCTION	36	3,543	-	3,030	-	2,548	-	864	-	-
WOODY BIOMASS	677	76,562	-	60,517	-	45,788	-	12,663	-	-
WESTERN										
WOOD PRODUCTION	21	2,185	-	1,803	-	1,446	-	125	-	-
WOODY BIOMASS	478	55,484	-	42,639	-	31,487	-	1,872	-	-
KENYA										
WOOD PRODUCTION	12,314	41,138	9,106	38,440	7,190	35,580	4,478	26,892	2,047	5,222
WOODY BIOMASS	156,314	557,639	130,396	448,573	87,509	428,142	46,674	278,434	22,334	54,766

Low Production = Table 6 data X (AREA - TOTAL AGRICULTURAL LAND) X 0.75

High Production = Table 6 data X (AREA - TOTAL AGRICULTURAL LAND - AGRICULTURAL FALLOW).

Agricultural land projected from data published in the Statistical Abstract, 1977. Biomass is predicted from Langbein and Schum (1958) and is reduced by a given % to get the wood biomass (Table 7b).

Agricultural land has been projected as the sum of large and small farms. Large farms are projected on a compound growth rate using data in the Statistical Abstract (1977); while small farms are projected using a per capita agricultural land demand of 0.003 Km²; Physical Planning Department (1978) Human Settlements in Kenya: A Strategy for Urban and Rural Development.

TABLE 7(b)

ANNUAL RAINFALL (mm)	1975	1978	1981	1984	% BIOMASS THAT IS WOOD
200	1,828	1,940	2,380	2,442	50
250	1,844	2,184	2,707	2,788	55
300					66
400					70
450	2,447	2,684	3,002	3,103	72
500	2,487	2,728	3,046	3,147	76
550	2,487	2,728	3,046	3,147	80
600	2,487	2,728	3,046	3,147	84
650					86
700					88
750					90
800					92
850					94
900					95
1000					97
1100					99
1200					100

Log Biomass (g/m²) = 2.72 log Annual Rainfall (mm) - 1.8
 AND DATA SOURCES IN TABLE 7 (a)

TABLE 8

COMMERCIAL ENERGY CONSUMPTION

	1975	1979	1985	2000	2050
'000 TONNES OIL					
GDP-HIGH (6%)	1,658	2,237	3,391	8,810	171,113
GDP-LOW (3%)	1,658	1,940	2,399	4,042	19,425
DIRECT PROJECTION (6.9%)	1,643	2,144	3,197	8,676	241,922
TOTAL WOOD DEMAND AS '000 TONNE OIL					
HIGH	8,447	9,684	12,091	21,303	111,145
% TOTAL	84	81	78	71	39
LOW	4,487	4,888	6,316	11,127	57,308
% TOTAL	73	72	72	73	75

Source: Singh (1978)

The projections have been made using an equation derived from data by Singh (1978) giving the relationship between total GDP and total energy consumption of Kenya and total GDP vs per capita Kg of oil equivalent consumption.

$$Y = 1.3273X - 34.018 \quad (r^2 = 0.99)$$

Y = total energy consumption in '000 tonnes oil equivalent.

X = GDP in Kf million.

The equation uses indices where 1972 = 100 for both GDP and energy consumption. Fuelwood was converted to oil equivalent on a heat basis using conversion factors in Earl, (1975). GDP was projected at annual growth rates of 6% (high) and 3% (low). Direct projections of oil consumption were also made for comparison.

TABLE 9

URBAN POPULATION DEMAND FOR WOOD AS CHARCOAL

	1975	1979	1985	2000	2050
TOTAL URBAN POPULATION IN '000	1,514	2,000	3,035	8,610	50,000
LESS 20%=NON CHARCOAL USERS	1,211	1,600	2,228	6,888	40,000
HIGH DEMAND '000 TONNES WOOD DEMAND AT 1.485 TONNE PER CAPITA	1,798	2,376	3,309	10,229	59,400
LOW DEMAND IN '000 TONNES WOOD DEMAND AT 0.9 TONNES PER CAPITA	1,090	1,440	2,005	6,199	36,000

Population is projected at 7.2% annual growth up 2000, and there after at 3.6% Per Capita demand is from Chlala (1972) and Kabagambe (1976). Wood use is derived from charcoal by multiplying by 9, Openshaw (1976).

FIG.1. Projections of wood demand and supply on a Kenya-wide basis. Annual demand is projected from the assumptions given in Table 3. Annual wood production and woody biomass is calculated according to the assumptions given in Table 7a.

URBAN POPULATION DEMAND FOR WOOD AS CHARCOAL

	1975	1985	1995	2005	2020
TOTAL URBAN POPULATION IN '000	1,814	2,000	2,032	2,019	20,000
LESS 20% NON-CHARCOAL USERS	1,211	1,400	1,428	1,418	10,000
HIGH DEMAND '800 TONNES WOOD DEMAND AT 1.885 TONNES PER CAPITA	1,798	2,376	3,308	10,348	28,400
LOW DEMAND IN '000 TONNES WOOD DEMAND AT 0.8 TONNES PER CAPITA	1,090	1,140	1,002	8,198	38,000

Population is projected at 7.5% annual growth up 2005, and thereafter at 3.0% per capita demand is from Chiala (1975) and Kapanga (1978). Wood use is derived from charcoal by multiplying by 8.0 (Ogden 1978).

FOREST RESOURCES IN THE SEMIARID LANDS OF KENYA

By

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INTRODUCTION

The total area of gazetted forests in Kenya is just under 3 per cent of the total land area. Most of Kenya's forested country is on the plateau and upland slopes. The montane conifer forest comprises the largest forest areas in Kenya and are the most important economically. The lower slopes between 1219 and 1829 m support rich semitropical rain forests. A few such forests are also found in the Nyanza basin, and in the coastal strip.

The semiarid lands have been described by Pratt, Greenway and Gwynne (1966) as land of marginal agricultural potential, carrying as natural vegetation dry forms of woodland and savanna. The low country, covering much of marginal lands, does not contain high forest (Logie and Dyson, 1962). The rainfall in this zone is low and erratic with extensive periods of drought, except for the last two years which have been exceptionally wet. The annual precipitation ranges from over 300 mm to 600 mm and is usually concentrated in one or two relatively short periods of the year.

INDIGENOUS FORESTS IN THE SEMIARID LANDS

The indigenous forests and natural vegetation of the semiarid lands may be broadly grouped under the following categories:

Upland dry forests

These are semideciduous forests dominated by Brachylaena hutchinsii (Muhugu), Croton megalocarpus, Caledendrum capense and Techlea nobilis. Juniperus procera and Olea hochstetteri may also occur in this region but they are often dwarfed. The forests are well represented in Ngong, Kiambu, Kikuyu escarpment, Nanyuki area, and hills in the North Eastern Province, Mt. Kulal, Mathews Range, Marsabit and the Ndottos.

Acacia - Savanna Vegetation

The most extensive vegetational type of marginal lands is Acacia - Themeda triandra (a tall grass) savanna. The belt more or less stretches from the upland dry forests to the lowlands where it gradually diffuses into the arid zone. The rainfall ranges from 500 to 760 mm but is erratic and droughts are a feature of the climate.

Bushlands and Thickets

Bushlands and thickets occur in many areas particularly in Tsavo National Parks. Lind and Morrison (1974) observed that the woody cover in this area varies in density from scattered bushes to dense thickets with a great variety of species, notably Acacia brevispica, A. mellifera, A. nilotica, A. nubica, A. senegal, A. tortilis, Balanitis aegyptica, Commiphora campestris, Euphobia candelabrum, Grewia similis, G. tenax and Lansea humilis. Valleys where the water table is near the surface support savanna communities dominated by A. xanthophloea and species of Combretum.

The most prominent formations are Commiphora, Acacia mixed woodlands with occasional larger trees especially Delonix alata, Melia volkensii, Entandrophragma bussei and the baobab (Adasonia digitata). In the lower altitudes are Steculia africana, Lennea alata, and Boscia sp. Prominent bushes are Cordia gharaf, Premna sp., Bauhinia taitensis and Terminalia orbicularis. The Galana and Tsavo rivers, in Tsavo area, are fringed by Populus ilicifolia, Acacia elatior, Hyphaene coriacea (Doom palm), Tamarindus indica and species of Ficus. In many areas, these communities provide a significant amount of browse.

Tracks of semiarid belts occur in western Kenya. In this savanna vegetation, the prominent trees are scattered and vary from 3 m to 5 m high. Among the trees, species of Acacia are frequent but typically broad leaved trees, such as Combretum, Terminalia brownii, Albizia and Tamarindus indica are noticeable. To the south of this western belt of vegetation is a vast parkland covering Transmara area. The characteristic species include Olea chrysophylla, Rhus glaucescens, Teclea nobilis and Carissa edulis.

A small belt of lowland dry forest occurs north of the Tana River in Boni-Lungi area and on Arabuko-sokoke forest 64 km north of Mombasa. Logie and Dyson (1962) have shown that the dominant species in this area vary with

soil types. Brachylaena hutchinsii is often dominant on red soils. Other associated species are Azelia cuanzensis, Manilkara sulcata, Combretum schumannii, Diospyros abyssinica, Trachylobium verrucosum, and Dalbergia melanoxylon.

A unique evergreen, dry semi-deciduous forest occurs in Kibwezi area about 144 km from Nairobi, along the Nairobi Mombasa road. Characteristic species are Olea africana, Commiphora baluensis, C. schumannii, Ficus sycomorus, Adansonia digitata, Newtonia hildebrandti, Terminalia brownii, Trichilia emetica, Phoenix reclinata and various species of strangler Ficus.

The entire semiarid zone is subject to prolonged periods of drought during which fire frequently sweeps through extensive portions. Indeed grass firing is a deeply rooted custom of the communities and fire and stocking together exert a marked influence on the relative abundance of the species.

On the whole indigenous trees in this belt are very slow growing producing less than 2 m³ per ha per annum. The trees are characterized by profuse branching habits and heavy wood. Only a few indigenous trees in the semiarid lands (Appendix I) have commercial end uses. However, nearly all trees species in this zone can be easily burnt into charcoal, a situation which the local people have selfishly exploited. Perhaps, the most important function of trees, shrubs and herbage and grasses is provision of vegetative cover.

FOREST MANAGEMENT IN THE SEMIARID LANDS

Benefits of Forestry to rural communities

Trees play an important role in making life more pleasant. The vegetation greatly ameliorates the environment particularly by checking erosion both by wind and surface runoff, besides providing shelter for man and beast. Along the rivers they regulate stream flow and by holding the soil together, protect the reservoirs against silting. The forests provide all the wood needs for rural population, in the form of woodfuel, building and fence posts, poles, wood for agricultural tools, and farm buildings, and herbal medicines. There is tremendous potential for developing minor products, such as, tannin, fruits, seed, forage and browse for animals, gums, resins, and oils. Flowers of several species of trees in this area provide browse for the honey bee, Apis mellifera, and therefore constitute a source of honey and beeswax. The "greening" effects of trees in an otherwise desolate country is certainly important besides their direct aesthetic and recreational impacts.

According to Appendix II forest products are both economical and well fitted in the rural economy.

Constraints to Forest Development

The climate becomes increasingly harsh as you move from the wet uplands to the arid zone. Low, bimodal rainfall that comes during relatively warm months and prolonged dry spells are major constraints to forest development in the marginal lands. Moreover certain areas receiving between 650 and 800 mm rainfall do not support substantial forests. This could be due to added effects of unfavourable edaphic factors. The soil on hills and rocky areas is shallow, poor or almost absent. In sandy areas the soil, though not very poor, have little clay content and cannot retain moisture for sufficient time. On the other hands, soils with sufficient clay-content tend to compact tightly, allowing only little water to penetrate into the ground when it rains.

Lack of land for forestry dims all hopes for realizing possible development of industrial plantations in this zone. Any substantial investment on plantation programme in areas outside the gazetted forest reserve is bound to sink under because in the absence of appropriate legislation, the forestry officers cannot control wanton tree felling and destruction of the forest crop. At present, legislation is very weak. The Chief's Act is the only effective law, but this does not provide sufficient mechanics for control and forest management. Although technical information on candidate species and cultural techniques have been wanting for some time, considerable progress has been made over the last five years.

Species Trial Programme in the Semi-Arid Areas

Indigenous trees in the semiarid areas, good as they are, are very slow growing and even when brought under a gainful forestry programme, their volume production would still fall below the local needs. Although growing conditions in the semi-arid lands are harsh and difficult, compared to those in the highlands, there are good prospects for growing exotic and some indigenous species given suitable provenances and good silviculture.

Species trial planting in the semiarid lands date from the 30s when colonial foresters initiated a token programme in Machakos district. Many of these trials, especially in the difficult sites, failed undoubtedly due to heavy reliance on the wonder trees of the highlands and techniques that

had been adopted for raising trees under an equable growing condition in zones II and III. The first well thought out trials in marginal lands were not planted out until 1970. Intensive species trials followed four years later.

Appendix III lists all species tried, so far, in the semi-arid areas. The highland species particularly Cupressus lusitanica, Pinus radiata, P. patula, Eucalyptus saligna, E. grandis have shown poor performance except in areas receiving over 750 mm rainfall with good soil. P. caribaea and P. occarpa grow satisfactorily at Katende with an annual rainfall of 750 mm. Azadirachta indica, E. camaldulensis, E. maculata, E. paniculata and hybrid of E. tereticornis and E. camaldulensis (A Zanzibar provenance), Callitris hugelii and C. robusta have shown consistently satisfactory results both in establishment and growth at Ramogi and in Machakos area. At age three these Eucalyptus spp can provide building poles. Cassia siamea, Azadirachta indica, Parkinsonia aculeata grow satisfactorily in this zone. Provenances of Dalbergia sisso, Leucana leucocephala, have been introduced at Hola and Ramogi but the trials are still too young to provide any convincing suggestions. Various species of ornamental and shade trees, such as, Cassia grandis, C. spectabilis, Bougainvillea, Delonix regia, P. aculeata, Schinus molle and various Euphobiaceae are grown successfully in homesteads, schools, market centres, hospitals and other institutions. Among prominent trees with multiple functions, that are cultivated in this zone are: Macadamia ternifolia, (provides edible seed, wood is used in fancy turnery); Mangifera indica (Mango) provides edible fruit, shade, wood used for canoe building, planking and woodfuel); and Syzygium cumini (Mzambarau) (provides edible fruit, shade and woodfuel).

Further species trials are still needed with more replications in sites that are representative of the natural economic, demographic and edaphic conditions of larger regions.

The following species will be used in further species trials in the semiarid lands.

<u>Species</u>	<u>Product</u>	<u>Provenance</u>
<u>Acacia albida</u>	cover, poles, woodfuel and fodder	N.E. Kenya
<u>A. tortilis</u>	cover, poles, woodfuel, fodder	N.E. Kenya
<u>A. nilotica</u>	cover, poles, woodfuel, fodder, gum arabic	Sudan.
<u>A. senegal</u>	cover, woodfuel, gum arabic, live fences	N.E. Kenya

<u>Species</u>	<u>Product</u>	<u>Provenance</u>
<u>Aegel marmolosa</u>	fodder, woodfuel fruits	India
<u>Ailanthus excelsa</u>	poles, timber, fodder, shade	India
<u>Albizia lebbek</u>	shade, fodder, timber, fuel	India, Tanzania, Uganda
<u>A. procera</u>	shade, fodder, timber	India, Kenya
<u>Bombax malabaricum</u>	timber, poles	India, Kenya
<u>Brosimum alicastrum</u>	fodder, food	Mexico
<u>Cassia siamea</u>	fodder, fuelwood, timber	Kenya
<u>C. sturtii</u>	fodder, cover	Israel
<u>Casuarina glauca</u>	Poles, timber, fuelwood	Australia, Kenya
<u>C. stricta</u>	poles, fuelwood, timber, fodder	Australia, Kenya
<u>Colophospermum mopane</u>	fodder, poles, fuelwood	Malawi
<u>Dalbergia latifolia</u>	cover, timber	Kenya, India
<u>D. sisso</u>	copper, timber	Kenya, India
<u>Dendrocalamus strictus</u>	poles, baskets, furniture	Malawi, India
<u>Khaya senegalensis</u>	timber, veneer	Sudan, Malawi
<u>Populus ilicifolia</u>	riverbank stabilization, timber	Kenya
<u>Prosopis spicigera</u>	cover, fodder, live fences	Pakistan, India
<u>P. tamarugo</u>	fodder, cover	Israel, USA
<u>Simmondsia chinensis</u>	Jojoba oil	Israel, USA
<u>Syzygium cumini</u>	shade, fruit	Kenya
<u>Terminalia spinosa</u>	shade, timber	Kenya

<u>Species</u>	<u>Product</u>	<u>Provenance</u>
<u>Acacia alba</u>	cover, poles, woodfuel and fodder	N.E. Kenya
<u>A. tortilis</u>	cover, poles, woodfuel, fodder	N.E. Kenya
<u>A. senegalensis</u>	cover, poles, woodfuel, fodder, gum arabic	Sudan
<u>A. gerrardii</u>	cover, woodfuel, gum arabic, live fences	N.E. Kenya

APPROPRIATE FORESTRY FOR THE SEMI-ARID LANDS

In many areas, the pressure of growing populations has forced landless farmers into soils which cannot sustain crop production and into slopes which cannot be safely cultivated. The rural people have, once settled in such areas, understandably sacrificed their forests to obtain fuel and more land for food. Through this outlet, they have achieved temporary relief from food shortages at the expense of the biological capital of trees and soil. In many cases, forest land once stripped cannot support agriculture for long because of erosion or the shallowness or low fertility of the soil.

Many people in Kenya today have realized the irreplaceable value of trees. Indeed several leaders have bitterly condemned cutting trees in rural areas, vehemently suggesting a total ban on the use of woodfuel, to save the environment!! I find this suggestion unrealistic, defeatist and totally undermining the mission of forestry to mankind. Forests are renewable resources, which with appropriate scientific management can be maintained and cropped on a sustained basis to perpetuity. With foresight the government could forestall shortages of fuelwood and charcoal and other forest products and also overcome problems arising from mismanagement of the land by establishing industrial woodfuel plantations, and community forests and woodlots.

Plantations grown for woodfuel on a 5-8-year rotation with species such as Acacia, Cassia and Eucalyptus with expected annual yield of 18 m³ ha, could give a real return of about 7 per cent per year on money invested at the nominal stumpage fee of shs. 19.00 per 1 m³. Such plantations can be located in several sites as may be permissible by growing conditions, and be managed to meet all local demands for fuelwood, charcoal and other products with surpluses for export.

To meet the demand for wood in ASAL areas we need to develop industrial plantations in public land, and community forests in private land to be run on co-operative basis. These can be augmented through the development of agroforestry systems in the farming streams.

Development of Industrial Plantations in Existing Trust Lands

Several hills today lie idle in ASAL areas due to lack of trust and co-operation between local leaders and the government. In the interest of development for the benefit of the people, the leaders and the government must resolve their past differences over the ownership and use of

these land areas. Because the areas are not suited for viable agricultural development, they should be turned over to the government to develop them into gainful forests. Appendix IV lists a few candidate areas in Kenya which could benefit from such a programme.

In addition to blocks of forests shown in Appendix IV the following are the only catchment forests in the districts named:

These forests are gravely endangered today, because of mans free use. To support the governments efforts in environmental protection and goal of providing every homestead with water by 2000 AD, these forests must be placed under the custody of the Forest Department now.

Loita Hills	Narok
Ol Pusimore Forests	Narok
Ngong Hills	Kajiado
Suswa	Narok/Kajiado
Olongasailie Hill	Kajiado
Endonyo Narok Hill	Kajiado
Lemileblu Hill	Kajiado
Lokululit Hill	Kajiado
Olenegasoloi Hill	Kajiado
Maparasha Hills	Kajiado
Melwa Hill	Kajiado
Aspen Hill	Kajiado
Kiasa Hill	Kajiado
Soy Sambu Hill	Kajiado
Chyulu Hills	Machakos
Karasuk Hills	West Pokot
Lima Hills	Turkana
Huri Hills	Marsabit

Today these forests fall under the auspices of the local authorities who are unable to maintain any management programme due to lack of trained personnel and funds for keeping the necessary punitive legislations and regulations. There are sufficient reasons to believe that scientific management of these forests would not only ensure effective conservation and protection, but would enhance their catchment potential and improve stream flow. Much of forest management in these areas will be concerned with better management of the natural forests for the benefit of the local people. By halting uncontrolled cutting, the processes of degradation can be reversed through concentrating

the cut on annual coupes, while the rest of the area remains protected to allow natural regeneration in selected areas. In this system of management, it would be possible to open the forests, where it is necessary, during the dry season for grazing livestock from surrounding communities provided that livestock numbers are brought down to the carrying capacity of the land. Such rights can be incorporated in the legal notice drawn up to legalize the gazettment of the forests. Silvicultural practices and research would be undertaken to enable development of high yielding compensatory plantations.

Development of Community Forests

It has been the government's policy for many years for the Forest Department to encourage tree planting in farms by making available tree seedlings to farmers either free or at every low prices. In 1902, a legislation was passed regarding 10 per cent of farm land to be maintained under perpetual forest, but this measure did not seem to have been forced for long.

It is possible now when our people have a changed attitude about growing trees to organize farmers to form co-operatives for growing trees to meet their own domestic consumption with surpluses for sale. Each farmer can set aside a parcel of his land for such a project according to his capability. Farmers with large farms would be encouraged to develop their own woodlots. Increasing cost of woodfuel (shs. 28.00 per bag of charcoal, shs. 2.00 per piece of wood 2 m long) would provide sufficient incentive. Moreover, we shall not continue to enjoy alternatives of oil fuel for long. Shortages of imported oil fuel either through non-availability due to excessive costs are inevitable and will soon catch up with us. An early start on the development of a cheap, and renewable source of fuel is most desirable.

In developing community forests the programme must avoid traditional pre-occupation of forestry which focus on the production of commercial products and conventional forest management practices and conservation through punitive legislations. This bias also surfaces in the structure and staffing of forestry administrations and in the traditional training of foresters, who often find that they are well equipped to deal with trees but much less prepared to handle people. This will need to be corrected.

Integration of Forestry with Agricultural Systems

Because the people must firstly feed themselves and their families, forestry development must not antagonize food production. The forestry activities must be integrated in the overall regional development programmes, and be reconciled with land tenure and cultural practices. Direct competition with food production for land may be avoided by taking up unused area; widespread use of roadside, ridges, boundaries of fields, river sides, surrounds of dwellings and villages.

It will be important to select tree species which are as productive as possible, and competitive with alternative non-food crops. Trees with multiple-purposes will be preferred. Quick growing species which can yield an income as early as the first year, as well as, those providing leaves, nuts, fruits or bark, interspersed with species to produce industrial wood etc would provide an acceptable compromise. Species used for wind-breaks should possess adequate height, rapid growth, evergreen, compact form limited root competition, and resistance to windfall and wind breakage. Grevellea robusta, and cupressus pyramidalis can be used. Acacia elatior, species of Eucalyptus, and Populus ilicifolia can be planted in the riparian zone with very high yields.

At the present time, rational and optimal land use, particularly in farms is possible through agroforestry systems. In an agroforestry systems, the land supports both forest trees and agricultural crops and or animals together or in a rotation geared to an overall increased productivity. In Kenya agroforestry has been largely practised in the form of "Shamba" system in plantation establishment. Von Maydell (1978) has rightly observed that our present knowledge of agroforestry is still very young and its further development hinges on integrated research efforts to be launched now. We have a great opportunity in Kenya today of conducting gainful studies on agroforestry. The following combinations are worth trying.

- (a) Temporal combination - cropping or pasturing under tree cover.
- (b) Temporal separation - traditional Taungya involving crop cultivation for two to three years before the trees develop extensive crowns, or a more specifically defined form of crop rotation with trees.
- (c) Spatial combination - permanent pasturing or cultivation between trees or growing trees in sections of farms that are not amenable to cultivation or agricultural crops.

Development of Live Fences

It has been estimated that woodfuel consumption by pastoralist is very small indeed. According to Lamprey (1979) pastoralists wood demand for "boma" (Kraal) building is about 300 times more. UNESCO's IPAL project has tried wire and bamboo fences, but these are bound to be too costly either to the government or to individuals. Because the people are shifting intermittently from place to place in search of fresh pastures, the most appropriate fencing material for them must be light (portable) and durable enough to stand dismantling at one point and reuse in new "boma" elsewhere. I cannot figure out precisely what could meet these requirements. We must therefore, find an alternative that is feasible.

Social workers with experience in northern Kenya have observed that pastoralists normally shift regularly with the seasons. It is not clear whether they take regular routes. Studies should therefore, be undertaken to map out their migratory routes. Results of such studies could enable suitable points to be located along the routes, where "bomas" can be established. The "bomas" would be surrounded by live-fences using any or a mixture of the following species: Acacia abyssinica sub sp. calophylla, Carisa edulia, Commiphora baluensis, Euphobia spp. and Rhus spp. At an appropriate time when the community is moving along, the "bomas" would be left intact. Such "bomas" would in time be constructed at appropriate points along the routes and be left undisturbed for reoccupation and use during subsequent migrations through the seasons, in subsequent years.

Scientific Research

Pilot projects involving thorough researching are prerequisites to the implementation of what is discussed in this paper. The Forest Department plans to conduct experiments in representative locations. Establishment techniques including affectiveness of pits of different depths with crescent shaped ridges and long trenches dug in a staggered pattern, enrichment planting schedules and weeding regimes, will be examined. Quick growing, drought resistant species that are ecologically suited to the areas will be tried. Preference will be given to trees with multiple functions.

Conservation of Wood Resources

In addition to radical afforestation and conservation effort, a more rational use of the meagre wood resource is needed. This could be tackled through the development of more efficient wood stoves and ovens for the rural and urban communities. Fuelwood is traditionally used very inefficiently and most of the heat is wasted. Open hearths should be avoided. Commercial development and use of briquetts made from sawdust, cashew/groundnut shells, rice/maize husks, and coffee waste should be taken up by the government. The use of other forms of energy including biogasification, solar energy and electricity from wind power should be considered as these would relieve the pressure on wood.

Extension

Little work has been done on training in rural forestry extension. General experience and techniques will have to be adapted for it. The value of involving the local people in community forestry cannot be over stressed. A useful first step would be to help them to document their needs and problems. This would reassure the rural communities that the programmes will be relevant to their needs. Furthermore, it imbues them with a feeling of responsibility for ensuring success. More conventional extension effort will include pilot projects implemented by the government, local people or both; with technical advice through regular visits and material assistance, such as, provision of seeds, seedlings. Progressive farmers could be organized to form co-operative or associations in each village as a nucleus for developing and managing community village woodlots and forests.

The local people must play the principal role in community forestry development, while government agencies and non government organizations, such as, the European Economic Community and Christian Council of Kenya etc have a special place in bringing about successful programmes. The forest department must continue to play a co-ordinating role.

Education

While many people have now realized the irreplaceable value of trees, many Kenyans still love the forest products including the forest land for growing maize, potatoes, wheat, etc, more than they love the trees. To many Wananchi, forests appear as "land banks" to be drawn from regularly to absorb the ever increasing population.

Indeed, apart from a benign relationship with the forest among Dorobos, the forests tend to be seen as a negative element of the environment by many poor rural farmers. The majority regard the forest as an inexhaustible god-given resource to be harvested at will freely and without replacement. To the settler, it is an impediment to clearing of his lands, and a heaven for his enemies - birds, rodents, monkeys and wild pigs etc. and must therefore be removed as rapidly as possible. These views are fundamentally inimical to forestry. Conditions for inserting forestry in communities will therefore, call for some adjustments, such as, accompaniment of measures to provide the farmer or the community with alternative ways of generating some income before the trees are yielding.

The teaching at the professional and technical levels has only given a passing attention on the role of forestry in rural development in areas outside the forest reserve. The forester working on community forestry must be familiar with social and economic problems in the rural areas. He should be conversant with land use under marginal conditions, agroforestry and range-management systems. In addition he should be able to communicate with members of the rural communities. The education curriculum should be readjusted accordingly. While the educational system is being restructured to provide courses in community forestry in-service training can provide useful stop-gap measures to enable the programme to realize an early take-off.

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APPENDIX I

ECONOMICALLY IMPORTANT INDIGENOUS TREES OF SEMIARID
LANDS THEIR DISTRIBUTION AND COMMON USAGE

Species	Distribution	Usage
<u>Acacia albida</u>	Common in alluvial valleys at low to mid - elevations, often in association with <u>A.tortilis</u> and <u>A.elatior</u> .	cover, browse. timber.
<u>A. elatior</u>	dry western Kenya, in Turkana etc. along the larger water courses	cover, shelter-belt.
<u>A. lahai</u>	Savanna, bordering forest zone and certain lowland areas	shade, locally used for fencing and rough farm buildings and woodfuel.
<u>A. seyal</u>	mid-elevation in season-ally water-logged ground.	cover, browse.
<u>A. tortilis</u>	Occurs below 1530 m especially in alluvial valleys.	Shade, locally used for fencing, constructing farm buildings and as woodfuel.
<u>Azelia cuanzensis</u>	Lowland dry forest in coastal belt.	Joinery for out door or indoors use, popular with Arabs and coastals for carved doors, and chests.
<u>Brachylaena hutchinsii</u>	Lowland dry forest in coastal belt and dry upland forest.	Locally used for fencing. Commercially used for carvings, floor blocks and parquets and furniture.
<u>Brachystegia spiciformis</u>	Lowland dry forest in small quantities	Cabinet making, railway sleepers (only for Tanzania)
<u>Combretum schumansii</u>	Lowland dry forest	Wind instruments (flutes), wooden pulleys, used on sailing boats.

APPENDIX I Contd.

<u>Dalbergia melanoxyton</u>	Savanna in the lowland dry forest	hand carving of fancy articles and ornaments, waling sticks, and wind instruments.
<u>Juniperus procera</u>	Dry upland forest	Many purposes and construction & lining, joinery in flooring strips and parquets, fence and posts roofing timber & shingle.
<u>Melia volkensii</u>	Low rainfall range land and in the coastal belt.	Poles and locally used for door jambs and other joinery.
<u>Newtonia buchanani</u>	Hill tops in Machakos & Kitui districts, and around Lake Victoria.	Timber for cabinets, boat building.
<u>N.hildebrandtii</u>	Southern Kenya, coast, and Samburu.	wood carving, wood-fuel.
<u>Olea africana</u>	Woody grassland and dry upland forest.	woodfuel, poles and for hut construction.
<u>O.chrysophylla</u>	Dry upland forests	Tools handles, flooring blocks, and pulleys.
<u>O.hochstetteri</u>	Dry upland forest	floor boards, panelling car bodies tool handles and carving of fancy articles.
<u>Podocarpus grasilior</u>	Dry upland forests	Standard building and joinery timber in Kenya.
<u>Populus ilicifolia</u>	Alluvial plains along Tsavo and Galana rivers	Traditionally used for match splints, logs peel well.
<u>Terminalia brownii</u>	Dry lowlands	A good shade tree, locally poles used for building, provide timber of poor quality.

APPENDIX II

BENEFICIAL FEATURES OF FORESTRY PRODUCTS
TO THE RURAL COMMUNITIES

Product	Beneficial features
Fuel	Cheap; sustained production possible at low capital investment; substitutes costly imported fuels; saves agricultural residues; saves house hold labour.
Building materials	Economical in use; sustained production possible locally, low cost; alternative to costly heavy materials.
Food, fodder and grazing	Stabilization of crop land against the eroding effects of wind and water. Complimentary source of food or fodder and forage. A source of supplementary food production e.g. honey. Generates increased crop productivity in marginal lands.
Saleable products	Raising farmer (community) incomes and expectation. Diversifies the community economy. A source of direct & indirect employment.
Raw materials	Inputs to local handicraft. Small scale industries.
Amenity and cover	Provide a pleasant landscape, provide natural shade for relief from hot sun, barrier to incessant hot dry winds and blowing dust. Prevents soil erosion.

APPENDIX III

A RECORD OF SPECIES TRIALS IN THE SEMIARID AREAS IN KENYA

<u>Species</u>	<u>Location</u>	<u>District</u>
<u>Azadirachta indica</u>	Gede	Kilifi
	Jilore	"
	Mutito	Machakos
	Hola	Tana River
	Garissa	Garissa
<u>Callitris robusta</u>	Uuni	Machakos
	Mutito	Machakos
	Mumoni	Machakos
	Endau	Machakos
	Ramogi	Siaya
	Hola	Tana River
<u>C. hugelii</u>	Ramogi	Siaya
<u>Cassia siamea</u>	Gede	Kilifi
	Jilore	Kilifi
	Mutito	Machakos
	Hola	Tana River
	(wide spread in farms throughout the marginal areas)	Garissa
<u>Cupressus lusitanica</u>	Utangira	Machakos
	Makuru	"
	Kilungu	"
	Mutito	"
	Mumoni	"
	Kyawea	Baringo
	Saimo	"
	Pemwai	"
	Katimoh	"
	Kinyo	"
	Mtarakwa	"
Tarambas	"	
Perkerra catchment	"	
Kimojoch	"	
<u>Dalbergia sisso</u>	Gede	Kilifi
	Jilore	"
	Ramogi	Siaya
<u>Eucalyptus camaldulensis</u>	Ramogi	Siaya
	Gede	Kilifi
	Hola	Tana River
	Jilore	Kilifi
	Mutito	Machakos
	Garissa	Garissa

APPENDIX III Contd.

<u>E. columellris</u>	Ramogi	Siaya
<u>E. maculata</u>	Gede Jilore Ramogi	Kilifi Kilifi Siaya
<u>E. camaldulensis</u>	Ramogi	Siaya
<u>E. tereticornis</u> (hibrid)	Hola Sigor	Tana River W. Pokot
<u>E. paniculata</u>	Mutito Ramogi Hola Endau Mutuluni Kyawea Garissa	Machakos Siaya Tana River Machakos Machakos Machakos Garissa
<u>E. tereticornis</u>	Hola Ramogi Gede Uuni Jilore Mulinduko	Tana River Siaya Kilifi Machakos Kilifi Machakos
<u>Grevillea robusta</u>	Kilungu Hola	Machakos Machakos
<u>Leucana leucocephala</u>	Garissa Hola	Garissa Tana River
<u>Melia volkensii</u>	Mumoni	Machakos
<u>Parkinsonia aculeata</u>	Garissa	Garissa
<u>Prosopis chilensis</u>	Hola Garissa	Tana River Garissa
<u>Pinus caribaeae</u>	Endau Katende Kyawea	Machakos Machakos Machakos
<u>P. elliotti</u>	Uuni Mutito Mumoni Endau	Machakos Machakos Machakos Machakos

APPENDIX III Contd.

P. patula

Mataa
Ikilisa
Nunguni
Mumandu
Ututeni
Kutoo
Kyai
Makuli
Nzaii
Kilungu
Mutito
Mumoni
Maranga
Kianjiru
Kamiti
Saimoq
Katimok
Kiyuyo
Mtarakwa
Tambara
Pekerra
Kimojock

Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Machakos
Embu
Embu
Embu
Baringo
Baringo
Baringo
Baringo
Baringo
Baringo
Baringo
Baringo
Baringo

P. radiata

Mataa
Ikilisa
Utangwa
Ngunguu
Mumandu
Utuneni
Kitoo
Kyai
Nzau
Mutito
Kinyo
Mtarakwa

Machakos
"
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Baringo

APPENDIX IV

UNGAZETTED FORESTS IN THE SEMIARID AREAS OF KENYA REQUIRING
SCIENTIFIC MANAGEMENT

Name of Forest	Approx. Area (ha)	Managing Agency	District
Kesop	1969	Trust	Elgeyo/Marakwet
Karaini	24	Trust	Embu
Kiambere	643	Trust	Embu
Kiang'ombe	2104	Trust	Embu
Kianjiru	1004	Trust	Embu
Kirimiri	104	Trust	Embu
Maranga	219	Trust	Embu
Molinduko	194	Trust	Embu
Njukiini East	498	Trust	Embu
Namanga	11768	Govt.	Kajiado
Kingatua	50	Trust	Kiambu
Njukiini	570	Trust	kirinyaga
Ngorome	348	Trust	Kisii
Marabu-Magina	494	Trust	Kisii
Koguta	413	Trust	Kisumu
Rangwe	1214	Trust	Kisumu
Endau	6718	Trust	Kitui
Gaikuyu	3075	Trust	Kitui
Imba	732	Trust	Kitui
Kabonge	31	Trust	Kitui
Kyawea	63	Trust	Kitui
Mai	515	Trust	Kitui
Maimu	500	Trust	Kitui
Mumoni	10441	Trust	Kitui
Mutha	1785	Trust	Kitui
Mutuzuni	596	Trust	Kitui
Museue	48	Trust	Kitui
Ndoani	1387	Trust	Kitui
Boni	18466	Govt.	Lamu
Kanzalu	100	Trust	Machakos

APPENDIX IV Contd.

Kibauni	200	Trust	Machakos
Mango	45	Trust	Machakos
Matha	100	Trust	Machakos
Mavindi	100	Trust	Machakos
Muune	100	Trust	Machakos
Yekanga	100	Trust	Machakos
Kakuzi Hill	1800	Govt.	Murang'a
Huri Hills	30000	Trust	Marsabit
Mount Kulal	45729	Trust	Marsabit
Magumo South	369	Govt.	Nyandarua
Oracho	595	Trust	Siaya
Ramogi	283	Trust	Siaya
Usenge	63	Trust	Siaya
Oroso	294	Trust	S. Nyanza
Awach Nursery	2	Govt.	S. Nyanza
Aywaya	142	Trust	S. Nyanza
Gembe	1987	Trust	S. Nyanza
Gwasi	12140	Trust	S. Nyanza
Homa	1062	Trust	S. Nyanza
Lambwe	2516	Trust	S. Nyanza
Mikuro	100	Trust	S. Nyanza
Miriu	171	Trust	S. Nyanza
Ranen	150	Trust	S. Nyanza
Wire	392	Trust	S. Nyanza
Chawia	86	Trust	Taita
Choke	74	Trust	Taita
Fighi Ju Mukumu	1000	Trust	Taita
Igno Mkundu	2000	Trust	Taita
Irzi	2891	Trust	Taita
Kalangu	200	Trust	Taita
Kigala	200	Trust	Taita
Kinye Shamvua	51	Trust	Taita
Kitovu	161	Trust	Taita
Latema	100	Trust	Taita
Mng'ambwa	1000	Trust	Taita
Mbaru	200	Trust	Taita
Mbololo Juu	170	Trust	Taita
Mbololo (Mwambirua)	45	Trust	Taita
Mwaganini	36	Trust	Taita

Mwakinambu

APPENDIX IV Contd.

Mwakinambu	1000	Trust	Taita
Mwandongo	1698	Trust	Taita
Ngangao	139	Trust	Taita
Ronge	318	Trust	Taita
Sagalla	70	Trust	Taita
Salaita	100	Trust	Taita
Tana River	340000	Govt./Trust	Tana River
Loima Hills	10000	Trust	Turkana
Kamatira	1910	Trust	West Pokot
Sekerr	8021	Trust	West Pokot

THE RANGELANDS : PASTORALISM AND RANCHING

By

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INTRODUCTION

Kenya is acclaimed for the diversity of its landscape and scenery, and for the accompanying variation in climate. Although the montane areas of high agricultural potential are striking, they are very limited in extent (e.g. National Atlas of Kenya 1970), and most of the country falls into the categories of semi-arid, arid or very arid. For present purposes, Kenya's semi-arid lands are taken to include Eco-climatic zones IV and V, with mean annual rainfalls of 600-1100 mm and less than 600 mm respectively (Pratt and Gwynne, 1977). On the other hand, these zones cannot be regarded in isolation from the more dry sub-humid to semi-arid areas (Zone III) and the very arid zone (VI), and these will be referred to.

The grazing lands of zones IV and V cover 31,417,000 ha. (Chemonics, 1977), falling in 17 districts. Although approximately 60% of Kenya's surface, these rangelands contain only 37% of the national cattle herd, 68% of all goats, 66% of all sheep (Annon, 1979). In 1970, the rangelands contributed 20% of the estimated national output of beef, indicating that their productivity was relatively low. However, by 1975 their contribution had dropped to 13.5%, in the face of greater production from the more populous areas of higher potential (Chemonics 1977). As these latter areas face the greatest problems of their grazing lands being turned over to agriculture, it is not surprising that between 1975 and 1990 the national carrying capacity is predicted to decline by 14%. This will result in a drop in meat output of 21% (Chemonics 1977).

With such trends and a human population increase of 3.5% per annum, it is not surprising that a severe deficit in the supply of meat for the domestic market is forecast by 1990 under present conditions of production and economics. Moreover, Kenya could be a net importer of beef and veal by 1985 (Chemonics 1977). One obvious solution to this predicament would be to utilize more fully the rangeland livestock, either by improving individual productivity or by increasing offtakes. Von Kaufmann (1976) suggested that

if the annual offtake rate could be raised from present levels halfway to those found on developed, commercial ranches, the contribution of the rangelands to the national economy would increase by nearly 70%, and would help to alleviate the predicted meat shortage.

This paper is concerned with the factors and principles affecting animal production under the two extreme conditions of commercial ranching and pastoralism, and also considers their rationales. Kenya has a variety of types of livestock enterprise: company, commercial, co-operative, individual and group ranching, and pastoralism, to name the main ones. While these labels refer to their institutional aspects, their management policies are usually directed either to commercial offtake or to subsistence, or to some combination. The two activities of commercial ranching and pastoralism are not mutually exclusive on one holding, but for the purposes of this paper they will be treated as opposite ends of a spectrum of activities based on livestock.

The strategies of the pastoralist and rancher

In most people's perceptions, the cattle of the rancher look more productive because, to Western eyes, they are more reassuring: compared to those of the pastoralist, they look in better condition and are more uniform in size and colour. Furthermore, the ranches usually carry more grass in neatly fenced paddocks. But, behind these images, there has been little attempt to examine critically the pastoralist's rationale nor to enquire whether commercial ranching is as efficient as we would like to think. Any attempt to do this must also ask whether the same criteria of efficiency can be usefully applied to both systems.

Ranching is a commercial enterprise and the rancher is therefore aiming to maximise production per animal, using fast-growing breeds, to take advantage of the wide differential in prices paid between carcass grades. He is also subject to the slight constraint of trying to maintain a consistent supply of animals through the year. The numbers of head on such ranches stays within fairly close limits, and the emphasis on maximising production of one commodity, meat, results in a characteristic herd structure allowing offtakes of 20-25% per annum. This production policy is aided by heavy capital investment for development (von Kaufmann, 1976). With his emphasis on high productivity in the better-than-average years, the rancher relies on his capital improvements and skilled management to

ensure the survival of his stock through the inevitable drought years.

By contrast, traditional pastoralism is a subsistence activity, and consequently supports up to seven times more people on the same area of land. Ownership of livestock lies in far more hands, and the herd structure and management are geared to the production of several, different resources, some of which can be harvested on a renewable basis (see below). The actual offtake of animals from pastoral herds is unlikely to exceed 10% per annum (S.J. Meadows, pers. comm.), which is far less than from the rancher's herd, but it is important to appreciate that this offtake does not represent the entire production of the herd. Until recently, the sale of pastoralist cattle for cash has been a last resort solution in the face of stock deaths from starvation (Meadows and White, 1979), and at this point the seller receives low prices because of the large supply of similar, poor quality beasts.

Characteristically, the sizes of pastoralist herds fluctuate with wide amplitude according to current conditions, and their management is geared, inter alia, to promoting the rate at which the herds can increase when conditions permit. Unlike the rancher, the pastoralist is not maximising production, and his principle objective is that in the inevitable hard times there should be enough stock to enable his family to survive. The economist would term this a guaranteed minimum return. Allowing the herds to increase as fast as possible is one way of fulfilling this objective, and it will be argued later that it is advantageous to the pastoralist to enter a drought period with large herds of small cattle.

Ecological characteristics of the two strategies

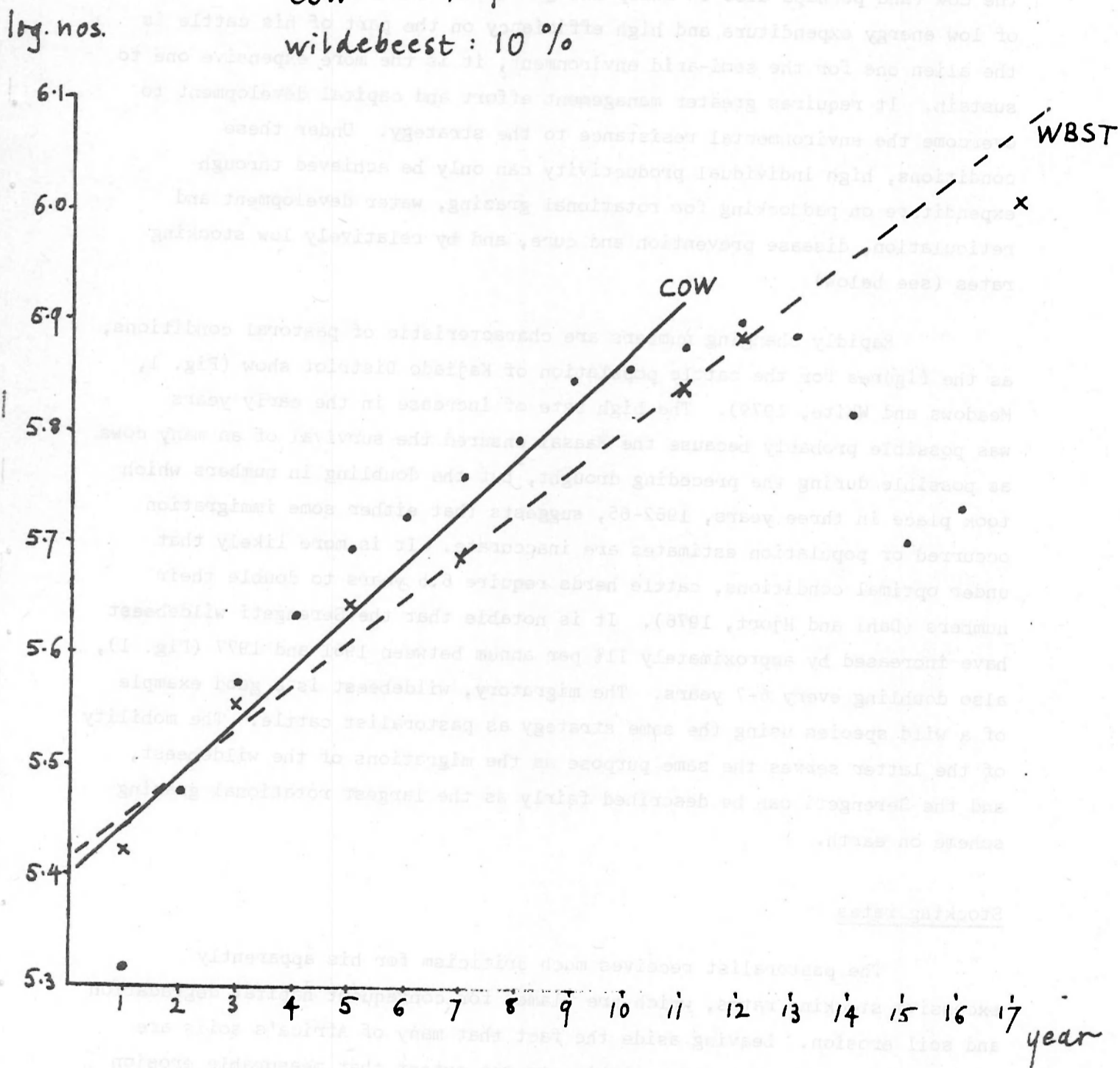
The structure and appearance of the semi-arid rangelands, and the uses to which they can be put, are largely determined by their climate (Pratt and Gwynne, 1977). Of the various aspects of climate, rainfall is the most relevant here because of the general relationship between the amount of rain falling and the quantity of vegetation growth it causes (Potter in press, Cassady 1973). Rainfall in semi-arid areas is noted for (i) its low total in most years, and (ii) its erratic occurrence in terms of time and space, which becomes more extreme in more arid areas.

One consequence of this is that the number of herbivores which can be supported by, or can remove a fixed proportion of the plant production, varies greatly each year. To the ecologist, animals which live in such environments exhibit certain characteristics, in contrast to those occupying

Fig. 1. Rates of increase of cattle in Kajiado District 1962-1973 (o), and Serengeti wildebeest 1961-1977 (x).

cow : 11 % p.a.

wildebeest : 10 %



habitats which are less variable temporally or spatially. Table 1 shows some of these characteristics. Those which are not relevant to domestic animals have been omitted. The sets of contrasts bear considerable resemblance to the strategies and behaviour of the herds of the rancher and pastoralist.

It is of considerable interest that these two extreme strategies should be found alongside in the same habitat, and in the same species, the cow (and perhaps also in sheep and goats). As the rancher's strategy of low energy expenditure and high efficiency on the part of his cattle is the alien one for the semi-arid environment, it is the more expensive one to sustain. It requires greater management effort and capital development to overcome the environmental resistance to the strategy. Under these conditions, high individual productivity can only be achieved through expenditure on paddocking for rotational grazing, water development and reticulation, disease prevention and cure, and by relatively low stocking rates (see below).

Rapidly changing numbers are characteristic of pastoral conditions, as the figures for the cattle population of Kajiado District show (Fig. 1, Meadows and White, 1979). The high rate of increase in the early years was possible probably because the Maasai ensured the survival of as many cows as possible during the preceding drought, but the doubling in numbers which took place in three years, 1962-65, suggests that either some immigration occurred or population estimates are inaccurate. It is more likely that under optimal conditions, cattle herds require 6.5 years to double their numbers (Dahl and Hjort, 1976). It is notable that the Serengeti wildebeest have increased by approximately 11% per annum between 1961 and 1977 (Fig. 1), also doubling every 6-7 years. The migratory, wildebeest is a good example of a wild species using the same strategy as pastoralist cattle. The mobility of the latter serves the same purpose as the migrations of the wildebeest, and the Serengeti can be described fairly as the largest rotational grazing scheme on earth.

Stocking rates

The pastoralist receives much criticism for his apparently excessive stocking rates, which are blamed for consequent habitat degradation and soil erosion. Leaving aside the fact that many of Africa's soils are geologically very young and unstable, to the extent that measurable erosion

rates occur in the absence of livestock (Dunne 1977), the stocking rates commonly found in the two contrasting enterprises are worth examining.

Conventional wisdom states that on the medium-altitude grasslands of Kenya, a stocking rate of one beast per 8-10 acres is maximal, and most ranches stock at about this rate on a year-round basis. Ranchers justify such densities on empirical grounds, that "at the end of the dry season, enough grass is left", using unspecified and subjective criteria. Stocking rates under pastoral conditions are difficult to assess (see below), but are almost always higher than on ranches with the same conditions. They frequently exceed the rates of 4 ha. and 12 ha./livestock unit recommended for Eco-climatic zones IV and V (Pratt and Gwynne, 1977).

More objective support for the rancher's stocking rates is provided by limited experimental work such as that in Uganda on Cymbopogon/Hyparrhemia/Themeda pasture of rather high annual rainfall (average 890 mm.) (Harrington and Pratchett, 1974) in Table 2. On the basis of these stocking rates, the rancher who is concerned with maximum individual growth appreciates that a rate of 2.4 ha/head is best. The other side of the coin appears when the results are expressed in terms of total production per unit area (Table 2). These figures show that the pastoralist who is concerned with total production is correct in stocking more heavily.

There has been enough work on experimentally created pastures to formalise the trade-off between individual gain and production from an area (Jones and Sandland, 1974). However, recent work in Kenya on unimproved native grassland (East African Community, 1975, 1977) shows that over 5 years, including the extremely dry year of 1976, two years of average rainfall, there was no difference in the gain per animal in Zebu paddock the sward was in good condition at the end of the dry season. The mechanism by which the equal gains were obtained is likely to lie with the diversity of grass species in the local pasture. Each species has a characteristic morphology, palatability and nutritive value, which allows enormous scope for selective feeding by animals, enabling them to maintain an even intake of nutrients over the range of stocking densities used.

This result again suggests that the pastoralist is serving his interests well by stocking heavily. One consequence of a high stocking rate, which is often not appreciated by range ecologists, but which is prominent in wildlife ecology, is that herbivores improve the quality or quantity of their own food supply by their own activities (e.g Vesey-Fitz Gerald, 1969, MacNaughton 1976). There is a two way relationship between

herbivores and their food. The impact of different stocking rates of cattle on sward structure and composition can be striking (Harrington and Prachett, 1974), but its relevance to pastoral conditions of heavy stocking is rarely appreciated.

One of the factors associated with the increase of wildebeest in the Serengeti has been the conversion of large areas of medium-long grass woodlands to shorter grasslands by heavy grazing as the growing wildebeest population expands its range. Currently, the 1.4 million wildebeest occupy a total range of 25,000 square km. (Sinclair, 1976), a stocking rate of 2.45 ha/300 kg. animal. For an area in Eco-climatic zone V (Pratt and Gwynne, 1977), this is a high density even when taking no account of the biomass of the other large herbivore species which is about half that of the wildebeest. There are no signs of habitat degradation in the Serengeti, and the carrying capacity is increasing.

In general, the grazing resources of semi-arid rangelands are distributed patchily with respect to both space and time. Consequently, the pattern and intensity of occupation by stock is different from that found on managed swards of limited size. Some range areas may sustain very heavy densities of animals for periods as short as hours or days, and will then be empty for the remainder of the season or year. Other areas may receive a constant level of dry season use each year. Because of the patchiness of resources and the size of the Serengeti or the pastoralists range, it is perhaps inappropriate to speak of stocking rates in terms of ha/head over such large areas. It is certainly very difficult to calculate such figures on a realistic basis. For different portions within a whole ecosystem.

Animal size

Associated with the fact that pastoralists stock their cattle at higher densities than the rancher is the observation that the cattle of the former are smaller. This is often used as a point of criticism by those who are trained to think in terms of maximum growth and size per head. But, division of the total biomass of stock into more small animals instead of fewer large ones is not necessarily a disadvantage (Table 3).

The weight of food required to support an animal is not directly proportional to its weight, but to some exponent of it, commonly taken as 0.75 and known as the metabolic weight. This means that a small animal requires proportionately more food than a larger one. Thus, if a total

biomass of 5000 kg. is apportioned either as 20 pastoralist's cows, each weighing 250 kg, or 14.3 rancher's cow, each weighing 350 kg, the pastoralist's herd will need approximately 9% more food. This might appear disadvantageous but, on the other hand, this herd contains 40% more mouths to search for this extra amount of food. Under drought conditions, when food is scarce (see below), the pastoralist's 5000 kg of cattle can cover and search the sward far more efficiently than can a herd of fewer, larger animals. This increase in efficiency more than offsets the greater total food requirement. As the same argument holds when comparing the merits of cattle and small stock, it can be seen why the pastoralist aims to have high densities of relatively small animals.

When the quantity of food is further reduced, as in a drought, there are further advantages in having more small animals: consider the same herds of the pastoralist and rancher. If the total amount of food available to the herd above daily decreases by 40 kg. per day, this decrease represents a reduction in intake of only 31.7% for each pastoralist cow, but a 34.5% reduction for each ranch cow. Under extreme arid conditions, the greater drop in the intake of the latter might result in death, while the pastoralist's cows only lose weight, to which indigenous breeds are adapted (below).

Herd management under arid conditions

Both the rancher and pastoralist are concerned that as many of their animals as possible should survive each dry season or drought. But whereas the rancher takes any losses as an affront to his management, to the pastoralist some death is inevitable, and, indeed, it is a normal part of his strategy. Management strategies by both groups are designed to take advantage of the behaviour and physiological adaptations of the livestock for survival. But in doing this, the rancher is severely constrained by virtue of having access for his animals to a smaller area, which is subdivided by fencing, and by a rigid herd management system which does not permit division into smaller units, nor the mixing of different sex/age combinations. This should be apparent from consideration of first the management practices of the Maasai, and then a description of the physiological processes on which these are based. The strategies of herd management in dry conditions are based largely on the work of Western (1973, 1979).

1. The pastoralists herds are highly mobile in their search for vegetation in greater quantity or of higher quality, resulting in effective, free-form rotational grazing.

2. As conditions become drier, the herd size decreases so that the total range is covered more thoroughly, and the forage required for the livestock is extracted more efficiently. The upper limit to this process is set by the labour available for herding.
3. The pattern of range use is stratified with respect to different classes of livestock. Thus, with cattle, an area around the boma is reserved for use by the calves, while the next outer zone is used by milking cows, whilst the adult males walk furthest to the feeding areas.
4. As grazing areas and watering points become scarce and further separated, a greater proportion of the day is spent in trekking. In order to leave adequate time for feeding, the times of departure from the boma in the morning and return in the evening are progressively advanced and pushed back. In addition, the stock are watered less frequently, to reduce the time spent trekking to water without feeding (see below).

Breed selection and diversity

Domestic livestock are known to have been in Africa for at least 5000 years (Payne, 1969), and the Zebu cow has occupied the present pastoral areas of East Africa for almost as long (Phillipson 1977). Over this period of time, the severe selective pressures caused by the extremes of climatic in semi-arid regions have produced breeds adapted to these conditions. In line with the pastoralists' strategy of reducing his risk of drought loss by keeping many, small animals, his livestock have been selected for their survivability under extreme conditions. Their ability to recover when droughts break is at a premium compared to their ability to grow at high rates under best range conditions. It is, of course, the latter which is the rancher's objective, and it often lies behind attempts at breed improvement by crossing with exotic strains, which have been developed for maximum yield under temperate conditions. The inability of pure exotic breeds to withstand extremes of heat and aridity can be striking (Robertshaw and Gwynne, unpublished results). It is important to note that crossing indigenous cattle with exotic breeds may result in the destruction of the gene complexes which confer their greater survivability. This is particularly important in view of the increasing use of Sahiwal and Brahman bulls in pastoral areas; the performance of such cross-breeds requires evaluation under range conditions. Under normal conditions, the quantity of food required to maintain a Boran animal (Bos indicus) is significantly less than that required for either a Hereford (B. taurus) or a crossbreed (Ledger, Rogerson and Freeman, 1970).

The pastoralists' herds usually contain a mixture of species - cattle, sheep, goats and donkeys, and in the more arid areas, camels. As each has its characteristic feeding habits (Gwynne 1977), the wider spectrum of herbivores makes more efficient use of the resources of the area, and diversification adds significantly to the area's animal productivity (McKay 1968).

The pastoralist is able to obtain a variety of consumable products from his several species, in addition to their other functions as cash reserves, beasts of burden etc. Each product has its own characteristics, making it most suitable or abundant under certain conditions (Table 4).

The physiological adaptations of cattle to drought

As conditions become drier, cattle are able to ameliorate their impact by physiological and behavioral adaptations. These functional responses are analogous to those which occur first when good conditions return after rain, namely, greater intakes of better quality food and improvement in body condition. They are followed after a time - lag by the numerical response of an increase in numbers. In times of drought these responses start to operate to prevent or delay numerical decline, and are the basis for the changes in management described above.

The most important responses are shown in Table 5 in which drought conditions are summarised as:

- 1) Sparser food of lower quality
- 2) Scarcer water
- 3) Higher ambient temperatures

It is apparent that the many adaptations and adjustments are evoked by the onset of dry conditions, and it is important to appreciate that they represent a coordinated and interdependent solution to such conditions. In addition, there are two important adaptations which are not conveniently included in Table 5.

- 1) Under experimental conditions of simulated drought, the quantity of food required to maintain Zebu steers at constant weight can be reduced progressively. Ledger and Sayers (1977) found that for Boran steers of 185 kg liveweight, the daily food intake over a period of 3 - 24 weeks could be progressively reduced by 52% without any reduction in weight. This was achieved by an increase in the efficiency of energy utilization. Further

work (Finch, unpublished) has shown that under simulated drought conditions, Boran cattle can lower their fasting metabolic rate. This means that a smaller fraction of their food intake is used on the essential life-maintaining processes, and a greater proportion can be directed for productive purposes or for the prevention of weight loss.

2) If conditions are extreme, weight loss may be unavoidable, but, again, a Boran animal can lose upto 30% of its body weight and yet recover fully and quickly when conditions improve. Its powers of compensatory growth are such that unless the animal receives a severe set-back at the critical age of 12-15 months, the period of maximum skeletal growth, there is no long term effect of stunting or impairment of carcass quality.

Within the opportunist production strategy of the pastoralist with its guarantee of available food in the dry season, it is advantageous to have many, small cattle with labile bodyweights. Under drought conditions, the total biomass- and hence food requirement - is reduced, but without reduction in the number of individuals constituting this biomass. This promotes the rate at which the herd can increase when better conditions return, and is the antithesis of the strategy of the rancher who aims to sustain a few large beasts through the drought with a minimum of weight loss. This difference is considered further below. It is also important to realise that under the developed conditions of a commercial ranch, the cattle have far less scope for utilising their natural, functional responses to arid conditions, because they are confined to paddocks with unlimited water available. Ranch management has to play the role of maintaining conditions such that these functional responses are rarely called upon, and one of the easiest ways of doing this to have lower stocking rates, resulting in larger reserves of forage through drought periods. But, as has been mentioned already, this strategy does not optimise production per unit area.

Management responses to extreme drought

Periodically, severe drought occurs, during which the functional responses of the livestock and their managers' efforts are no longer able to avert death. Although drought conditions are usually widespread, one response on the part of the pastoralist is to move in to the new areas, either by occupying habitats which previously were sub-optimal because of their greater risk of disease or predation (Western, 1979), or by emigrating to take advantage of better range conditions or new food resources. Cash sales of cattle increase, but the pastoralist finds himself in the

predicament of supplying poor quality beasts at depressed prices because of the abundant supply. Coincidentally, purchases of food increase (Campbell, 1978) and increasing use is made of other resources, such as wildlife (Western, 1979). Also, under such conditions there is an increasing calling in of social obligations from distant relatives or friends (e.g. Swift, 1975). Between 1972 and 1976, the Kajiado Maasai divided their herds amongst relatives to reduce the chances of total loss of their stock (Campbell, 1978). These arrangements can be very complex, and contribute significantly to mitigating the effect of drought on human populations.

Destocking by sale is avoided by the pastoralist for as long as possible because of its adverse effect on the ability of his herd to increase rapidly when conditions improve. At this point, there are usually few cattle to be bought, and little cash for purchasing. This effect was apparent in the slow build-up of cattle numbers in the Athi plains following the 1973-74 drought (J.C. Hillman, pers. comm.).

The response of the rancher to extreme conditions is similar in many respects. He is usually more able to support his cattle on the ranch by buying and bringing in feed, either hay or, under more extreme conditions, combinations, such as chopped sisal, urea and molasses. Like the pastoralist, the rancher prefers to destock through emigration, first, rather than through sale, and in the 1973 drought there were instance of ranch cattle being railed from Nairobi to the coast, which was less affected by drought. Again, the pastoralist would be unlikely to raise the cash for such a movement. Compared to the pastoralist, the rancher has two further reasons for being more reluctant to sell his stock.

- 1) When conditions improve, the rancher also has the problem of building up his herd, but with the additional problem that he is unlikely to be able to replace any improved or partly - exotic lines with similar animals. Therefore, his herd, whose individual animals have a greater financial value than those of the pastoralist, must be kept alive through drought as a breeding stock.
- 2) The rancher has the luxury of financial arrangements such as cash reserves or bank overdrafts, which are largely drought-resistant. This means that the personal survival of the rancher and the few employees which this form of enterprise supports, is not at stake. This is obviously not true of the pastoralist and his many dependents.

Extensive ranching or commercial pastoralism

In all of what has been said before, commercial ranching and pastoralism have been represented as fundamentally different strategies with different aims. They are of course, only at different ends of a continuum of management systems, which can be found in Kenya today. As it is Government policy to extend the areas of commercial ranching, it seems that the area available for traditional pastoralism will decrease. Yet, as shown above, this system is a logical solution to the problem of exploiting these areas, and one wonders if some of its features could not be incorporated usefully in to new commercial ranching ventures. Since 1968 there has been in operation one enterprise with a management philosophy combining both elements, which might be called extensive commercial ranching or commercial pastoralism.

The Galana Ranch occupies the dry hinterland of Kilifi and Tana River districts, and lies in EcoZone V with a small portion in EcoZone IV. Some 175,000 ha are used regularly by cattle, and of these about 105,000 ha are "developed", in the sense of being within daily walking distance of water for cattle. The latter areas are used in the dry season, on average 8 months each year, equivalent to an approximate stocking rate of 1 head/5 ha. While natural surface water lasts the herds move around the undeveloped areas using the areas of best grazing, as would pastoralists' herds, at stocking rates as high as 1 head/3.5 ha. There is no fencing on the ranch.

The cattle are all pure Boran Zebu, with a programme of upgrading recently started to develop an animal for local conditions through creation of a stud herd of grade bulls and cows. Cattle performance is improved by constant culling of cows on the criterion of intercalf interval. The cattle are organized in to breeding and steer herds, and are further divided on the basis of age, as on a commercial ranch. Despite the highly seasonal rainfall, the cows are in good enough condition to show very little seasonality in breeding. Herd management and movements are achieved through a strong, hierarchical management of cattle manager - assistants - headmen - herder responsible for one herd - assistant herders.

To prevent scattering and mixing of herds and to reduce the risk of predation, the cattle are brought back to a camp each night, but are not enclosed in a boma. By day, each herd forages under the supervision of a herder. The mobility necessary to use the resources of such a large area efficiently is obtained by efficient management and organisation and the

employment of single, young men from pastoral tribes as herders. Management also involves a strict programme of disease control, either by spraying against ticks or through prevention of specific diseases such as Contagious Bovine pleuro-pneumonia or trypanosomiasis.

On the Galana Ranch, the main limitations to production under pastoral conditions of water shortage and disease (Western 1979) have been eliminated, although losses through predation remain. As no supplementary feeding is practiced, no finishing of carcasses is possible to benefit from the higher prices paid by the Kenya Meat Commission for the higher quality grades. However, high turnovers are obtained, with a current annual offtake of about 20% from the balanced herd. This turnover is augmented each year by a variable amount through the sale of trading steers. These are bought from pastoralists further north, and grown on until marketable. With them, the turnover rate has reached 25% of the total herds. This is in marked contrast to the offtake of about 10% from group ranches in Kajiado (S.J. Meadows pers. comm.) which are supposed to represent a form of "improved pastoralism".

It is notable, though, that the herd structure on the Galana Ranch, from which an annual offtake of 20% is possible is very similar to that across all the group ranches involved in Phase 1 of the Livestock Development Project in Kajiado (J.M. White, pers. comm.):

	% Cows	% Heifers	% Bulls + Steers	% Calves
Galana Ranch	43.1	15.2	21.4	20.3
Group ranches	40.6	24.5	23.4	11.5

The social benefits of the Galana Ranch are also substantial. About two hundred people from pastoralist tribes are employed as herders in a dual subsistence/cash economy, through provision of two milking cows for each man and a cash wage. As administrative staff, and to maintain the ranch's equipment and installations, a further 60 people are employed as clerks, drivers, pump attendants, labourers etc. At any one time there would be a further 60 wives and children temporarily on the ranch.

Future rangeland development and trends

While not every rangeland area is suitable to an enterprise along the lines of the Galana Ranch, there may be good reasons for trying to improve the existing pastoral system, rather than replacing it totally with a commercial ranching system, which may have developed under different climatic, economic or social conditions. In most attempts or

projects to improve rangeland production, the emphasis is on encouraging the pastoralist to sell more cattle on a sustained basis, and on improving the productivity of individual animals. To achieve the latter by introducing exotic strains may be a short term solution, until the full potential of local, indigenous breeds is fully appreciated. This requires further research.

The increase of animal productivity by means of rangeland improvement is an obvious possibility, but with the exception of the ecologically successful, but short-lived, grazing blocks at Baringo and West Pokot (Pratt and Gwynne, 1976) little attention or research effort has been directed towards this. The aim should be to improve the level of dry-season nutrition to prolong the period of animal growth. Two approaches might be tried.

1) The provision of dry season dietary supplements. The lopping of trees to supply goats with a diet of higher protein content is well known, as, for example, at Baringo (Pratt and Gwynne, 1977) but is of no use for cattle. On much of Kenya's rangelands, unlike in areas further south or west, there is little bush cover for cows to eat. Under these circumstances, pastoralists might be induced to sow leguminous herbs, noted for their high nitrogen content, near their bomas or at lower densities through the grass-land nearby. Small additions of highly nutritious supplements can improve the digestive efficiency of a ruminant to an extent far out of proportion to the actual nutritive value of the supplement. This principle is used in the feeding of urea supplements, in which the nitrogen released stimulates the growth and activity of the rumen flora, resulting in greater digestion of the rest of the low quality diet. One cautionary note is necessary though: it is technically feasible to grow and make rangeland silage out of sorghum, but it is difficult to persuade cattle to eat it in dry conditions (H.L. Potter, pers. comm.). The latter observation may be due to the fact that the silage is so rich that its digestion would require reversing some of the animal's slowly acquired adaptations to a diet of low quality, so that if these conditions are continuing, the animal is better off by not eating the silage.

2) The same effect of providing a small, high-quality supplement may be achieved practically by altering sward composition by an application of fertilizer, principally containing nitrogen (H.L. Potter, pers. comm.). Trials have shown that one year after a single heavy application, a Themeda triandra sward can be converted to one dominated by Cynodon dactylon. The latter is a low, creeping species, and has a higher nutritive value than Themeda. The mechanisms of this change seems to be that the fertiliser removes some factor limiting the growth of the Cynodon plants or seeds

already present in low numbers. When grown they are more deep-rooted than the Themeda, which is then out-competed. Although it takes only one year for the improved sward to develop, it seems that reversion to Themeda takes five years. Thus, despite a fairly high initial cost of fertilizing, the recurrent costs and level of management required are not great. Pasture improvement on this scale by such methods promises to be an effective and cheap way of growing supplements on an individual boma basis.

The most suitable areas for such efforts at growing supplementary feeds are the higher potential portions of the semi-arid zones, yet in Kenya it is here that most land is being lost to the pastoralist through encroaching agriculture (Campbell, 1979). So far, these new farmers are concerned with growing crops for human consumption, and there are no inter-tribal arrangements by which cattle graze on crop-residues in the fields in the dry season. Such arrangements are common in the West African Sahel (e.g. Horowitz, 1975).

The long-term viability and wisdom of growing crops at the edges of Kenya's rangelands is far from certain. Farmers are easily impressed by the size of yields which new seed varieties for arid lands can produce in good years. As with all advertising, the farmer is not told what the new varieties will yield if there is no rain, or its distribution is inadequate. In many cases, the farmer harvests nothing and faces starvation because his strategy is not geared to ensuring he has a guaranteed minimum yield under drought condition, which is in marked contrast to the pastoralist's strategy (see above). This is relevant to the argument that because more people are supported per unit of land by farming than pastoralism, farming is the "better" form of land use in a country with enormous pressure on land. Over a period of years, there is no doubt that the farmer will face starvation more often through crop failure than the pastoralist will through reduction of his herd below a minimum level. The apparent waste as hundreds of cattle die may seem a weakness of the pastoralist system, but it is an inevitable part of trying to ensure that enough animals remain for maintenance purposes during drought. In this situation, pastoralism is more viable in the long term than farming at the margins of the rangelands. On the other hand, the viability of farming could be increased through selection of more suitable crops. Generally, in the years when conditions allow a harvest of seed crops for human consumption, the pastoralist will also enjoy good dry season conditions. But if multipurpose crops were planted, there would remain a supply of fodder to be traded or sold for the pastoralists' cattle in those years when a harvests of the primary seed or fruit products failed. If an

area's potential for primary production can be directed into a wider range of species and activities a more flexible response in the face of adverse conditions is possible. This is a good reason for diversifying and improving rangeland agriculture.

The other critical issue in rangeland development is Government policy on which groups are to benefit from development in these areas. Currently, the large and concentrated populations in Kenya's towns depend on the extensive and peripheral rangelands for their meat supply. The supply is not guaranteed because meat for sale is not the primary objective of the pastoral livestock industry. In addition the current pricing policy discourages the pastoralist from producing a steady supply, although the town-dweller expects to enjoy meat at low and controlled prices.

Although the populations of the agricultural areas are growing faster, the pastoralist peoples are probably increasing at 2.0 - 2.5% per annum. As the carrying capacity of the rangelands is not increasing at this rate (disregarding year-to-year fluctuations due to rainfall variation), a smaller proportion of the total pastoral population can be supported in these area each year.

Over the last four years, this socio-economic effect has been apparent in several ways:

- i) pastoralists have diversified into small-scale farming (Campbell, 1978)
- ii) many people have left their traditional, rangeland homes to seek employment in towns as, for example, security guards
- iii) more cattle are being sold from pastoral herds (Meadows and White, 1979)

Some of these changes were responses to the drought conditions of the early to mid 1970's, but not all, in particular the greater offtakes, can be ascribed to this.

A paradox exists whereby Government wishes to encourage greater off-takes from pastoral herds, and is promoting ranch development to this end, while the prices received are no stimulus to the producer to do so. If controlled meat prices were increased considerably for the consumer, a better supply would follow. Moreover, if many of the necessary livestock-related industries could be located in the pastoral areas, as Campbell (1979) has suggested, the greater rural employment opportunities would encourage many

potential emigrants to stay in these areas. Development along these lines would reduce the intense centralisation of Kenya's industrial enterprises (Ojany and Ogendo, 1973), and promote development of the natural resources of the semi-arid lands, while improving the welfare of their peoples.

CONCLUSIONS

It is hoped that this paper has identified the major differences between the goals and strategies of the commercial rancher and pastoralist in exploiting semi-arid lands with their patchy resources. While each has its own aims, the management system of the rancher is alien to this environment and is capitally expensive to maintain as a result. It should be apparent that the pastoralist takes more advantage of the physiological flexibility and adaptability of his stock. It would be an enormous loss if this was swept away to be replaced in toto by commercial management methods in the pursuance of greater meat production. Such a solution is put forward quite often, but it is reassuring that the Government of Kenya's Arid and Semi-Arid Lands Programme recognises the need for careful improvement of traditional ways of management as a means of increasing rangeland productivity (Anon 1979).

Many of the physiological adaptations to arid conditions by indigenous livestock have only been investigated in the laboratory. Their importance and relative significance under field conditions of drought have often never been investigated, and more, practical research is required. At the same time, more effort should be devoted to research programmes of range improvement, especially in the cultivation of range-grown supplements. It has been pointed out (Peberdy, 1970) that in Kenya the livestock and crop industries are not integrated, and that the greatest improvements in meat production will depend heavily on the development of fodder crops.

There is an urgent need in Kenya for the application of rational planning to zone the rangelands according to the uses to which they can be put. Loss of the higher potential rangeland areas to cultivators at a time when Kenya's self-sufficiency in meat is ending hardly seems in the national interest. But, such problems require careful investigation, and with new, sophisticated techniques for risk analysis (Simpson, Gunawardena and Wynne, 1977) and drought prediction for long-term planning (Wallen and Gwynne, 1978), rational solutions should be possible.

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Table 1. Key characteristics of animal populations occupying habitats of opposite extremes

<u>Habitat</u>	stable	fluctuating, of temporary nature or patchy in space
<u>Strategy</u>	low energy expenditure high efficiency	high energy expenditure low efficiency
<u>Animal Characteristics</u>	<ol style="list-style-type: none"> 1. population maintained at equilibrium level 2. evolutionary pressure for population to remain close to carrying capacity, and not above 3. selection for large size 4. high competitive ability for resources 	<p>population levels fluctuate widely; mortality rates may be high</p> <p>opportunistic strategy of 'boom or bust' in face of fluctuating carrying capacity.</p> <p>typically small in size</p> <p>no great competitive ability</p> <p>high fecundity, short generation time</p> <p>migration common</p>

Source: from Southwood (1976)

Table 2. The effects of stocking rate on average weight gain per head and per hectare, over 6 years.

Stocking rate ha/head	average weight gain kg/head	average weight gain kg/ha
2.4	136	57
1.2	106	88
0.6	71	118

Source: Own Compilations

Table 3. A model to show the consequences of having small or large cows in herds of equal, total biomass

total biomass of herd = 5000 kg.		
Herd	PASTORALIST	RANCHER
Average weight kg/head, W	250	350
No. in herd	20	14.3
Daily food requirement, g/W ^{0.75}	100	100
Metabolic weight per head, W ^{0.75} kg.	62.87	80.91
Daily food per head, kg.	6.287	8.091
Daily food for herd, kg.	125.74	115.70
Ratio of food for herd	1.09	1.00
Ratio of number of heads per herd	1.40	1.00

Source: Own Compilations

Table 4. The pastoralist's products and their characteristic features.

Product	dependability of supply in drought	cost of production	other features
meat	good	high	non-renewable or an individual basis
blood	good	medium	renewable, but offtake limited in frequency.
milk	poor	low	renewable, and harvestable dairy. But, yield sensitive to nutrition and must be shared with off spring.

Source: Own Compilations

Table 5. Simplified scheme of the physiological responses of cattle to drought conditions.

	Condition	Response	Results	Results
1. <u>Sward</u>	Less grass	diet selectivity decreases (a)	→	less reduction in dry matter intake
		increase grazing time (b)	→	greater intake
	lower quality	eat more browse (c)	→	higher protein content diet
		increase bite rate (d)	→	greater selection for more nutritious parts of grasses
		herd progression rate increases (e)	→	greater volume of sward inspected
			→	rumen morphology and physiology adapt to low quality roughage diet
2. <u>Water</u>	scattered	less frequent watering	→	reduction in energy expended on watering
			→	better coverage of range by herds (f)
	limited in quantity	restricted intake	→	loss of appetite (g) lower dry matter intake
			→	slight dehydration } nearly const- improved digestive } efficiency (h,i) } nutrient intake
			→	reduction of water loss by:- drier faeces (j) more concentrated urine more shade-seeking (k)
more "polluted"	coincidental intake of nitrogenous compounds (l)	→	activation of rumen flora increased digestive efficiency	
3. <u>Higher ambient temperatures</u>	greater likelihood of heat stress	deep body temperature rises	}	more shade seeking
		increased cooling heed		→

Table 5. - continued

References:

- (a) Hamilton et al. (1973)
- (b) Allden and Whittaker (1970)
- (c) Stobbs (1974)
- (d) de Leeuw (1979)
- (e) Western (unpub. obs.)
- (f) Western (1975)
- (g) Phillips (1960)
- (h) Rogerson (1963)
- (i) French (1956)
- (j) Stanley Price (unpub. obs.)
- (k) Lewis (1978)
- (l) Weir (1971)
- (m) Western (1973)
- (n) Robertshaw and Finch (1976)

FORAGE FOR LIVESTOCK PRODUCTION IN SEMI ARID
AREAS OF KENYA

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INTRODUCTION:

Many people in this country are aware of some problems pertaining to the semi arid areas of Kenya even though these problems may appear different for different people. The tourist promoter may be concerned that the wild game is in imminent danger of elimination by poachers: the grazier may be concerned that the cultivators are encroaching too much on certain wetter areas which normally provide him with dry season grazing: an enlightened farmer in the area may be worried that deforestation for charcoal purposes may be causing shortage of rain for his crops. Even for us scientists we may be tempted to think of the problems in relation to our own disciplines. The enthusiastic agronomist may see dry farming as the only solution for the semi-arid areas forgetting that there could be better uses for the same land resource. The range ecologist on the other hand may wish to see marginal areas protected from any cultivators even though he may see inevitable settlement by cultivators who are already trying to derive livelihood from arable cropping. It is my hope that during the discussion of my paper you will point out to me any areas where you think I have overemphasised livestock production without due regard for the other activities.

In Kenya today people have migrated and started cultivating in dry areas which, it is feared, are unsuitable for agriculture (Campbell, 1977; Pratt and Gwyne, 1977). As this is a challenge to the old concept that agriculture could only be practised in high and medium potential areas, attempts are being made to try and re-define the environmental limits, within marginal areas, below which agriculture should not be carried out (Woodhead, 1970; Braun, 1974 and van Eijnatten, 1976). It is not the purpose of this paper to try and define such limits but it is true to say here that most of the areas with 500 to 750mm annual rainfall and lying between the altitudes 1000m and 1500m coincide with the problem areas where expansion of

hazardous farming is already in progress (van Eijnatten, 1976). It is vital that urgent measures must be taken to develop viable farming techniques for these areas in order to prevent irreparable damage occurring to the potential for further agricultural productivity of the area. It should at the same time be understood that owing to the vagaries of climate, any development programmes for the semi-arid areas are made on compulsion rather than for economic reasons. The exploitation of these areas, for agricultural production must therefore be made with due caution to avoid any damage to the land resource.

The agricultural communities found in most semi-arid areas of Kenya have great attachment to livestock and any dry farming programmes must include livestock production. Livestock provides important animal proteins in diets of local families and it would be costly to rely on either meat or milk supplied from other parts of the country. Livestock is also required for social purposes such as the payment of bride price. More importantly livestock plays a very significant role in encouraging a stable mixed farming system through fertility maintenance on the farm and other advantages which are discussed further below. It is emphasised here, however, that with the increasing human population pressure and the consequent reduction in farm size, extensive livestock grazing cannot be sustained, livestock must form part of an integrated crop and livestock production system whereby each section tries to derive from each other as many benefits as possible.

The Importance of livestock in small scale farms whose emphasis is on cropping

As indicated above, mixed farming tends to promote stationary agriculture in contrast with shifting cultivation systems. Through livestock, viable rotations of crops and pastures can be established on a farm. The grazing animal on a pasture through the accelerated nutrient recycling via dung and urine tends to have a multiplier effect on pasture growth and organic matter accumulation in the soil. The end result is increased rate of soil fertility build up and increased livestock production from the farm. Where stall feeding is preferred, still large quantities of boma manure accumulates and this can be used to bring fertile areas of the farm into arable phase. Unfortunately no work in this country has so far been carried out to assess actual benefits of grazed pastures towards maintenance of soil fertility under semi-arid situations.

For most small scale farms in semi-arid areas it is possible to integrate crop and livestock production without the necessity for well developed pastures. Often the emphasis on these farms is on cropping but livestock can thrive on crop residues such as stubbles and maize stover supplemented with rough grazing and sometimes with planted fodders. At times of crop failures due to rainfall shortage, livestock can graze any such crops which fail to develop instead of them being wasted.

Livestock in addition to their use as protein food can also be useful for energy supply on a farm. The use of a dual purpose dairy animal for draught power in semi-arid areas has already been proposed by the Kenya Marginal Lands Pre-Investment Project.

Problems of Livestock Production in Semi-Arid Areas

While diseases and poor animal quality are recognized as important limitations to livestock production in semi-arid areas, the most important single factor crippling livestock production in these areas is poor nutrition especially during the long dry seasons which characterise the semi-arid areas.

Grass growth follows very closely the rainfall pattern in the semi-arid areas. Except in the semi-arid areas found West of the Rift Valley where rainfall pattern is unimodal, most of the marginal areas of Kenya which are found east of the Rift Valley receive a bimodal pattern of rainfall with the two peaks occurring in April and November for the long short rains respectively. The long rains supposedly last from March to May while short rains begin in mid October and continue up to December. In Eastern Province the short rains are more reliable than the long rains but for both seasons the rains are notoriously erratic in quantity, distribution and intensity.

The natural grasses found in the semi-arid areas establish very fast with the onset of the rains and by the time the rains stop, these grasses have flowered and set seed. So that in six to eight weeks most grasses will have completed their reproduction cycle and started senescing or going dormant until the next season. This fast growth and development of these grasses is normally accompanied by rapid deposition of lignin on plant tissues making them difficult to digest by grazing ruminants. Karue (1974) found that most grasses in semi-arid areas are deficient in protein and carbohydrates throughout the year. Perhaps livestock in these areas are dependent for their maintenance and growth requirements on their ability to

selectively graze the natural grasslands. Thus natural grazing in semi-arid areas is deficient in quantity and quality not only during the long intervening dry spells but also during the wet periods. Therefore for any meaningful livestock production in these areas other sources of forage must be sought.

Management problems also place severe limitations to livestock production in semi-arid areas. The communal ownership of land and often the lack of fences even where individual land ownership exists, make it impossible to control overgrazing which causes the degradation of grazing lands. It is necessary to institute the concept of grazing rights in extensive grazing areas and to encourage fencing and provision of adequate watering points if the overgrazing problem has to be surmounted. If these responsibilities are shouldered first then it might be easier to persuade livestock owners to accept reducing their stock numbers where overstocking is obvious.

Possibilities for Increasing Forage Availability

While carrying out a survey to identify pasture research priorities in semi-arid areas of Eastern Province, Rossiter and Ndegwa (1974) observed that for any development in livestock production in that area, certain principles must be borne in mind. Firstly, in all aspects of cropping whether for food and cash crops or for forage crops, moisture conservation and utilization to the fullest extent must take priority. The use of cross-tied contoured ridges on arable land should always be encouraged. Agronomic practices such as wide spacing of crop plants to economise the use of soil moisture and frequent wet season growth should whenever possible be adhered to.

The second principle which ought to be borne in mind is the question of costs. On most small scale farms it would be difficult to justify any large scale input on capital investment. Farmers will continue to rely on manpower and sometimes on animal traction although this raises the question of maintenance of the draught animal. Therefore in planning for development of small scale farms in semi-arid areas care must be taken to maintain production costs as low as possible.

The third principle advocated for is the necessity for cooperative development in livestock programmes. Although this cannot be successful where farms are small and intensive, it can be very convenient and cheaper with respect to capital investment such as water supply and fencing among

larger holdings. The organization could be similar to 'Group Farms' where people contribute animals but they also retain individual rights to the animals.

1. Establishment of Improved Pastures

It has already been pointed out that natural grasslands cannot provide enough quantity and quality of grazing for any serious livestock system. One of the alternatives to natural grazing would be to plant a pasture consisting of well chosen grass species and if possible grass and legume species combination. The qualities necessary for sown pasture species in semi-arid areas should be, drought resistance, fast establishment, persistence, good seeding and, for legumes, good nitrogen fixation. Unfortunately most of the available species are not strong in these characteristics and there is great need for more selection and breeding of local material together with introduction of new cultivars from other regions.

Among the grasses available, probably rhodes grass (Chloris gayana) especially cv. Masaba is the best particularly in wetter parts of the semi-arid areas. Buffel grass (Cenchrus ciliaris) which is considered the most drought resistant of all grasses cultivated in Kenya (Bogdan, 1965) is another possibility. The seed for this grass is not readily available and it is a difficult grass to establish although once established it persists well. Guinea grass (Panicum maximum) cv. Mackinnon Road is another grass which should be tried. Very little agronomic evaluation of these and many other species has been done and it should be initiated as a matter of urgency for semi-arid areas. Commercial interest is also important for the sake of seed production and marketing to farming areas.

Legumes are useful when planted in mixture with grasses. They make the herbage richer in protein and fix atmospheric nitrogen through their symbiotic association with Rhizobium bacteria and the so fixed nitrogen gets transferred to the companion grasses. The most suitable pasture legumes for the marginal areas would be those which are perennial and capable of growing or remaining green during the dry season when the quality of grazing from grasses drops badly. For Kenya, such legumes have not been found except for Glycine wightii which has some promise for marginal areas. Glycine is drought resistant, remains green in the dry season and mixes well with the majority of pasture grasses including Chloris gayana, Panicum maximum and Cenchrus ciliaris (Bogdan, 1977). Otherwise because of the long dry spells found in semi-arid areas, it is difficult to obtain adapted perennial legumes.

It appears that an alternative might be to try some annual legumes. These would have to be capable of self regeneration through seed so as to last throughout the duration of the pasture. Townsville lucerne (Stylosanthes humilia) is one possibility for the marginal areas. Although it is an annual completing its life cycle very quickly during the wet season, it leaves many protein-rich pods which are readily eaten by cattle. Some of the seeds eaten through the pods pass through the animal's gut intact and viable thus becoming available for regeneration in the following season. Emphasis in the past has been on perennial pasture legumes which are proving to be unadapted and now annual legumes should be tried using both local and exotic material.

2. Fodder Crops

A fodder crop is any forage or root crop which is grown under arable conditions for a special purpose which is often to provide feed when pasture grazing is inadequate. Because fodder crops are given the same care as arable crops and also because they do not necessarily have to withstand the same grazing requirements as perennial pastures, they tend to give higher dry matter yields compared with normal pastures. They can also be selected for special qualities depending on the use to which they are designed. For instance in addition to high dry matter yield requirement, forage sorghums are selected for high sugar, low fibre and high protein contents which are all necessary for the making of good quality silage. For the semi-arid areas fodder crops are required to supplement pasture grazing mainly during the dry months. Alternatively they could be high yielders of dry matter which can be conserved either as hay or silage during the wet seasons and be used in the dry season.

A few annual and perennial fodder grasses are recommended for use in semi-arid areas but these do not possess sufficient drought resistance and require further improvement in this aspect by breeding and selection. Among the annual grasses Sudan grass (Sorghum sudanense) seems to be the most drought resistant fodder which yields reasonable quantities of forage during wet seasons and recovers quickly after cutting or grazing to give one or more aftermaths for dry season grazing.

Perennial fodder grasses are more preferable to annual grasses because of their advantage of lower cultivation costs as they need to be planted and ploughed less often than annual grasses. Perennial grasses can also make

immediate use of out-of-season rains which often occur in semi-arid areas. Two commonly grown perennial grasses in semi-arid areas are Napier grass (*Pennisetum purpureum*) and Bane grass (*Pennisetum purpureum* x *P. typhoides*). Owing to their deep rooting characteristic rather than drought resistance these grasses are capable of surviving through dry seasons. Moisture conserving practices such as wide spacing and ridging can extend the growth of these grasses into the dry season. The biggest problem with these grasses however is their inability to establish fast before rains stop. Better establishment is achieved through the use of root splits instead of stem cuttings. Bane grass is normally considered to be superior to Napier grass in drought resistance but experience at Katumani in 1975 and 1976 (Authors unpublished data) did not show any clear cut differences in dry matter yield over the dry seasons. However, Bane grass had superior herbage characteristics such as good tillering ability, higher leaf/stem ratio and better invitro digestibility.

There is a general lack of annual fodder legumes which can be grown either alone or in mixtures with grasses and used for conservation or for dry season green feed. It is very important that annual fodder legumes should be sought because they could become useful in increasing protein content and voluntary intake of dry season stand-over grazing.

Fodder trees and shrubs are presently being considered seriously as the most promising sources of high protein forage for livestock production in marginal areas. Desert plants such as *Acacia albida*, *Cassia sturtii*, *Prosopis tamarugo* and salt bushes (*Atriplex* species) are very well adapted to drought conditions and they have been found to contain very high levels of crude protein. *Leucaena leucocephala* is another very promising browse shrub which, although originating from humid Latin American region, has some degree of drought resistance.

Many leguminous and non-leguminous fodder shrubs have been collected by the Plant Introduction Section of the Ministry of Agriculture and are in the process of evaluation. The Faculty of Agriculture is also initiating an agroforestry programme around Kibwezi area where these fodder shrubs will be studied not only as forage but also for afforestation purposes.

Most of these shrubs have peculiar characteristics; for example, many have thorns and may contain certain alkaloids which may affect the livestock. In any evaluation programmes therefore these shrubs should always be tested against livestock performance. Management practices

necessary for the maintenance of these shrubs should also be studied carefully.

3. Forage Conservation

Whatever methods are employed in order to maintain pasture growth in the dry season, forage is always limiting during later stages of the dry season unless stocking rates are altered. One way of ensuring steady stocking rates is to conserve forage as either hay or silage. Normally there is a surplus of forage from perennial grasses during the wet season and if there could be cut at an early stage when the quality is good they could be conserved for the dry season.

Although hay making can be an easy practice even on a small holding, it has certain problems which make it unprofitable in marginal areas. High losses both in quantity and quality can occur between the cutting of the forage and feeding out to animals later on. Hay making requires sunny weather which is often difficult to get during rainy seasons in marginal areas. Termite damage can also be high both when drying the material in the field and during storage. The common practice today is to cut the grass in the field, allow it to dry partially and then transfer it into stores where drying would be completed. This reduces termite damage but unfortunately encourages losses during storage through moulding as a result of excessive humidity and temperature.

Silage making is equally difficult in semi-arid areas especially in small holding situation. Silage making is less limited by climate and often silage can keep in good condition during storage for long periods. Silage making, however, requires considerable labour to cut and carry wet material to silos. The material also requires to be chopped into small pieces a job which requires the use of expensive machinery such as forage harvestors (for large scale holding) or Chaff-cutters for small holdings. Small scale silage making tends to be uneconomic because of considerable wastage both in storage and when feeding out. Surface decomposition is related to surface area and hence the big disadvantage for small lots of silage. In general, there is great need for research into methods of forage conservation especially because of its importance as an insurance against sudden droughts.

CONCLUSIONS:

The problem of dry season feed is fundamental for livestock production in marginal areas and many possibilities for increasing dry season feed have been considered. However the success in providing adequate

dry season feed cannot be achieved by only one method. It will require a combination of well established and managed pastures, fodder crops and conservation.

At this stage the most urgent areas of research in livestock production for marginal areas are, plant introduction and forage conservation techniques. More reliable pasture grasses and legumes are required. Fodder trees and shrubs should be introduced and evaluated either singly or in mixtures with pasture grasses or with field crops in an integrated system where such trees/shrubs could become useful for soil conservation, fertility maintenance and even provision of fuel.

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WILDLIFE IN THE DEVELOPMENT OF DRY LANDS

by

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INTRODUCTION

The past decade has seen a change in Kenya government policy towards fulfilling its role as custodian of the wildlife² resource. Conservation of the resource is still the keynote, but the operational strategy has shifted from one of pure protectionism to one of distribution of benefits to the people. In theory, the end-product of either approach should be a vigorous and diverse wildlife community. Pure protectionism appears to benefit the recreating upper classes and the odd PhD student. A benefit-distribution policy, however, is fully compatible with the needs of tourists and scientists as well as the citizens who, on a day to day basis, must bear the brunt of the costs in maintaining the resource.

An analysis of the costs and benefits accruing to people from wildlife must be made at four distinct levels:

- Individual/ranch level
- Local community level (e.g. County Council or District)
- National/regional level
- International/global level

Current wildlife policy must attend to all four levels. However, it is at the level of the individual where controversy and conflict surrounding wildlife

1. Current address: United Nations Environment Programme, P.O. Box 30552, NRB.
2. In the broadest sense, "wildlife" refers to all free-living plants and animals. We will, however, restrict the meaning here to include wild animals appearing on Schedules One and Two of the Wildlife Conservation and Management Act (1976). In practice, this means most "useful" species, sunbirds to elephants.

are most apparent and intense. Distribution of benefits and the costs borne by the individual are often not commensurate, yet it is the individual, in our view, who is going to decide the fate of wildlife in the long run. The government is aware of this and not just paying lip service to a policy of distribution of benefits, as witnessed by the fact that compensations for wildlife damages paid to landowners in 1978/79 financial year amounted to approximately 5 million shillings.

The relationship between the individual landowner and wildlife is a very special one, unlike that of any other resource. While living wild animals are on your land, they belong to you, but you must not harm them nor even 'manipulate' them unless you are doing so in self-defence or whilst protecting your property. If there is a wild animal dead on your land, then it does not belong to you: it belongs to the government. You are obliged to report it, account for the circumstances of its demise, and either surrender it to the Wildlife Conservation and Management Department (WCMD) or apply to that same body for a Permit of Legal Possession.

Despite the legal niceties of who owns wildlife, the pastoral peoples of Kenya have traditionally had an amicable, perhaps even symbiotic, relationship with the herbivorous wild animals who share their lands. On the one hand, the pastoralists, with their characteristic good ecological sense, realise that the wild herbivores are more likely to survive very dry times than their own domestic stock. Hence, during particularly bad times, the wildlife provide a buffer against the inevitable dry-season protein shortage. On the other hand, the wildlife enjoy a considerable amount of tacit protection from the pastoralist's self-interested and quickly-defended attitude to his rangelands. It is no coincidence that some of the best wildlife parks and reserves in semi-arid areas of eastern Africa are legacies from pastoral people.

Making a living in semi-arid areas is a risky business. The primary hedge against a prolonged period of lack of grass for the pastoralist is the ability of the zebu cow to reduce temporarily its maintenance requirements (V. Finch, pers. comm.) and hence protect the pastoralist's capital. Equally important is the mobility of the pastoralist's life style, which allows him to accompany his herds as, together, they seek to optimise protein intake throughout their home range,

The traditional interaction between dryland farmers and wildlife is not as benign as in the case of the pastoralist. The farmer's risks of crop failure are high on average, and existence of wildlife in the home area undeniably adds to that risk through resource competition. On a sward of grass, it may be possible for man's stock and wild herbivores to co-exist successfully; in a maize field is clearly impossible. The farmer suffers greater direct costs due to wildlife than the pastoralist. Nevertheless, despite these costs, there is an undeniable place in the farmer's heart for wildlife as witnessed by the predominance of many species in folklore and traditional perception of the environment. Moreover, unlike high-potential agricultural areas, dryland farmers characteristically occur at relatively low occupance densities. Not all of the drylands is covered with crops, and this leaves open parts of the land and the possibility of Lebensraum for wildlife. Traditionally, the dryland farmer dealt with the really hard times by being sufficiently mobile to be able to retreat to better-watered regions. Today, he is bound to one place by his title deed. He attempts to spread his risk by avoiding monocultures, by storing food, by encouraging back-yard livestock, or by earning money as a labourer and saving it to buy food when crops fail.

Wildlife, for both pastoralist and farmer, has always been an alternate source of protein. Today, with wildlife based tourism earning almost as much money for the country as coffee, both types of rural landowner have the opportunity to dilute the ever-present environmental risks to their cash as well as subsistence economy. That is easily said from a Nairobi perspective. Demonstrating to conservative, rural folk what opportunities exist in utilising the wildlife resource is a task to tax the imagination and far-sightedness of both governments and conservationists.

In a national park, porcupines, vervet monkeys or baboons are protected entities. On your farm, they are vermin. Nevertheless, the Wildlife Conservation and Management Department is responsible and accountable for public stock even on private land. But decisions on which line management should take have to balance protection of the national herds with compassion and common sense. At each problem site, the WCMD must ask itself: where is transgressing beast, what is it doing, and what consequences to the species would control entail? The Wildlife Conservation and Management Act gives guidelines, but invariably each individual case must be considered in the light of economic, social and environmental costs and benefits for the citizens, the country and the rest of the world.

We believe that the case for wildlife is strong or at least clear cut in most regions of Kenya. In the high potential areas, only 18% of Kenya's land area, agriculture or forestry occupies virtually all of the land and is profitable enough to meet most of the people's material needs. In such areas the only future for wildlife, other than birds and small mammals, seems to be in relatively small habitat relics excised as museum pieces from the mainstream of life. In the arid and very arid regions, an impressive 72% of Kenya, human activities occur at very low densities: only one-fifth of the population occupies this three-quarters of the country (Govt. of Kenya 1979). There is still plenty of physical space for wildlife and plenty of opportunity to explore its utilisation without jeopardising the processes of getting enough to eat.

In the so-called marginal lands, the 10% of Kenya classified as semi-arid, the inclusion of wildlife in land utilisation plans is as tricky a business as recommending to the farmer which particular crop type or crop/livestock mix to bet on. In one run of years, a marginal region is suitable for cropping; in the next, it is best used as ranch land. This alternating of optima, coupled with the increasing pressure put on such lands by growing farmer populations on the wetter side and increasing pastoralist demand on the drier side, creates a situation which taxes the planning skill of the wildlife manager. In general, he believes he has a product which can enhance the development potential of both groups.

2. WILDLIFE BENEFITS AND COSTS

In this section we will attempt a narrative cost/benefit analysis of wildlife in semi-arid areas. We will describe those costs and benefits which are important, and leave it to our economist colleagues to do the sums. It is not possible, in any event, to give a general bottom line credit/deficit figure. Although the types of interaction between man and animals are relatively limited, the intensities and importance of the interaction vary in a complex way with the animal species, the habitat type and the social group involved.

Although we have made a point above of distinguishing between differing levels of analysis, we will concentrate at the grassroots, from the individual to the community. We have pointed out that the individual may suffer most from wildlife. It is implicit in our understanding of the government's policy that benefits which now accrue to the community are or will soon be made available to the individual through direct works of the County Council or the District Development Committee.

2.1 Benefits from wildlife

2.1.1 Landowner Benefits

The existence of wildlife in a particular region, presents the people of that region with two possibilities for entrepreneurship. One type has to do with utilisation of the wildlife themselves, the other with taking advantage, in a legitimate sense, of the tourists who pass through the land seeking wildlife.

2.1.1.1 Landowner use of wildlife: direct

The most obvious direct utilisation of wildlife by landowners is as source of food. Subsistence hunting has been and still is practised by rural peoples throughout Africa, e.g. "bushmeat" in West Africa. Depending on tradition, tribal custom and taboos, the wildlife contribution to a people's protein supply can be as high as 20% and in some cases 80% (Croze 1978). It is a hoary problem for the custodians of the wildlife, who cannot be everywhere at once to **look** after the resource. However, at a strictly subsistence level, the effects of such hunting on the wildlife populations is likely to be insignificant. Yet the WCMD is obliged to maintain an adequate and costly policing force to curtail exploitation which gets out of hand, such as poaching for certain skins, teeth and horn products.

Sport-hunting has traditionally been the **prerogative** of rich visitors to the arid and semi-arid lands. There is a feeling today in Kenya that the system of control imposed on fee-paying sport hunters (see below) should be re-instated³ as a way of allowing the landowner to "manipulate" the animals on his land under an ecologically determined quota system. Whether the landowner eats the animal or stuffs its head for the wall is entirely up to him.

There are considerable possibilities for small-scale enterprises concerned with cropping wildlife and either selling the carcasses or processing the products in situ. The potential returns from this activity are considerable (Hampson, 1974), given

3. A blanket hunting ban was introduced by the Government of Kenya in 1976.

knowledge of what offtake rate to use for a sustainable yield and where the market is. Furthermore, this form of activity poses enormous problems concerned with control and regulation of the activities associated with the exploitation. And finally, until the question of wildlife ownership is firmly and unambiguously resolved, utilisation operations are not feasible. Imagine two adjacent Maasai entrepreneurs, both with cropping licences, and a herd of wildebeeste feeding along their common borders

Wildlife ranching and domestication should be mentioned together, for, although they are operationally different, the latter is a logical extension of the former. Ranching involves treating wild herbivores like domestic stock by enclosing a piece of land and harvesting a fixed number of animals each season. Domestication is essentially the same, except that the animals, usually one or two species only, are tamed, herded and kraaled.

Where domestication has been examined, it appears that little is gained from the physiological adaptations of wild animals (with the exception of those of the Oryx - Stanley Price 1978). Although some wild species survive very well in very marginal lands, their success depends on behavioural and ecological adaptations, for example, the maintenance of a herd size small enough to permit a progression rate which is maximally efficient for the selection of particular nutritious plant species. The successful domestication of wild herbivores may require a complete redesign of herding techniques.

The domestication activities are usually based on the assumption that wild herbivores are more efficient in producing red meat than domestic stock under dry rangeland conditions. This assumption is in fact a hypothesis which needs to be critically examined, both biologically and economically. For example, there are biological reasons for questioning the wisdom of trying to create a better cow or sheep out of wildebeest or a gazelle. And, there are serious economic reasons for asking how many citizens can one square kilometre of game ranch support, as opposed to the same area of group ranch?

2.1.1.2 Landowner use of wildlife: indirect

The wildlife-based tourist industry affords opportunities to rural populations for profitable exploitation of the tourist. The opportunities range widely, from providing accommodation of international standard to posing for pictures at the roadside, which is one step up from outright begging. Between these two extremes lie a series of activities, which fall into categories of service employment, performing, providing services and selling. There is no need to elaborate on the details of the activities in this paper. What should be stressed is the employment potential through the 'multiplier effect' which wildlife can provide for an imaginatively directed rural population, and which can rank very high as a local cash source when compared with other agricultural activities.

It is important to mention one activity in the field of selling, which has been successfully tested. Although one usually conceives of selling as being confined to curio kiosks, it may also include selling the rights for a particular type of activity on privately owned land. Thus Group Ranch Committees in Kajiado District in 1974/76 sold Hunting Concession rights to private firms of hunter-guides which cater to an exclusive market of 'big game' hunters. The fee paid was a composite figure calculated by adding rates for animals shot to an annual fee. The money was used for a variety of community activities: from parties to schoolrooms. One group ranch, for example, was averaging a receipt of Shs. 25,000 per quarter when the hunting ban was introduced in July 1976. In the opinion of the Group Ranch Game Committee, one of the few, perhaps the only material benefit from wildlife was eradicated at a blow, and with it, the only reason for conservation of the wildlife resource.

2.1.2 COMMUNITY BENEFITS

A major recommendation of the UNDP/FAO Wildlife Management in Kenya Project (UNDP/FAO, 1978) was that large portions of wildlife-generated revenues must return to the regions which generated them. Current government policy is attempting to follow such lines. In June, 1977, just under Shs. 2 million was paid by the Minister for Tourism and Wildlife to the District Commissioner of Kajiado District. This money was earned from hunting fees in the District,

and was pledged at the ceremony to be directed into community projects by the District Development Committee. It would be an instructive exercise today to trace the pathway of that money through the community.

Nor was the June 1977 payment an isolated event. Rents paid by lodges and tented camps to the County Council in Kenya's most famous wildlife viewing areas - Mara, Amboseli and Samburu - have increased over the past five years until today they average around Shs 500,000 per annum. In one area, Maasai Mara, when the bed-night occupancy fees and camp site fees are added to the basic rent, it is estimated that the community earnings this year will top one million shillings. The Narok County Council, which hosts the Maasai Mara Game Reserve, is looking for an appropriate name for a recently built primary school funded from wildlife sources. They are considering names like 'simba' (lion) and 'kiboko' (hippopotamus).

2.1.2.1 Employment potential

Whether or not local entrepreneurs are responsible for management of industries related to wildlife, the multiplier effect on employment generated by the activity can be considerable to the local populace. The operations which cater to wildlife-based tourism, such as lodges, garages, curio production, all generate employment. It is estimated, for example, that 20% of the labour force around Amboseli National Park and 45% around Maasai Mara are provided employment by the local wildlife viewing enterprises.

2.1.2.2 Wildlife for local recreation

One of us as a youth spent long hours with his contemporaries in the bush hunting for small animals. (The other engaged in similar activities, but without the glamour and opportunity for adventure.) This apparently trivial youthful past time pivots around the wildlife resources and has far-reaching social implications. The participation in group sport teaches cooperative behaviour and builds strong peer bonds which extend beyond youth. The strenuous activity diverts potentially destructive energy characteristic of young males. A considerable burden is taken off the mother, who is bound to household chores and the younger children, and who can well do without additional constant demands of an exuberant teenager. Finally, the objects of the hunt are frequently, vermin, such as rats or seed eating birds. All these positive effects far outweigh the potentially negative effect on the wild animal populations. Without additional impetus to the young hunters, the traditional predation rate on local wildlife populations

is certainly low enough to allow a measure of leniency on the part of the authorities, who, under the circumstances, would be hard pressed to exert their authority effectively and without creating unproductive rancour in the community.

2.1.2.3 Aesthetic value of wildlife

Wildlife is a part of the natural scheme of life. No African community would permit the complete elimination of the wildlife in the community area. Obviously, certain 'hot-spot' problems with wild animals are dealt with summarily, but in general, there is a deep moral and spiritual attachment to life in all forms. This may come as somewhat of a surprise to westerners who seem to think they have a corner on the aesthetic market. It has been a long while since Aesop; whereas current African lore and moral perceptions are richly structured with parallels from the animal world.

2.2 Costs accountable to wildlife

2.2.1 Indirect costs

The indirect costs imposed by wildlife on ranchers and farmers usually arise from resource competition between the wildlife and the landowner or his stock. Particularly in the dry season, when water and forage are at a premium, the offtake by wildlife must create a deficit for the landowner. This in turn decreases, if only fractionally, the chance of survival of his stock, or in the case of irrigation, his crops.

2.2.1.1 Resources Foregone

Indirect costs are always difficult to calculate, but based on the recommendations of the UNDP/FAO Wildlife Management in Kenya Project, the WCMD is pioneering an innovative concept: Guaranteed Minimum Returns based on a 'trophic opportunity cost' (EcoSystems 1978). The following is an excerpt from the consultancy report which calculated the biological basis for Guaranteed Minimum Returns for Mara and Samburu.

Wild herbivores feed on ranchers' land and eat grass and browse that could, in theory, be eaten by domestic stock. It is known that herbivores eat herbage in proportion to their metabolic weight or 'metabiomass' Metabiomass is the body weight raised to the three-fourths power, and is a better

common denominator for comparing the offtake of vegetation by species of different sizes than straight body weight. The reason is that a small animal eats relatively more food on a weight-for-weight basis than a large one: A small animal has a greater surface area for its volume and therefore loses more of its ingested energy as heat radiated from the body.

Now, if the average metabiomass of wild herbivores using a rancher's land during a particular period were known, it would be possible to calculate the number of say, cattle which could have been there in place of the wildlife. The value of those cattle (or whatever species of stock are appropriate for the area) would be considered a fair opportunity cost for the support of the wildlife.

The Systematic Reconnaissance Flight (SRF) is now well established in tropical rangelands as an ideal method of obtaining both numbers of distribution data for large herbivores, (Gwynne and Croze, 1975). The method produces animal number data in grid squares over the entire study area. Thus individual grid squares can be assigned to sub-areas (such as group ranches) so that specific occupancy data can be calculated for each sub-area).

For each wildlife species, it is possible to estimate the average weight of a population member of the absence of detailed data on herd structure. These data are converted into metabiomasses and cattle equivalents, from which, given current market prices, the wildlife utilisation fee' or 'guaranteed minimum returns' to the landowners may be calculated.

2.2.1.2. Psychological costs

The psychological effects on the individual or community form direct losses of property or life due to wildlife (see below) can be considerable, if virtually impossible to quantify. Some material effects on the community from fear of wildlife has been seen in parts of Kenya, such as the restriction of movement after dark.

2.2.1.3. Disease Transmission

A popular cost which is accounted to wildlife is the carrying and transmission disease, mainly to domestic stock but also to man himself. In the last few years, specialised veterinary research has gone far in the task of estimating the importance of wildlife in reducing the viability of stock by harbouring and passing on debilitating or fatal diseases. The picture with respect to some of the most important livestock diseases is summarised below. (G. Grootenhuis, pers comm).

Food and Mouth Disease (FM) This viral disease is highly contagious but has a low mortality rate. FM imposes a considerable cost to the farmer in terms of loss of condition of his stock as well as restricting movements for local trade. The cost to the nation is potentially enormous, since import restrictions due to foot-and-mouth can eliminate an entire overseas market. Experiments at the Wildlife Diseases Research Unit, Kabete, with some of the most abundant wildlife species - wildebeest, buffalo, eland and impala - have examined the role these animals play in transmitting FM disease. For example, despite the high infection rate and the fact that the virus found in buffalo has been shown to affect cattle if injected experimentally, transmission of the disease between infected buffalo and susceptible cattle did not take place. The results all indicate that wildlife plays no significant role in the transmission of FM disease.

East Coast Fever (ECF). This tick-borne disease is found in all parts of Kenya and probably imposes the highest cost of all livestock diseases to both ranchers and the government because of the costs of tick control. The disease is usually fatal, but its rate of infection is largely a function of the ecology of the tick vectors rather than the presence of wildlife. Only the buffalo plays a significant role in the disease and constitute an impediment to effective control. Other suspected carriers of ECF, eland and waterbuck, have been largely exonerated by research results. Even if all wild ungulates were eliminated, ranchers would still have to dip their stock because of endemic ECF as well as a host of other tick-borne ailments. Thus the cost of this disease attributable to wildlife is virtually nil.

Malignant Catarrhal Fever (MCF). MCF is usually attributed by both Maasai and Vets to the presence of wildebeest particularly during their seasonal calving. Once a cow is infected, it will almost certainly die. However, outbreaks are localised, and the transmission rate of the disease is such that less than 5% of animals in an infected herd will die. A 5% loss a herd may impose a significant cost to an individual rancher, but is relatively, unimportant at the district level. The District Veterinary Officers Animal Reports for 1970-1975 in Kajiado District showed that the average animal loss of cattle due to MFC was 2 per 10,000.

Rinderpest. Rinderpest has now been controlled in domestic stock because there is an effective vaccine. Historically, it seems as if wildlife were more at risk from livestock than the other way around.

Trypanosomiasis. Sleeping sickness has been one of the most effective diseases in retarding livestock and indeed human development in Africa. Wildlife as well as cattle serve as reservoirs, but, rather like with tick-borne diseases, little would be gained by eliminating wildlife when the tse-tse fly vector is still at large. The cost attributable to the presence of wildlife is difficult to calculate, but is believed to be trivial.

Rabies and Hydatidosis. There is no evidence of a rabies reservoir in Kenyan wildlife, and hydatidosis is maintained by a man-dog cycle.

Worms. There is an unconfirmed suspicion that gut parasites may be transmissible from wildlife to cattle. The worms compete with the animals for the food they are trying to digest, and hence with man for livestock products. The costs are very difficult to measure, but may be considerable through the chronic depression of livestock productivity.

In summary, the image of livestock ravaged by disease carried in by wildlife is somewhat exaggerated, and only a very few percent of the costs involved in keeping stock healthy can be charged to the wildlife resource.

2.2.2 Direct Costs

Wild animals are undeniably destructive: they break down fences, damage irrigation ditches, eat crops and, worse, injure or kill people. These costs, except of course that of the last transgression, can be calculated with some precision. They could be broken down for a precise calculation into the following categories:

- A. Damage to people
 - loss of life
 - bodily injury

- B. Damage to property
 - cattle
 - crops
 - houses
 - fences
 - fixtures (water, electricity, etc).

Compensation claims to the WCMD for losses to landowners totalled over Shs 4 million in 1978/79. One rancher in Laikipia estimates that damage by elephants costs him of the order of £10,000 per annum (pers.comm.). The above figure for compensation paid, which was less than all compensation claimed, and probably far less than what could have been claimed, is not an unreasonable amount to expect wildlife to provide. In round terms, this cost amounts to some 10 cents per hectare if spread over the arid and semi-arid areas the bulk of which support wildlife and about two shillings per hectare if attributed to just the gazetted wildlife reserves and national parks. This may be compared to order of magnitude figures for net earnings from viewing, which, as long ago as 1972, were something like two shillings per hectare for the total possible dispersal areas and forty shillings per hectare for the parks and reserves.

3. TOWARDS A POSITIVE CONTRIBUTION OF WILDLIFE TO DEVELOPMENT

It seems to us that the theoretical outcome of a cost/benefit analysis of the usefulness of the wildlife resource in semi-arid areas must result in a considerable net benefit to the local landowner. Measured against traditional forms of landuse, active utilisation of wildlife, whether consumptive or non-consumptive, can be at least of economic benefit to the landowner. Even compared with cattle ranching at full development, a landowner could realise several times the revenues if he had the wildlife on his land to support a hunting concession, and some ten times as much if the diversity of both habitat and fauna were rich enough to accommodate viewing tourists (Hampson op.cit).

The policy makers in the Wildlife Conservation and Management Department feel that they have evolved a fairly enlightened approach to conserving their wildlife charges, one which materially contributes to national development activities and which requires the cooperation of other agencies, particularly the Ministry of Agriculture. In a nutshell, the policy entails:

- a. A broad-based approach to decision making, one which actively seeks a workable multiple-use land tenure (and hence resource ownership) system;
- b. An extension programme based on dialogue rather than monologue to re-educate the landowners on the unique characteristics of wildlife as a resource; and

- c. An imaginative, fair and prompt scheme for the distribution of wildlife benefits to the landowner, either directly or through community channels.

The wildlife resource, as it were, speaks for itself, on both the cost and benefit side. We feel there is no doubt that the wildlife bottom line is or very soon could be in the black. The onus now falls on the extension arm of the Ministry of Tourism and Wildlife to develop a salesmanship strategy in order to convince other policy makers as well as landowners. If the landowners are put in a position where they may realise and take advantage of the potential economic and psychological harvest to be reaped from wildlife, then national development as well as the international conservation heritage will automatically be served.

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THE SEMI ARID LANDS OF BARINGO DISTRICT
A CASE STUDY

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INTRODUCTION.

Baringo District has long been recognized as an area where environmental degradation resulting from intensive utilization of relatively scarce land resources is a major problem. Population growth has increased the demands of both farmers and herders upon the land and water resources of the district and bush and forest clearance, soil erosion and the consequent disruption of drainage patterns has ensued. While characteristics of the problem such as soil erosion have long been recognized (Maher, 1937) and strategies for remedying them investigated (Bogdan 1954, Pratt 1963, 1964) the district resources continue to decline in productivity.

Recent government concern over the condition of Kenya's arid and semi-arid lands (Kenya, 1979) and over Baringo District in particular is reflected in the recent incorporation of the Kerio Valley Development Authority and in the involvement of the World Bank and of the Ministry of Agriculture Arid and Semi Arid Lands Branch (ASALB) in the development of integrated development projects for the district. This paper is based upon the Report of the latter (Gichohi and Kallavi, 1979).

The paper reviews the major physical and socio-economic characteristics of the district and provides a context within which the major problems of development can be identified. The overall strategy for development proposed by the ASALB is then summarized and a number of specific project areas identified.

Physical Background

Baringo District is located in the Rift Valley of Kenya (Map 1). Its topography is characterized by two valleys which are part of the Rift Valley system and which are separated by the Tugen Hills which run north-south along the centre of the district and rise over 2300 m. To the west of the hills elevation drops sharply to the floor of the Kerio Valley which is 4-12km wide and lies at 1100 m. To the east the hills descend through a series of steep slopes and narrow plateaux to the main floor of the Rift Valley at 900 m. Lake Bogoria and Lake Baringo lie in the valley floor which is 25 km wide at this point. To the east the topography rises sharply into the Ngelesha and Laikipia Escarpment to the edge of the Rumuruti Plateau where the altitude reaches over 1500 m.

The climate of the area is characterized by a marked seasonal rainfall pattern and year round high temperatures. The variations in relief result in higher rainfall and lower temperatures at higher elevations where more temperate conditions result in higher ecological potential than in the lowlands. The Tugen Hills are generally forested though the central spine has largely been cleared for cultivation and population pressure is resulting in widespread clearance of slopelands. The lowlands of the Kerio Valley, Lake Baring Basin and the Njemps Flats have generally low potential for crop agriculture though where water is available irrigation is possible. The Perkerra Irrigation Scheme near Lake Baringo and the Barwesa Cotton Scheme in the Kerio Valley reflect this potential and some evidence has been found of past irrigation elsewhere in the valley although animal husbandry is the principal economy of the lowlands.

Major constraints to economic activity in the area are water availability and soil erosion. The high rainfall in the Tugen Hills gives rise to numerous small streams. These drain into major rivers some of which are ephemeral, drying up during the dry season. The principal perennial streams are the Perkerra, Molo, Lobo, Ol Arabel and Yeptos rivers. The major catchments flow either westwards into the Kerio River or eastwards into Lake Baringo. As the groundwater reserves are thought to be adequate only for domestic exploitation (Taylor 1978) farmers and herders are dependent upon rainfall and streams for their water and the seasonal availability of water imposes a seasonal rhythm on most activities.

The soils of the area also constrain productivity. In general they are shallow, stony and relatively infertile and many have a tendency to compact under rainfall resulting in high runoff. Some good soils are found in the Kerio Valley and in the deltaic deposits of the Baringo Basin and cultivation is possible, particularly under irrigation. On the Tugen Hills rainfall amounts favour cultivation but the soils are often shallow or friable and thus susceptible to erosion. The highest rates of erosion occur on the eastern slopes of the Tugen Hills where poorly structured soils have in some areas been completely stripped of the soil mantle and only the C horizon remains (Sketchley et. al. 1978).

Erosion is often severe where forest or bush clearance combined with steep slopes or friable soils occurs. Increased runoff in such areas results in reduced infiltration, more irregular streamflow and in an increase in the silt content of streams. Clearance of vegetation and soil erosion in the upper catchment of the Perkerra River have been identified as contributing to the increasing irregularity in the flow of that river and in the higher silt content of its water which has turned L. Baringo into a brown lake. Continued forest clearance elsewhere in the Tugen Hills threatens to exacerbate this problem and the ASALB Report recommends that immediate action be taken to protect the forest cover on the steeper slopes (Gichohi and Kallavi, 1979).

Despite the fact that soil erosion has long been recognized as a problem in the area, relatively little has been done to reduce its effects. Kinyanjui and Ng'ethe (1976) report that projects related to environmental conservation were minimal up to 1976 though an afforestation programme was given high priority for the 1976/77 financial year. Most past efforts were concentrated in the lowlands of South Baringo where revegetation experiments demonstrated that rangeland rehabilitation was possible. Much of South Baringo has been demarcated as individual ranches and fencing and range management has enabled the productivity of the land to be maintained. In other lowland areas of the district lower rainfall and higher population densities reduce the potential of such a programme being a success.

The Economy

Most of the area is of low agricultural potential. The lowlands which represent about 75 percent of the district's land area are classified as Ecological Zone IV while the upland areas which receive higher rainfall amounts are classified as Ecological Zone II or III. These higher potential lands are however hilly and rocky and farming is difficult.

On the central spine of the Tugen Hills settled agricultural systems predominate with maize and millet being the major crops though some dairying is also practised by smallholders. Some growing of coffee and pyrethrum as cash crops occur but these activities are restricted by poor marketing facilities, unavailability of inputs and by problems of disease control.

In the Kerio Valley and on the eastern slopes of the Tugen Hills shifting cultivation is prevalent. Less than half the families in these areas are permanently settled and forest clearance is accelerating as the population grows. The relationship between forest clearance, particularly on steep slopes, for cultivation without the implementation of soil conservation measures and the rate of soil erosion has been discussed above.

In the majority of the lowland areas crop production is prohibited by lack of water. Where water is available subsistence crops such as maize, millet and sorghum are grown though some cotton and sunflowers are produced in the Kerio Valley. The success of these cash crop activities has been severely curtailed by poor marketing, lack of credit availability and the poor road system which results in poor delivery of the crops after harvest.

Efforts to improve the infrastructure available to farmers are being made by the District Development Committee and the Baringo District Development Centre has attempted to upgrade farming techniques through providing courses to local farmers. The intake of farmers to be trained at the Centre has been very low however (Gichohi and Kallavi, 1979).

While problems related to land shortage and to poor infrastructure restrict the development of farming on the Tugen Hills the potential for increasing forestry activities is being undermined by accelerating forest clearance for cultivation, timber and firewood. There are a number of gazetted forests in the district notably those at Chemorok (1346.8 ha), Kabarak (1392.1 ha), Katimoko (2080 ha), Kilombe Hill (1539.4 ha) and the largest Perkerra (4358 ha). The indigenous trees are mainly hardwoods and some have value as timber including Juniperus procera, Podocarpus graciolor and occasionally Ocotea usambarensis (Uvoo, 1979).

In the lowlands cultivation under irrigation is far more important than rainfed cultivation. Indigenous irrigation systems are known to have existed in the area especially on the Njemps flats but the only organized irrigation Projects is the NIV - operated Perkerra Scheme. The Project was

started in the 1950's by the colonial government through the African Land Development Board (ALDEV). The plots in Perkerra scheme were allocated to IL-Chamus and the Tugens. At present onions and chillies are the main crops. The number of tenants has been decreasing throughout the years and there are only 350 tenants now compared to 463 in 1969/70, 445 in 1971/72, 372 in 1973/74. The hectareage has also decreased from 305 in 1971/72 to about 222 ha. in 1978/79. Lack of water limits the possibility of expanding this scheme and at the moment the irrigation operation at Perkerra implies heavy Government subsidy to the tenants of about K. Shs. 600.000 yearly.

There are other minor irrigation schemes at Barwesa, Lobo and Endau. These schemes seem to have been abandoned, possibly due to lack of proper management and extension guidance. At present what used to be more than 100 ha. under irrigation in Barwesa growing cotton, is but a one acre horticultural garden, owned by a Junior Agricultural Assistant. The others are not in any appreciably better condition.

THE PROBLEM AND THE STRATEGY FOR DEVELOPMENT

The Problem

The fundamental problem in the area is that the demands of a growing population, engaged in predominantly subsistence activities, is threatening to outstrip the capacity of land resources to meet them (Gichohi and Kallavi, 1979). The immediate response to this is to extend and intensify land use, which tends to exacerbate other problems for which the District has suffered in the past such as - soil erosion and overgrazing.

While it is clear that the increase of livestock numbers, occurring concurrently with reduction in the availability of grazing and water resources due to changes in land and management, is a principal cause of environmental degradation in Baringo District, the problem is more complex, and involves the social and economic well-being of the local people. That the problems confronting the area are the result of social, economic and environmental factors, therefore, demands that an integrated long term development strategy be formulated to deal with them. The principal objective of such a strategy should be to develop a sustainable production system which is capable of improving the quality of life of the people of the area (Gichohi and Kallavi, 1979).

Strategy for Development

The situation in Baringo today is one of the expanding human population on static or declining resource base. The traditional subsistence systems are ill-adapted to handling of the population pressures to which they are now subjected and they are ill-adapted to using the economic and transport links with other areas.

Among the principal lines of strategy for these areas is strengthening of the reliability and credibility of the economic infrastructure and marketing linkages. This would permit a decreasing reliance on milk consumption among the pastoral people and increased reliance on meat and animal sales and grain purchases which would yield major benefits in the area. This would only be possible however, if a good marketing system is established for both livestock and grain and an alternative savings mechanism encouraged through the provision of banking facilities. Also creation of alternative sources of income is called for. Potential sources include irrigated agriculture, fishing processing, manufacturing, local industries development and other off-farm employment. While the development of such employment opportunities has great appeal, the fact should not be ignored that limitations exist in terms of launching economically viable projects.

Perhaps most basic to an overall strategy for these areas is the development of production systems which manage and conserve the soil, water and forage resources on which the entire production system must continue to depend. While soil conservation and rehabilitation are completely central to any strategy for a sustainable production system, it must be recognized that this is not merely a matter of soil conservation works. This should include the overwhelmingly important soil conservation issues related to the preservation of a ground cover of plant life and the refraining from the cultivation of unacceptably steep slopes. While the latter issue can and must be dealt with by regulations, zoning and adjudication, the former cannot be separated from the issues of livestock, forage and range management in the pastoral areas.

Interwoven in the whole strategy of development is the question of priority which should be placed in land use planning and adjudication. This as a project, along with soil/water conservation and road communication programmes, should be given top priority and should be treated as one of the salient project pillars if an integrated ASAL Programme is to succeed in Baringo. Following those general strategies of development various projects

have been identified in ASALB Report (Gichohi and Kallavi, 1979) and they need not be reviewed here in full. The authors would however, like to mention a few proposals of programmes of action which are recommended for the district.

SOME SUGGESTED PROPOSALS OF PROGRAMMES OF ACTION

Soil Conservation

Action should be taken to initiate both soil conservation and vegetation rehabilitation in the Perkerra river catchment. The forest clearance under slash and burn cultivation taking place in the eastern slopes of the Tugen Hills should be stopped by gazetting the area as a Forest Reserve. In the lower slopes where there is widespread gully erosion, efforts should be made to restore the productive potential of those areas, such as Sabor-Kipcherere and revegetation as a long-term strategy may be the only viable alternative.

Water

The development of different sources poses some specific problems and has to be assessed in terms of the type and amount of water demanded by different users. The main aim should be to develop water for domestic use and later for agriculture which should improve livestock and irrigation farming. Thus reservoirs should be constructed on perennial and ephemeral streams and the water in Lakes Baringo and Kammarok should be made available for irrigation purposes as well as for livestock use. Water pumps and treatment sites will have to be installed to provide access to the water from Lake Baringo and to upgrade its quality. Lake Kammarok could be blocked by a high wall at the outlet hence giving a bigger storage and permitting the necessary control to irrigate areas downstream of the lake. Captation boxes on perennial springs should be constructed where appropriate and the water used for domestic and livestock purposes. Roof catchment could also be exploited to provide water for domestic use. Groundwater could also be tapped through construction of more boreholes. There are 42 boreholes in the District at present most of which are situated in South Baringo. More should be drilled in the Eastern and the Northern parts of the District.

In the District most ephemeral streams are filled with muddy silts of very low porosity rendering them unsuitable for subsurface dams. However, where suitable conditions occur as in the Sibilo river it should be exploited. Water pans also should be dug where necessary, especially in the range areas for livestock.

Livestock Production

While it is clear that large areas of Baringo District are overstocked relative to range resources they are not overstocked relative to the subsistence needs of the people. Objectives of livestock management programme should therefore involve:

- a) A reduction in the level of dependence upon the subsistence livestock sector by increasing grain consumption. Thom (1978) found that over 40 percent of the Il-Chamus he interviewed obtained 25 percent or more of their subsistence from grain and thus it would appear that there is a good potential for encouraging increased grain consumption. This can only occur however if grain is available and if the Il-Chamus have the cash needed to purchase it. It is essential therefore that regular livestock sales be held and that grain supplies be available at reasonable prices.
- b) Livestock numbers are likely to remain high while the majority of the population is engaged in the subsistence economy. Employment opportunities outside this sector should be promoted, particularly for those who have completed their primary school education. Among the activities which should be investigated is a local livestock-based industry. Local animals would provide the raw materials for such an activity and slaughtering and leathercraft production would provide employment.
- c) For livestock management to be successful an incentive system designed to motivate a reduction in the stocking rate will have to be evolved. Recognition of the complex social and economic roles of livestock in the pastoral economy is essential and inducements to reduce livestock numbers will have to be developed with the herders if they are to succeed. The people of the area have a need for alternative foodstuffs, employment opportunities and outlets for cattle sales. Provision of an infrastructure which facilitates these objectives is a principal component of an effective range management strategy.

Crop Production

The primary objective should be to supply enough food to the local people. Thus problems associated with input supply for farms need to be examined with a view to overcoming them. The credit and marketing systems need to be improved and should include establishment of a mobile bank to serve areas like Marigat, Nginyang, Kapedo and Tangulbei. Rehabilitation of existing irrigation schemes like Barwesa, Endau, and Lobi should also be given priority. These should incorporate food production into their farming systems.

Basic Needs

Since road communication is cited as an important component of the strategy for development, this should be taken up immediately. In the health sector there is a need for mobile health units and for the training of local people as health workers. Procurement of drugs for local hospitals should also be looked into, as well as educating the people about family planning. Adult education should be given high priority be it in a Farmers Training Centre (F.T.C.) or in any other place. Education of the local people will lead to adoption of new innovations and to the consequent success of the integrated development programme.

Supply of credit and farm input system will have to be improved if most of the projects are to succeed. This in part means acceleration of land adjudication if title deed remains a collateral to securing of loans. The problems of security should also be looked into and should include the strengthening of the police force where necessary and the building of new police posts at strategic points.

Employment Opportunities

At present the area offers few opportunities for employment. However a number of the area resources have potential for commercial exploitation and even though each one might only employ a few people the cumulative impact on employment might be significant.

The physical environment, the lakes and the spectacular bird life in the area are a major tourist attraction and the completion of the planned tourist circuit through the area should provide a stimulus to the expansion of the local industry and thus to employment of local people.

The livestock of the area is a second major resource. Current projections imply a shortage of beef in Kenya in the near future and thus there is an opportunity for the herders of Baringo District to participate more fully in the meat trade. Foot and Mouth Disease quarantines currently inhibit regular marketing of livestock but local slaughtering could overcome this constraint. Should leather tanning and crafting facilities be provided adjacent to a local slaughterhouse, for example at Marigat, then a major source of employment and a local outlet for livestock could result. The Perkerra and other irrigation schemes could be rehabilitated and the cropped area increased providing employment in farming and in maintenance activities. Improvement of

local roads and of soil conservation measures should also be undertaken using local labour.

CONCLUSION

This paper has identified major constraints to the development of Baringo District and provided some suggestions as to how the area's social economic and natural resources might be utilized to promote development. It has been stressed that while specific problems such as soil erosion are frequently emphasized these are symptoms rather than causes of the difficulties facing the area. The major problem is the inability of existing social and economic systems to cope with increases in population given existing resources and technology and the prevailing economic conditions.

The need for a comprehensive development strategy which builds upon existing resources and technical expertise has been suggested and a number of specific projects identified. It is recognized however that substantial investment in infrastructure, in small scale industries and in agricultural activities is essential. Justification of such investment involving simple cost-benefit analyses might well demonstrate that many projects are financially unfeasible. However social factors should also be considered given the government's objectives of promoting rural development and of addressing the problems of rural poverty. Perhaps the gains from such projects, at the national and local levels, more than outweigh all the costs involved.

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KAJIADO DISTRICT - CASE STUDY

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INTRODUCTION

The vast majority of the population of Kajiado District is employed in subsistence activities associated with herding and farming, though wildlife and tourism and extractive industries offer non-farm employment. The three principal land uses in the district pastoralism, crop production and wildlife/tourism - are increasingly competing with each other for access to and control over the limited high potential areas and in the absence of substantial adaptation in the economies the demands of the growing population are likely to result in an imminent shortage of land.

Development planning for the district is therefore needed to deal with these problems and among the issues that should be addressed are the allocation of land resources between competing uses, strategies for improving the productivity of existing economic systems and the possibilities for developing non-farm employment opportunities.

In order to propose strategies for future development it is important that the processes resulting in the contemporary patterns of land use, and the opportunities and constraints to their development be understood. To this end the environmental conditions in the district will be described, the historical development of the contemporary land use system discussed and the possibilities for the development of the three principal land uses assessed.

PHYSICAL BACKGROUND

Kajiado District is located in the south east of Kenya and forms part of the belt of semi arid areas which border the high potential lands of central and western Kenya (Ominde, 1971). The rainfall regime is bimodal, with peaks in March - May and October to December. Average annual precipitation over the majority of the district is between 500mm and 600mm though the areas around L. Magadi and between Amboseli and the Chyulu Hills receive less than this amount and higher rainfall occurs around slopes of the Ngong, Chyulu, Kibini, and Machakos hills and of Mt. Kilimanjaro and around the isolated hills such as Ol Doinyo Orok near Namanga (Norton-Criffiths, 1977, p.5). The rainfall is however erratic in time and space and drought is a recurrent problem in the area.¹

The soils of the district are derived from volcanic rocks in the east and west and from the basement complex in the central part of the district and there are areas of alluvial deposits in the lake basins such as Magadi and Amboseli (Dunne, 1977). Climate exerts a greater influence than soil type upon the vegetation of the area and thus the productivity is closely related to rainfall. The greater part of the district, 98 percent, is of relatively low productivity being classified as Ecological Zone IV and V and only about 2 percent is classified as Ecological Zone II and III (Campbell 1979). The characteristics of the Ecological Zones are described by Pratt and Gwynne (1977, p. 43). These higher potential areas include the northern slopes of Mt. Kilimanjaro, the eastern face of the Ngone Hills and other isolated areas such as Ol Doinyo Orok and the summits of the Chyulu Hills. This broad classification however conceals the existence of relatively small, isolated areas which due to the existence of permanent water and fertile soil are potentially more productive than the surrounding rangelands. These locally more productive areas include

1. Droughts are recorded in the area in 1933-35, 1943-46, 1948-49, 1952-53, 1960-1 and 1972-76 and, in addition, occasional failure of the rains occurred in intervening years.

the swamps in the south-east of the district at Amboseli, Namalok and Kimana and the valleys of the perennial streams which flow off the Ngong Hills and Mt. Kilimanjaro.

EVOLUTION OF CONTEMPORARY PATTERNS OF LAND USE

In the pre-colonial period the area of what is now Kajiado District was the domain of a number of Maasai sections. Pastoralism was the dominant economy. Some cultivation by Maasai took place on the northern slopes of Mt. Kilimanjaro in the mid nineteenth century but these farmers were forced out of the area by the Il-Kissongo Maasai during the wars at the end of the century (Low, 1965). The area also had abundant wildlife (Thomson, 1885) but its economic value remained relatively low until the colonial period when hunting and tourism realised its value.

Within the Maasai socio-economic system livestock served a variety of purposes. They were the principal source of subsistence, hides and skins were used for clothing, for shelter for making ropes etc., they were a store of wealth and they had social and ceremonial uses, being presented as bride price and slaughtered at times of marriage, birth circumcision etc. They were also a medium of exchange often being traded to neighbouring people in return for grain etc. Many of these characteristics of livestock within the Maasai socio-economic system continue to exist today.

In order to maintain sufficient number of livestock to fulfill the above purposes within an environment in which drought and disease were a recurrent threat to the herd, the Maasai developed herding strategies based upon control of a variety of resources, mobility, diversification of livestock and social linkages which reduced the risks associated with livestock management within this unpredictable environment.

The seasonal pattern of rainfall and availability of grazing and water resulted in the development of seasonal movements of the animals to take advantage of the seasonally available resources. The major constraint was access to dry season and drought retreat areas and the Maasai controlled, through force, large areas offering such resources. The problem of disease was reduced by their mobility which enabled the herds to be moved away from diseased areas and by the keeping of a variety of livestock - sheep, goats and cattle - which reduced the possibility of a herder losing all his stock as different animals are susceptible to different diseases. A further range of strategies for reducing the risks of losing their livelihood were developed around social rights and obligations. Members of families, clan and age sets could call upon each other for assistance in the form of food, loan of stock or labour etc. in time of need. Many of these strategies for coping with environmental hazards are also still in use today (Campbell 1979a). The Maasai pastoral system therefore depended upon mobility, flexibility, diversity, a cohesive social structure and upon the control of access to areas which offered dry season and wet season resources for the livestock.

In the years immediately preceding the colonization of Kenya the Maasai suffered a series of disasters which reduced their ability to counteract the policies of the invaders. Between 1870 and 1900 the Maasai were affected by cholera which spread from the north, and by smallpox, their herds were reduced by outbreaks of rinderpest and contagious bovine pleuropneumonia and by a severe drought in the 1880s and the whole period was one of inter-sectional warfare (Hamilton 1965). In response to those disasters many Maasai sought refuge with the neighbouring Kikuyu and a few began to cultivate around the Ngong Hills (Low, 1965).

1900-1939: At the time of the colonisation of Kenya the Maasai had, therefore been weakened by a series of epidemics and by warfare but they were still regarded as a powerful force and continued to control wide areas of Kenya.

In penetrating Maasailand the British followed a policy designed to avoid conflict and to develop a degree of understanding between themselves and the Maasai (Low, 1965) and the success of this policy, together with the realisation by the Maasai of the military strength of the British, contributed to the relatively peaceful alienation of large parts of Maasai territory for European settlement.

The process whereby the Maasai were deprived of much of their best land and restricted to the Maasai Reserve, the area of what is now Narok and Kajiado Districts, by the Treaties of 1904, 1911 and 1912 is well-documented (Leys, 1924; Huxley, 1935; Great Britain, 1934; Low, 1965) and will not be discussed. At the time it appeared that, though much of the land in the west of the Reserve was waterless (Kenya, 1909), the area which was set aside for the Maasai was sufficient to carry their stock.

During the first few decades of the colonial period the Maasai were concerned with rebuilding their herds following the losses of the late nineteenth century and with adapting their seasonal movements to the resources available within the boundaries of the Reserve. Many of the Maasai of Kajiado District were less affected by the creation of the Reserve than were those who had been forced to move from the north to the Narok area in that their grazing areas remained relatively intact. However, like the western Maasai, they were cut off from trade with the pastoralists of northern Kenya from whom they obtained Boran bulls which were the basis of their traditional selective breeding of cattle (Van Zwanenberg and King, 1975, p. 94).

Despite this constraint the Maasai herds recovered to levels sufficient to meet the economic and social needs of the community. They were to some extent assisted by government-sponsored vaccination campaigns and range improvements. Concern among European farmers regarding the risks associated with diseases such as contagious bovine pleuro-pneumonia (CBPP), rinderpest and East Coast Fever (ECF) spreading to their stock from the Maasai areas resulted in the institution of a vaccination campaign against CBPP and rinderpest in Kajiado District in 1931 (Kenya, 1931) and despite the losses during the drought of 1929 cattle numbers were estimated at 300,000 in the district in 1931; and in his annual report for 1932, the district commissioner stated that the Maasai had more cattle than at any point in their history (Kenya, 1932).

The rise in livestock numbers in the district was viewed as a major problem by the administration however, as it was perceived as a major cause of overgrazing and soil erosion. The concern with this problem was greatest following the droughts, as with low rainfall the carrying capacity declined and stock tended to concentrate at places where water and grazing were available. The Europeans' response was that 'the only effective solution, in the long run, was to persuade the native owners to sell their surplus stock for cash' (Huxley, 1937, p. 247). In order to facilitate this objective of destocking, taxes were increased and proposals were made to open a meat canning factory to process native cattle which would be procured compulsorily if necessary by the government (Van Zwanenberg and King, 1975).¹

The numbers of livestock sold officially after the end of the drought of 1935 up to the beginning of the Second World War remained low however, at about 2000 per annum, partly due to the fact that the Somali traders offered better prices² and partly due to the fact that the herds were being rebuilt following the very high losses incurred during the 1933-35 drought.³ The primary objectives of the Maasai herding system had not altered, livestock remained the basis of their subsistence economy and in view of the frequency of drought the maintenance of large herds was a rational strategy.

1. The Maasai were not forced to destock compulsorily, a decision which Delamere saw as a weakness on the part of the administration (Huxley, 1935, p. 248) and the brunt of compulsion fell upon the Kamba who were forced to sell 20,000 head between January and July 1938 (Van Zwanenberg and King, 1975, p. 101).

2. By 1936 European traders were buying stock from the Maasai areas at the acceptable price of 38/- per head and in the last six months of that year, 1914 cattle were exported (Kenya, 1936). Sales to the Kikuyu areas were also continuing, the trade being controlled by Somali traders who the administration were actively attempting to displace by official markets (Kenya, 1939) as they disrupted the official attempts to supply the Leibigs factory.

3. It was estimated that the Maasai lost 150,000 stock during the drought (Kenya, 1935) but the official reaction was that the drought was a 'blessing' in that it enforced destocking, which the Maasai had resisted, and prevented deterioration of the grazing resource (Kenya, 1933).

While the creation of the Reserve appeared to guarantee the Maasai exclusive rights to it, during the period up to 1939 two other land uses assumed some importance in the district, land uses which were later to compete with pastoralism for access to and control over resources. One was cultivation and the other concerned activities to conserve and manage the wildlife resources of the area.⁴

Areas suitable for rainfed cultivation in Kajiado District are limited to the slopes of the Ngong Hills, of Mt. Kilimanjaro and of Ol Doinyo Orok near Namanga. Cultivation in the Ngong area, which had begun with the settlement of destitute Maasai at the end of the nineteenth century (Low, 1965), expanded as increasing numbers of Maasai married Kikuyu women who cleared small plots and as relatives of these women moved into the area to farm. The impetus to these migrations from the adjacent Kikuyu Reserve was land shortage consequent upon the alienation of large tracts of land by the colonial settlers (Sorrenson, 1967). Kikuyu migrants also commenced cultivation on Ol Doinyo Orok and on the slopes of Mt. Kilimanjaro.

Among the first farmers around Loitokitok were Kamba labourers who had been recruited in 1921 to assist in the establishment of an administrative post in the town (Kenya, 1930) but by the 1930s individual Maasai were owning plots which were cultivated either by their Chagga wives or by Chagga labourers hired by the Maasai. A major incentive to cultivation was the frequent failure of the rains which led to losses of livestock and encouraged the Maasai to seek alternative sources of subsistence.

The increase in cultivation was welcomed by the administration (Kenya, 1935) but it was concerned to prevent soil erosion. Terracing was encouraged and the Kikuyu settlers on Ol Doinyo Orok caused major problems and in 1939 they were removed as they had cleared seventy acres of forest and soil erosion ensued.⁵

4. This paper is mainly concerned with the development of extensive land use activities. During the period under discussion the Magadi Soda Company and Kenya Marble Quarries expanded their activities, by 1935 the former employed about 900 men and the latter 40 men (Kenya, 1935), but these industries were not major competitors for land with the pastoral, agricultural or wildlife activities.

5. The settlement on Ol Doinyo Orok was a persistent problem for the administration and was not resolved until the Kikuyu were repatriated to the Kikuyu Reserve during the Emergency.

Kajiado District, like many others in Kenya, had abundant wildlife in the pre-colonial period (Thompson, 1885) but unlike many districts it has maintained this quality to the present day. The survival of wildlife in large numbers is a consequence partly of the actions taken by the government to preserve wildlife but more importantly of the willingness of the Maasai to coexist with wildlife.

Traditionally the Maasai controlled their interaction with wildlife by for example, moving livestock to avoid diseases such as malignant catarrh fever associated with wildebeest (Woodford et. al., 1976) and hunting predators. The colonial government altered the situation as it enacted legislation which was designed to conserve and manage the wildlife resource. As the government assumed responsibility for wildlife management so the Maasai were discouraged from taking action, such as hunting, to protect their stock. Wildlife was no longer merely to be tolerated it acquired a status as a legitimate land user in the area.

The legislation concerning wildlife which was enacted prior to World War II had little impact upon land use in Kajiado District as, though the Southern National Reserve was established by 1901 (Casebeer, 1975) the herders continued to have access to it and cultivation was concentrated elsewhere.

At the outbreak of World War II the economy of Kajiado District though predominantly pastoral, had diversified to include a substantial amount of cultivation as well as a number of extractive industries such as the Magadi Soda Company and Kenya Marble Quarries. The Maasai continued their traditional way of life though the demands of the colonial government had resulted in greater commercialisation through official sales over and above the traditional trade with the Kikuyu areas. The colonial government saw increased sales as part of a strategy designed to reduce overgrazing and soil erosion in the reserve and it was also endeavouring to protect the European livestock industry from diseases by instituting disease control programmes in the district.

1940-1960

1940-1960: This was a period of great political uncertainty in Kenya. The Second World War followed closely by the Kenyan struggle for independence resulted in major demands being made upon the Maasai economy by the colonial

administration. It was also a period in which the development of wildlife, farming and pastoral activities came to compete for the scarce land resources of the district and only the repatriation of large numbers of Kikuyu farmers to the Kikuyu Reserve during the Emergency prevented serious problems.

During the Second World War the government established a quota of sales from the Maasai whereby they would sell 2000 head of cattle per month for the duration of the war. In the event sales during the war totalled 66333 despite a severe drought from 1943-46 and by the end of the war the Maasai were considered to have been overbought,⁶ a factor which influenced the decline in sales once compulsory sales ended (Kenya, 1947).

There was also an increase in the cultivated area during the war. The migrations from the Kikuyu Reserve continued, the Maasai put a larger area under crops to offset the effects of the drought and at Konza the government put 3000 acres under wheat as a wartime emergency measure.

Immediately after the war two processes forced the government to reconsider its policy of encouraging an expansion in cultivation. One was the problem of soil erosion and forest clearance but more important was the call by the Maasai for the immigration of Kikuyu to be restricted as their farming activities were threatening the access of the Maasai to dry season grazing areas.

In 1947 a policy was implemented whereby prospective immigrants had to be approved by a Section Committee and by the Local Native Council before they could move into the District. The effectiveness of this measure in restricting immigration was limited however by the fact that many of these wishing to move into the area were brothers-in-law of Maasai who made representations for their admission and they were thus permitted to enter the district and cultivate land (Kenya, 1946; 1947).

6. On the basis of a model of the Maasai herd developed by Meadows and White (1979) it is estimated that the wartime sales represented about 75% of the males over 3 years of age which form the saleable portion of herd (J. White, 1979). This is a very high figure considering that the Maasai were also slaughtering bullocks for meat during the drought (Kenya, 1944).

The costs and benefits of extensive cultivation were demonstrated during the drought of 1948-49 in the Loitokitok area as conflict between the Maasai herders and Kikuyu and Chagga farmers resulted from the Maasai grazing livestock on the farms as grazing was scarce elsewhere and as famine was averted by the availability of maize from these same farms. The Maasai continued to express concern at the rate of expansion of cultivation and the destruction of the forest around Loitokitok and Namanga and in 1951 the situation, whereby a relatively small number of cultivators was occupying dry season grazing land upon which many herders relied, had become so serious that Land Usage Bye-Laws were introduced which gave the county council the necessary powers to control cultivation in the district (Kenya, 1951).

Limits on the expansion of cultivation were imposed but the conflict over land were abruptly reduced with the declaration of the Emergency in 1952. Thousands of Kikuyu farmers were repatriated to their Reserve from the Ngong and Loitokitok areas in 1952 and 1953 and cultivation declined considerably and did not expand again until the late 1950s, in the period just prior to independence.

The conditions of shortage of dry-season grazing which were of concern to the Maasai were exacerbated by the government's policies towards wildlife management and conservation. The National Parks Ordinance of 1945 allowed for specific areas to be set aside exclusively for wildlife as national parks and others as national reserves in which land use was to be controlled by the appropriate county council. The people of Kajiado District were affected by the gazetting of two national parks, Nairobi in 1945 and Tsavo in 1948, and the Amboseli national reserve, all of which included grazing and water resources traditionally utilised by the Maasai. They continued to have access to the Amboseli reserve however until its status was changed to that of a National Park. In 1974 though they were not excluded from it until 1977.

That the authorities recognised the importance of the resources enclosed by the parks was demonstrated by the fact that during the drought in 1949 the Maasai were permitted to take their livestock into Tsavo Park

(Kenya, 1949)⁷ but when during the dry period in 1953 the Maasai repeated their request to enter Tsavo Park they were told they could do so only if they paid a fee. They refused and dropped their request.

During this period the Maasai pastoral economy was faced with the problem of maintaining sufficient animals to meet the subsistence needs of a growing population despite frequent droughts, reductions in the grazing area due to farming and wildlife activities and the exhortations of the government to reduce their livestock holdings in order to avoid overgrazing and soil erosion.

At the end of World War II the Maasai herds were relatively small, many animals having been bought by the government and many more having died during the drought. Their principal objective was therefore to rebuild their herds and they were constrained in this by recurrent years of low rainfall in 1948-49 and by the loss of dry-season grazing to other land uses.

The incidence of drought, the poor grazing conditions and the post-war increase in the concern of the government with African agriculture gave rise to renewed attempts to improve the Maasai husbandry system. The major problem continued to be defined as overstocking leading to overgrazing and soil erosion. It was argued that were livestock numbers to be reduced then the range resources would improve and this together with veterinary activities and water development would allow the Maasai economy to develop. Lack of outlets for selling livestock was again deemed to be the critical factor and in 1947 the Meat Marketing Board was set up as the sole official buyer of slaughter stock in the district (Kenya, 1947).

The prices offered by the Meat Marketing Board, and later by the Kenya Meat Commission (KMC) and the African Livestock Marketing Organization (ALMO) were however kept low as the KMC sought to create a great margin between producer and consumer prices in order to offset its large capital and overhead costs (McWilliam, 1976, p. 260). In consequence despite repeated

7. A similar situation arose in the case of Amboseli National Park. The status of the area was altered from that of a Reserve to a Park in 1974 but as the area was then in the grip of a prolonged drought the regulations requiring the exclusion of the Maasai from the Park were not implemented until June 1977 by which time good rains had allowed the area to regenerate and grazing was plentiful.

warnings from district commissioners that the low prices were discouraging sales (Kenya, 1947) official sales lagged far behind those to private traders who offered higher prices. Up until the mid 1950s when the Tanganyika market opened unofficial sales were estimated at about double the official sales and unofficial prices were about twenty percent higher than the official prices.

Marketing problems also reduced the effectiveness of government policy. Though low prices kept sales low, in 1953, at the time of the drought the Maasai were willing to dispose of livestock but the implementation of Emergency measures included the closing of the livestock markets. It was not surprising therefore that the Maasai should have had little confidence in official efforts to stimulate sales and continued to depend upon the unofficial traders.

While they failed to institute a viable pricing and marketing policy the administrators continued to complain of overgrazing and land deterioration. Under the terms of the African Land Development Programme (ALDEV), which was set up in 1946, efforts were made to establish grazing schemes on which control of stock numbers and rotational grazing would be instituted and which would serve as an example to the herders. In Kajiado District a grazing scheme was set up at Konza in 1947 and another, the Il Kissongo Scheme near Loitokitok in 1954 (Kenya, 1954).

It was with the formulation of the Swynnerton Plan (Kenya, 1955) however that a clear policy regarding rangeland improvement evolved. The basic concern of the plan as it concerned the pastoral areas was to encourage 'sound and productive' use of the land and to avoid overstocking. Five obstacles to these objectives were identified (p. 31).

- (1) The numbers of resident stock must be limited to the carrying capacity of the land.
- (2) There must be assured and regular outlets which will absorb all excess stock.
- (3) An adequate system of permanent water supplies must be constructed.
- (4) Grazing must be controlled and managed at a productive level and owners must maintain their grazing areas.
- (5) Where access to grazing is denied by tsetse fly, provided such grazings will be controlled, the tsetse must be eradicated.

In Kajiado District a number of these obstacles were tackled in the period up to 1960 but not under any concerted plan. The ALDEV grazing scheme at Il Kissongo proved relatively successful in that rotational grazing was instituted, improved water facilities were provided and the opening of the market with a dip at Illasit enabled the herders of the area to take advantage of the high prices offered in Tanganyika. Elsewhere boreholes were provided which allowed the period over which the wet season grazing area could be used to be lengthened (Western, 1975).

Adequate rainfall in the late 1950s facilitated a growth in livestock numbers. This increase was a response not only to the subsistence needs of a growing population⁸, the Maasai were still largely dependent upon milk and meat for their food, but also to the opportunities for sale created by the demand from Tanganyika and later from the KMC which 'began a much more active policy of persuading Maasai cattle owners to sell to it.' (Meadows and White, 1979, p. 10)

During the late 1950s therefore the Maasai economy improved due to good weather conditions, range improvements, continued veterinary campaigns and particularly the development of competitive outlets for livestock paying adequate prices. The increasing offtake rates, estimated at 13% in 1956 (Kenya, 1956), were matched by a growth in total herd numbers and by 1960 the Maasai of the district had more cattle than at any previous time since the arrival of the Europeans, 630,000 (Meadows and White, 1979).

While the regulations restricting movement continued to limit expansion of cultivation, by the mid-1950s there were demands from the farmers in the Ngong area for planned holding and a start was made on laying out village allotments. Elsewhere cultivation was not developing and efforts had to be made by the administration to maintain terraces and curtail soil erosion. Competition between different land uses was at a minimum as the cultivated area had declined and as the period of herd expansion was one of adequate rainfall and good range conditions.

8. Population estimates for the district have been unreliable. An indication of the growth in numbers of the Maasai is that the 1948 Census estimated the district population of Maasai to be about 22,500 (Kenya, 1948) and the 1962 census gave the figure at about 48,000 (Kenya, 1975). The estimates of the cattle population are also subject to error but Meadows and White (1979) indicate that in 1948 it was about 360,000 and by 1959 it was 600,000.

1960-76: This period witnessed the end of colonial rule in Kenya, a more vigorous approach to rural development including the major innovation of land adjudication, a resurgence of migration into the district by non-Maasai farmers resulting in major conflict over access to land and environmentally it begins and ends with major droughts. For the Maasai it was a period of great political uncertainty, of calamity and recovery and one in which the demands of a growing population approached the capacity of the available resources to meet them.

The drought of 1960 which was followed by very heavy rains and a plague of army worms resulted in catastrophic losses for the Maasai herders. The impact of the drought should be examined in terms of pre-existing conditions. The good years of the late 1950s had seen the Maasai herds rise to a very high level thus when the drought came the range had already been heavily grazed and the large numbers of livestock had to depend upon grazing and water resources depleted both by heavy grazing and as a result of the drought. The cattle population declined from 630,000 to 208,000 from 1960 to 1962 (Meadows and White, 1979).

The major losses and the high rates of erosion caused by heavy rains on a denuded surface encouraged the new government to take action to remedy the situation. The problem of excessive stock numbers and overgrazing was again identified as the root cause but as the grazing schemes had been unable to cope with the drought conditions a new approach based upon land adjudication was developed. It was intended that by providing people with legal title to their land they would be more likely to manage it with a view to sustained output. The importance of marketing arrangements and range improvements continued to be recognised and two divisions were created within the Ministry of Agriculture with responsibility for these activities, the Livestock Marketing Division (LMD) and the Range Management Division (RMD). The LMD was charged with the movement of livestock to slaughter or to finishing and through running stock routes and holding grounds it was intended that the stock would reach their destination in better condition thus realising a better price which the LMD could pass on to the producer (von Kaufmann, 1976; White, 1978). The LMD is now having some success in northern Kenya through organised auctions and in competing with private traders the price paid for livestock has increased as have sales (Meadows and White, 1979) but in Kajiado District trader prices have continued to be

high enough to prevent profitable activity by the land. The RMD was expected to supervise the group ranches that were proposed as the basis for a more economically rational and environmentally conservative livestock management system.

The process of land adjudication was seen as fundamental to the development of Kajiado District in the post-independence period. Among the first areas to be adjudicated were those around Ngong where pressure to demarcate plots had been expressed in the 1950s. By the end of 1964 over 8000 hectares had been adjudicated as individual holdings in the area. These were small farms which were located in the higher potential eastern slopes of the hills. The adjudication of land then proceeded in the cultivated areas on the slopes of Mt. Kilimanjaro. In some cases land had been set aside as individual ranches prior to independence as local Maasai leaders and government officials who realised the potential value of the land acquired plots. The suspicions of the administration that many of these people were speculators rather than ranchers (Kenya, 1961) were realised as many of these individual ranches were divided and sold or rented to immigrant farmers during the period of adjudication. The years 1966-69 saw the completion of adjudication of the farming areas around Loitokitok and over of 16,000 hectares on the higher potential slopes of Mt. Kilimanjaro were demarcated.

The adjudication of these areas of cultivation formalised the rights of immigrant farmers to the land. The period following independence saw major migrations of farmers, particularly Kikuyu and Kamba, to the Ngong and Loitokitok areas of the district. These were areas which had long been cultivated and from which many Kikuyu were removed during the Emergency but with the ending of restrictions on movements the great population pressures which had built up in the Kikuyu reserve during the 1960s were released and many migrated to Kajiado District.

In both the Ngong and the Loitokitok areas the land adjudicated as farms represented the highest potential land in the district. Its suitability for cultivation had long been recognised but it also represented the best of the dry season grazing land available to the Maasai herders.

The adjudication of the grazing lands began in northern Kajiado with the demarcation of six individual ranches in 1962 and the Poka group ranch in 1964 (Halderman, 1972). It was soon realised that there was insufficient

land to demarcate individual ranches for everyone and this together with the fears that many would become landless and that individual ranchers might sell their land to immigrant farmers led to the general acceptance of the concept of group ranches (Hedlund, 1971). From 1964 onwards the emphasis throughout the district was on the demarcation of group ranches and by 1976 over thirty group ranches covering an area of 750,000 hectares and including over 5700 owners existed in the district (Chemonics, 1977).

The objectives of the government and of the RMD in particular regarding group ranches were that they would use their title deeds to secure loans which could be used to initiate development projects such as dips, boreholes, fences etc and that livestock would be sold to repay the loans. Thus a more commercial livestock production system would evolve. The performance of the ranches has been reviewed elsewhere (Hedlund, 1971; Davis, 1971; Halderman, 1972; Von Kaufmann, 1976; Helland, 1978) and there is a general consensus that the original objectives of the government have been only partially fulfilled.

The major cause of this situation is the divergent objectives of the Maasai and the government. The Maasai welcomed adjudication as a means of acquiring legal rights to their land because they had feared that at independence the guarantees provided by the Treaties of 1911 and 1912 would cease to apply and non-Maasai might occupy the land. The existence of a ranch did not necessarily mean that its members would limit their activities to it. The system of reciprocity between members of families, clans and age sets meant that Maasai retained rights to grazing in a variety of areas, they were not restricted to the ranches. Thus during the drought of 1972-76 herders from Kaputeie moved to the Loitokitok area where better conditions prevailed (Campbell 1979a). The objective of the government that stock numbers would be reduced was in conflict with the desire of the Maasai to rebuild their herds after the major losses of 1960-61. The traditional values regarding livestock remained important during this period and as the population increased and as the livestock continued to afford the most reliable source of subsistence⁹ so restocking rather destocking

9. Although the Maasai had become accustomed to consuming grain products during the 1960-61 drought in the subsequent years livestock remained the only reliable source of food in much of the district until the products of the immigrant farmers became available in the late 1960s. The recent changes in diet represent a major cultural change in that traditionally the Maasai 'possessed strong prohibitions against the eating of agricultural and other non-pastoral food.' (Jacobs, 1975, p. 407).

was the most appropriate strategy.

Thus during the 1960s the improvement of range facilities, good rainfall and the need to rebuild a herd capable of supporting a growing population¹⁰ resulted in the number of cattle exceeding 700,000 by 1970-71. The demands upon the districts resources generated by this number of stock were probably in excess of the long-term carrying capacity of the district but favourable weather conditions and rangeland improvements (Western 1975) enabled this number of stock to be carried.¹¹ The situation was however precarious as many of the traditional dry-season grazing areas had during this period been occupied by farmers and were thus unavailable to the herders.

The dangers inherent in the situation became evident with the onset of a prolonged period of drought in 1972. As with that of 1960-61 this more recent drought had been preceded by years of good rainfall which had enabled the herders to build up their stocks. Unlike the situation in 1960-61 drought however the availability of dry season grazing had been reduced by 1972 due to an increase in the area under cultivation. The range of resources available to a very large herd was therefore severely restricted.

10. The 1969 Census estimated the Maasai population of the district at nearly 59,000 (Kenya 1970).

11. An estimate of the carrying capacity of the district can be made on the basis of the area in each ecological zone and the carrying capacity of each zone (Pratt and Gwynne, 1977, p. 43). Campbell (1979b) estimated the total carrying capacity of the district at nearly 350,000 Standard Stock Units which would represent 700,000 cattle. The 1970-71 cattle population approached the carrying capacity of the district. The total livestock population, cattle and sheep and goats (and of course the wild-life) was therefore probably in excess of the district's long-term carrying capacity. However, the high potential lands, classified as Ecological Zone II, were increasingly coming under cultivation during the period. Although they represent only about 2% of the district's area they include nearly 8% of its average carrying capacity; in the dry season or in periods of drought their importance is increased. Therefore overstocking of the rangeland relative to the long term carrying capacity was possibly occurring at this time.

As the drought became prolonged major movements of livestock took place, herders entered the Nairobi National Park and major concentration of stock occurred where water and grazing remained available. In the farming areas crop yields declined as the drought became prolonged and foodstuffs had to be imported from other areas.

A number of factors served to reduce the threat of famine as compared with 1960-61: The production of grain in the area, albeit limited as the drought intensified, and the more efficient trading mechanisms in the country as a whole resulted in grains being available in greater quantity although its price was often very high; the development of livestock marketing facilities through the LMD and the policy of the KMC to buy all livestock offered to it enabled the herders to sell many of their stock, although the animals were often in very poor condition, and thus they could obtain cash with which to buy food; and many Maasai had diversified their economy, growing crops and keeping livestock and those who obtained a harvest were often able to meet their own needs as well as assisting relatives. In consequence, though many depended upon famine relief from the government and the missions, over much of the area the threat of famine was averted.

That the consequences in terms of suffering were not as intense as in the 1960-61 drought should not be taken as an indication that the more recent one was not severe. Campbell (1979a) in a study of the response of the people of the Loitokitok area to the drought found that both the herders and the farmers of the area had suffered from losses of livestock and failure of harvests and had the short rains of 1976 and in particular the long rains of 1977 failed the situation would have been disastrous.

The experience of the drought did however serve to highlight the constraints to the development of the economies of the district. The issue of land use conflict became evident as during the drought wildlife and domestic stock concentrated at locations where water and grazing existed. The herders realised that many traditional drought-retreat areas were occupied by farmers and in many of the remaining areas they competed with wildlife, other herders and in some cases with farmers for the available resources. The farmers, particularly those located nearer the rangelands, complained of herders and wildlife grazing in their fields and damaging fences (Campbell, 1978) and those concerned with wildlife management and conservation were confronted with the problems of complaints from farmers and herders regarding the activities of wildlife and of herders grazing their stock in large numbers within the parks and reserves.

The farmers and herders also became aware of factors within their own socio-economic systems which limited their ability to deal with drought conditions. The farmers had been in the area for an insufficient time for them to develop social mechanisms for reducing the effects of drought and many of them had been planting crops suited to the good rainfall conditions which prevailed in the 1960s when they first settled in the area but ill-adapted to the more variable rainfall of the 1970s. They also cultivated relatively small areas which produced insufficient harvests under conditions of reduced yields. In order to improve their situation many farmers expressed intentions of planting more drought-resistant crops and of increasing the area under cultivation. They stated a desire to cultivate those areas within the rangelands, such as river valleys and swamp margins, which have soil and moisture conditions suitable for cultivation. Improvements in water supply and in grain storage and marketing facilities were also mentioned as potentially improving their economy as these would enable them to produce a surplus in good years which might be stored for use in the dry season or in periods of drought (Campbell and Mbugua, 1978).

The Maasai of the district also recognised the need to take measures to reduce their vulnerability to drought. While the majority saw the traditional strategy of rebuilding the herd as being the most effective many stated that diversification of the economy involving the growing of crops, and the sale of livestock and the saving of cash would be beneficial (Campbell (1979a).

The difficulty with the range of strategies proposed by the farmers and the herders of the district is that they involve a greater demand for those land resources which were demonstrably in short supply. Both the farmers and many Maasai expressed the desire to bring more land under cultivation but there remained relatively few areas, such as swamp margins and river valleys, where possibilities for rainfed or supplementary - irrigation agriculture exist. In the event of such areas being cultivated the shortage of dry-season grazing for pastoralists would be intensified and the farmers cultivating in these areas would be more prone to crop damage by wildlife and livestock.

The situation whereby the herders are faced with diminishing dry-season resources was made worse in the Loitokitok area by the changing of the status of the Amboseli National Researve to that of a National Park. The regulations of the National Parks prohibit grazing within them

but as the area changed its status during the drought, in 1974, an exception was made and the herders were not excluded until the grazing had recovered outside the park in June 1977. The Ministry of Wildlife and Tourism has come to recognise that while tourism may be a major earner of foreign exchange the conservation of wildlife entails major costs to the people in the areas occupied by wildlife and adjacent to national parks. These costs are associated with competition over forage, disease spread, damage to crops and property and predation and as the problems faced by adjacent land uses, pastoralism and farming, have increased so has criticism of wildlife management policies.

Kajiado District has been at the centre of efforts designed to reduce conflict between wildlife and other land uses while maintaining and exploiting the wildlife resource. The two national parks in the district, Nairobi and Amboseli are among the greatest attractions in the country, and in order to better plan the utilization of these areas the Kenya Government in association with the FAO carried out a comprehensive review of the wildlife activities in the district. One important outcome of that review was the proposal that landowners should be compensated for the losses incurred by tolerating wildlife on their land through the payment of Wildlife Utilization Fees (Thresher, 1976). These fees would be calculated on a regular basis in proportion to the numbers of wildlife identified in an area from aerial reconnaissance. Other provisions for compensation are set out under the Wildlife Conservation and Management Act (Kenya, 1977) but difficulties in assessing the appropriate rate of compensation have limited its effectiveness. The government has also recognised the need to enter into closer contact with landowners over the wildlife issue and to this end the Department of Wildlife Conservation and Management is embarking on a programme whereby officers will be trained specifically with a view to encouraging cooperation between landowners and those concerned with wildlife (FAO et. al., 1978).

These activities on the part of the government have been supported by the work of other organisations and individuals concerned with wildlife conservation and management. Detailed plans for the future of the Amboseli area were prepared in 1973 (Western and Thresher, 1973) which included provisions whereby ranches surrounding the Park could obtain direct revenue from the tourist industry by building camping or lodge facilities for tourists and indirect revenue from the employment and tourist expenditures generated by the Park.

The Ministry of Wildlife and Tourism and the Ministry of Agriculture have both proposed comprehensive development programmes for Kajiado District. The encouragement of both cultivation and of a more commercially oriented livestock sector has however led to serious difficulties over the allocation of scarce productive land resources. The situation has been complicated by the wildlife activities, a fact recognised by those concerned who have initiated discussions on how to incorporate wildlife management as an activity which can contribute to the overall growth of the district's economy. In order to resolve some of the issues of resource allocation a district-wide evaluation of the land use situation is required.

The processes of land use change during the years of heavy rainfall which have followed the drought have made the need for such an evaluation more urgent. The livestock population is recovering rapidly and there has been a considerable expansion in the area under cultivation both by Maasai and non-Maasai farmers. They have responded to the shortages during the drought by increasing cultivation along river valleys such as that of the Kiserian at Ngong and the Lolterish at Kisanjani and around the margins of swamps such as Kimana. As farmers cultivate less productive land and in doing so further reduce the pastoralists' dry season grazing resources so both the farmers and the herders become more vulnerable to drought, the dangers of overgrazing at locations of cattle concentration increase and the viability of the district's economy threatens to decline.

The period since Independence has been one in which many of the development problems identified during the colonial period have assumed major importance. The potential for overgrazing increased as the herds expanded to meet the subsistence needs of a growing population but the resources available to livestock actually decreased as land was brought under cultivation and set aside as National Parks exclusively for the use of wildlife. The concentration of large numbers of livestock on a restricted range of resources, particularly during the drought of 1972-76 raised fears of major land degradation. Given the situation of increased demands on finite resources within the existing technological social and economic environment such fears may now be justified whereas

in the past they may not have been.¹²

Another frequently identified constraint which continued to be apparent after independence was that of the irrational meat pricing policy. During the colonial period official prices paid to the African producer were kept low in order to provide a wide profit margin and the Maasai preferred to sell to private traders whose relatively low overhead costs enabled them to offer higher producer prices. The failure of the government to employ a pricing policy which would provide an incentive to the Maasai to sell on the official market limited the ability of other bodies such as the RMD, the LMD and the Veterinary Department to meet the objectives set out for them. Calls for a more rational pricing policy were made as early as 1947 (Kenya, 1947) and have continued to the present (Perberdy, 1970; Von Kaufmann, 1976; Chemonics, 1977). Since the end of the drought in 1976 there has been a steady increase in the price paid to herders for livestock and sales have increased.¹³

12. The problem of overgrazing was frequently identified during the colonial period as the major constraint to livestock development and a wide variety of strategies - enforced sales, grazing schemes, group ranches etc. were evolved to deal with it. Close examination of the historical record suggests that overgrazing was more a recurrent problem consequent upon drought than a continuous constraint to the development of the livestock industry. The Annual Reports Kajiado District speak of overgrazing as a problem after or during droughts and in a number of years when good range conditions prevailed specific attention was drawn by the District Commissioner that no overgrazing existed or that it was limited to areas of livestock concentration (Kenya, 1938; 1948; 1951; 1954). It may have been more appropriate in the context of the conditions in which the livestock economy was developing to have identified drought rather than overstocking as the constraint. A further factor concerning the importance given to overgrazing as the basic issue may have been the coincidence of drought (during which overgrazing may have occurred as the carrying capacity would have been suddenly reduced) and major reverses of development. The Carter Commission (Great Britain, 1934), the post-World War II period, the Swynnerton Plan (Kenya, 1955) and the move to independence around 1960 all coincided with years of drought and major livestock losses. Within the prevailing Maasai economy such losses were anticipated and strategies had been evolved to accommodate them however to policy makers the situation appeared irrational and in need of change, the Maasai economy was viewed as a destructive rather than as a viable production system upon which a more commercial system could be developed.

13. Throughout the district sales are increasing as the prices paid for livestock have risen. In the Ngong area smallstock in particular are being sold in larger numbers (Hillmann, 1979) while some young Maasai have begun selling cows (Meadows, 1979). Should this trend continue it would suggest that those who stated that they would begin to sell more livestock as a means of improving their economy (see p. 17 above) are in fact doing so.

For the Maasai to be able to become more commercialised in their herding activities alternative subsistence to livestock products would have to be consumed. White and Meadows (1979) provide evidence that purchased foods are becoming increasingly important to the Maasai. The effectiveness of purchased food as a means of supporting people through drought has yet to be tested but should grain supplies prove to be a reliable alternative to livestock as a provider of subsistence in a future drought then more Maasai herders may be willing to follow a more commercial production strategy. Such a strategy might involve a change in the herd structure to include fewer females or, alternatively, greater reliance on small stock which are more efficient than cattle in transforming grass into meat and which have a great commercial value both on domestic and overseas markets (Chemonics, 1977).

The economy of Kajiado District is therefore undergoing major changes. Cultivation is expanding, and is being encouraged to expand by the district administration (Kenya 1975), the wildlife-based sector is becoming increasingly aware of its interaction with other sectors of the economy and there are indications that the livestock-based sector is becoming less subsistence oriented.

Development planning for the area should be based upon a recognition that such changes are taking place and should seek to evolve an approach which would permit the development of different sectors within the constraints imposed by the limitations of productive land and the demands of a growing population. An integrative approach similar to that being evolved by the wildlife sector should be encouraged.

The lack of productive land relative to the demands for it from the farming, herding and wildlife systems is perhaps the major constraint to development. The land shortage may give rise to innovations which overcome the problem but contemporary trends towards more extensive rather than intensive land use particularly in the farming sector, may inhibit this. There is a need for the preparation of a land use plan for the area which would allocate the land resources on the basis of availability

and demand and which would encourage the development of more intensive production systems.¹⁴

The farming systems of the district may be strengthened by the development of crops better-suited to the environment, by the provision of more reliable water supplies and by improving storage and marketing facilities. The amount of arable land is limited and the migration of farmers into more favourable locations within the rangelands entails a greater risk of crop failure as well as a greater likelihood of conflict with herders and wildlife. Research into those aspects of the farming system which would encourage more intensive land use is therefore needed.

The pastoral system has for long laboured under the dual handicaps of a negative official attitude arising from the concerns with overgrazing, erosion, cultural backwardness etc. and irrational pricing and marketing policies. The latter problem appears to be less important at present and recent reviews of the livestock industry (Chemonics, 1977; UNDP-FAO, 1979; Kenya, 1979a) may lead to a more rational national livestock industry which would provide a stimulus to greater commercial activity on the part of the Maasai. The problem of land shortage is a very real one however, and is a consequence of the pattern of land use change in the district over the past fifty years rather than of any inherent irrationality on the part of the herders. There is clearly a demand for livestock products¹⁵ and the Maasai increasingly responding to that demand, but without incentives to reduce their reliance upon livestock for subsistence the problem of demand exceeding the capacity of the environment to provide will become more severe.

14. One approach to the problem of land shortage would be to assign specific areas of land for specific activities. Zoning, such as that proposed by the Maasai in the 1950's (see p. 8) might be instituted to protect dry-season grazing lands from cultivators. Campbell (1979b) draws a distinction between cultivation which is compatible with herding and that which is not. Compatible cultivation would entail crop production during the wet season when the livestock is dispersed while in the dry season the stubble and fallow would be available for grazing. Incompatible cultivation which excludes grazers from the land is the existing form. Zoning which allows for compatible cultivation would permit more intensive land use and a more flexible mixed farming economy which many Maasai favour.

15. Two recent studies have suggested that by the 1990s Kenya will have to import meat to satisfy demand (Chemonics 1977 Shah 1978). In view of the fact that Kenya has such great potential for rangeland development this is a deplorable state of affairs.

A concerted effort is therefore needed to develop the livestock sector and stimulate activities which will enable the growing population to be supported. Greater diversification through crop production as well as livestock raising¹⁶, stimulation of sales through a realistic pricing policy, measures to increase the value of the livestock enterprise by diverting value-added to the producers through locally owned fattening and slaughtering facilities and investigation of non-farm employment in livestock-based industries¹⁷ are among the policies which should be considered.

The importance of the non-farm sector arises from the developing situation under existing trends whereby the subsistence needs of the population may outstrip the capacity of the land before 2000 AD (Campbell 1979b). Even if radical changes in livestock management practises occur there are limits on the number of people that can be supported in land-based activities. The employment possibilities associated with the livestock, wildlife and possibly farming sectors should therefore be investigated and if viable opportunities exist, they should be encouraged.

16. Increasing cultivation by Maasai herders, a strategy favoured by many as a means of reducing the effects of drought (Campbell 1979a), is taking place. Individual Maasai are clearing plots e.g. at Kisanjani while Rombo group ranch is considering putting selected areas under crops. (Matampash, 1979).

17. A recent report (Winters 1978) states that Kenya has the capacity for one or two new tanneries operating as large-scale units. An alternative strategy aimed at decentralising industry, as proposed in the 1979-83 Development Plan (Kenya, 1979b) and in the government policies for Arid and Semi Arid areas (Kenya, 1979c), would be to construct a larger number of smaller units. Such a strategy would involve major costs in that the rate of return on invested capital would be about one-half that of the larger units and it would involve a great deal of support from the government with regard to quality control marketing and price incentives etc. (Winters, 1979). However such a strategy would have the major benefits of creating rural employment and reducing rural-urban migration. The Loitokitok area of Kajiado District might be a suitable location for such an industry which, beginning with a slaughterhouse and tannery, might eventually develop into a fully integrated leather-goods industry.

CONCLUSION

The economy of Kajiado District has undergone major changes in the past eighty years. While pastoralism remains the predominant activity its viability has been undermined by the loss of important dry season grazing resources to wildlife and farming activities. The processes by which this situation has arisen are as much a consequence of events external to the district, such as land alienation and land shortage in high potential areas and the development of a national tourist industry, as they are of internal factors such as population growth and the maintenance of traditional livestock management strategies. The population of the district is adapting to the opportunities and constraints consequent upon the greater participation of the area into the national economy but in the absence of integrated land use planning conflict over the available land resources is increasing.

If a situation characterised by land degradation, landlessness, unemployment and outmigration is to be avoided a development plan should be prepared which emphasises strategies designed to provide employment for the population in land-based and off-farm activities and to conserve the area's resources through land use planning. The potential contribution of the area to national development through wildlife/tourism, herding and farming is great. The population has valuable traditional skills and it is responding to changes in the national economy but in the absence of a concerted effort to develop a strategy which integrates the district's economies both with each other and with the national sectoral developments its resources will be at best underutilized and at worst squandered.

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