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Miscellaneous Soil Paper No. 4
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1. INTRODUCTION

Owing to the rapid growth in population in Kenya, the pressure on agricultural land is increasing, thereby calling for an optimum use of the available land resources. Implicit in optimum use is appropriate agricultural development. For the formulation of an effective agricultural development plan, the quantity and quality of the national land resources and their agricultural potential must be known.

To provide the Government with the desired information, the Kenya Soil Survey, with the support of Dutch Technical Cooperation, is making a number of reconnaissance soil surveys in areas which are representative of much larger areas throughout the country. The results of these surveys will provide the basis for multi-purpose land use planning. A required intermediate step between soil surveys and land use planning is land evaluation.

In its land evaluation, the Kenya Soil Survey is following the approach outlined in "A Framework for Land Evaluation" (1). This publication presents guidelines for land evaluation, the result of an Expert Consultation on Land Evaluation for Rural Purposes held in Wageningen, The Netherlands, in October 1972. The Consultation was convened by the Food and Agriculture Organization of the United Nations (FAO) in cooperation with the University of Agriculture and the International Institute for Land Reclamation and Improvement in Wageningen (ILRI).

Discussions at the Consultation centred on proposals put forward in a "Background Document" (2) prepared prior to the meeting by two multi-disciplinary committees, one within FAO, the other in The Netherlands.

The approach advocated in the "Background Document" and other basic papers (3, 4, 5) systematically relates the physical qualities of the land with the ecological and agricultural requirements of crops and with the requirements of specific land uses. This results in a suitability classification of the land for certain defined types of land use.

In its earliest stages land evaluation should make a selection of types of land use that are relevant under the given environmental, socio-economic, and national (or regional) political circumstances. To facilitate and to standardize the land evaluation procedure, the concept "land utilization type" has been developed. A "land utilization type", also known as "land use alternative" or "development alternative", expresses, in a generalized form, the management factor in rural land use. It is a technically and organizationally homogeneous type of land use within a specific socio-economic and socio-political setting.

In defining a land utilization type a varying number of essential land use characteristics, also known as "key attributes" are considered. These key attributes are selected for their marked influence on the productivity of the land. The most important are:
1) kind of produce, 2) capital intensity, 3) labour intensity, 4) farm power, 5) level of technical know-how, 6) farm size, 7) land tenure, 8) technical and institutional infrastructure (roads, markets, etc.) and 9) location.

Ecological zones serve as a basis for land evaluation within these zones evaluation areas are delineation, such that the socio-economic conditions are more or less homogeneous throughout these areas. Within a specific evaluation area each relevant land utilization type (or development alternative) should be evaluated independently of other uses of the same tract of land (3, 6).

To assist in the evaluation of the land resources in the Kwale soil survey area, and more particularly in the definition of the relevant land utilization types in that area, the author of the present report participated in the Kenya Soil Survey Project from 1 to 21 March 1976. The statistical data considered for this report were those related to the state of agriculture in 1975. More recent information was not taken into account.

Due to the general lack of basic data, difficulties were encountered in defining the land utilization types presented below. Some "key figures" had to be deduced from other related data or from similar data from elsewhere. This fact should be kept in mind when reading this report.

2. THE KWALE SOIL SURVEY AREA

General

The Kwale soil survey area covers more than half of the Kwale District, which is situated in the south-east of Kenya (see Fig. 1). The eastern boundary of the area is formed by the coastline along the Indian Ocean from Mombasa to the Tanzanian border. In the south, the area is bounded by the Kenya-Tanzania border. The western boundary runs north-south through the extensive Kwale range lands and the northern boundary runs east-west through Mombasa. The area covers some 4,000 km^2. From an agricultural point of view the area is very heterogeneous because of the wide variation in annual rainfall and with marked differences in soil conditions. This results in a strong spatial variation in population density and land use.

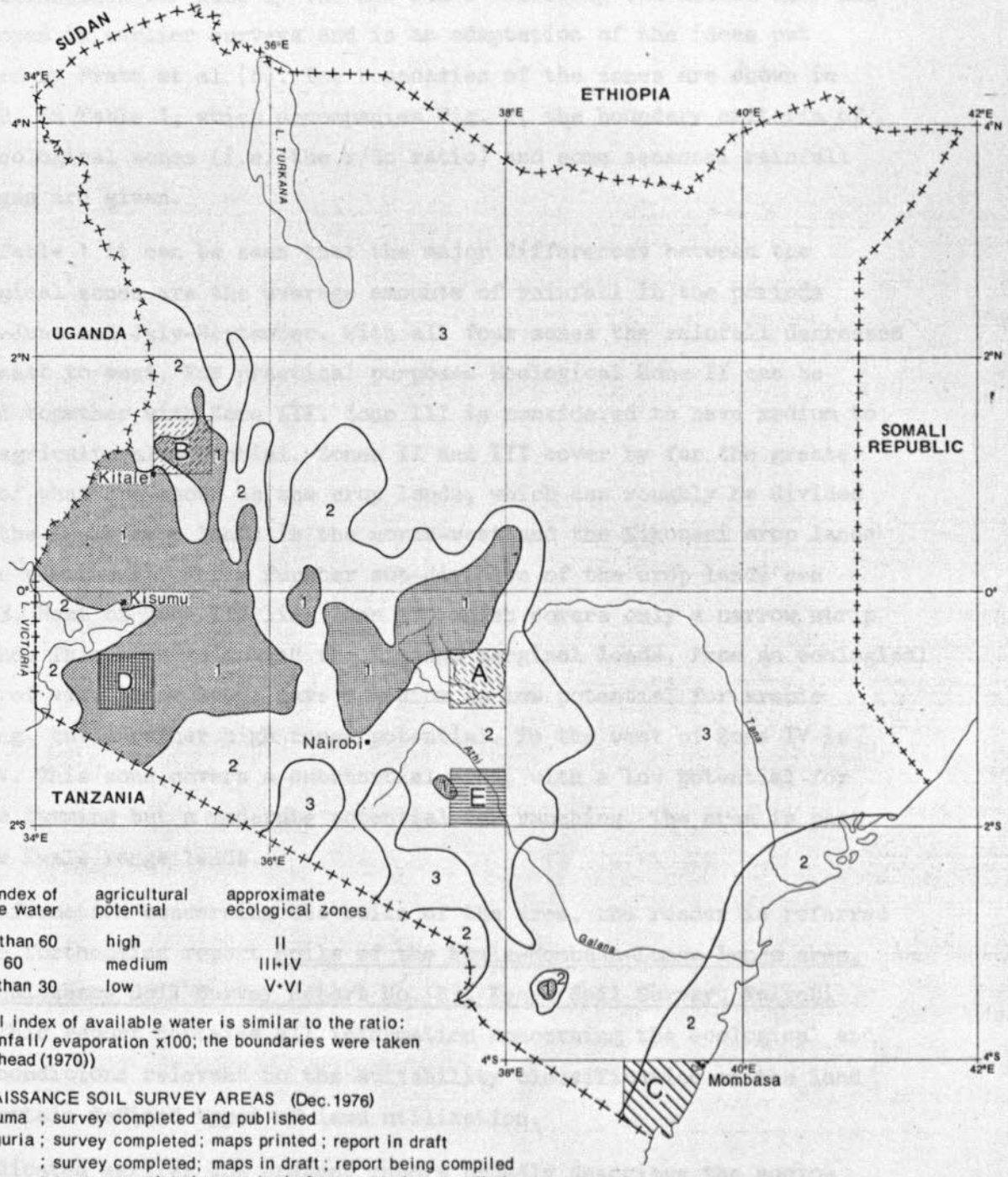
Climate and soils

The Kwale soil survey area has a monsoon type of climate. The year starts hot and dry and remains so until the end of March or early April when the "long rains" start. April and May are the wettest months of the year and they account for 45% of the annual rainfall in a coastal belt of some 10 km and for 30% of the annual rainfall in inland areas. The long rains peter out during the period June-August, which is the coolest period of the year. The "short rains" are virtually absent at the coast (October-November: 15% of annual total). Further inland, they are more important (October-November: 22% of the annual total). The period October-December is hotter than the period April-June, particularly at the coast (27% and 22% of the annual evaporation respectively, versus 25 and 24% for inland areas). December is transitional to the dry season. The average annual rainfall varies from 1400 mm at the south-eastern part of the coast to 600 mm along the western edge of the soil survey area. The average annual evaporation is of the order of 2200 mm (7).

Based on the differences in the ratio between average annual rainfall and average annual potential evaporation, and aided by differences in vegetation, the Kwale survey area has been divided into four climatic or ecological zones.

Fig. 1

KENYA - ECOLOGICAL ZONES AND RECONNAISSANCE SOIL SURVEY AREAS



annual index of available water		agricultural potential	approximate ecological zones
1	more than 60	high	II
2	30 to 60	medium	III•IV
3	less than 30	low	V•VI

(the annual index of available water is similar to the ratio: annual rainfall/ evaporation x100; the boundaries were taken from Woodhead (1970))

RECONNAISSANCE SOIL SURVEY AREAS (Dec. 1976)

- A Kindaruma ; survey completed and published
- B Kapenguria ; survey completed; maps printed ; report in draft
- C Kwale ; survey completed; maps in draft ; report being compiled
- D Kisii ; survey completed; maps in draft; report being compiled
- E Makueni ; field work being carried out

20 0 20 40 60 80 100 120 140 Km

Drawing No. 76035
Misc. Paper No. 4

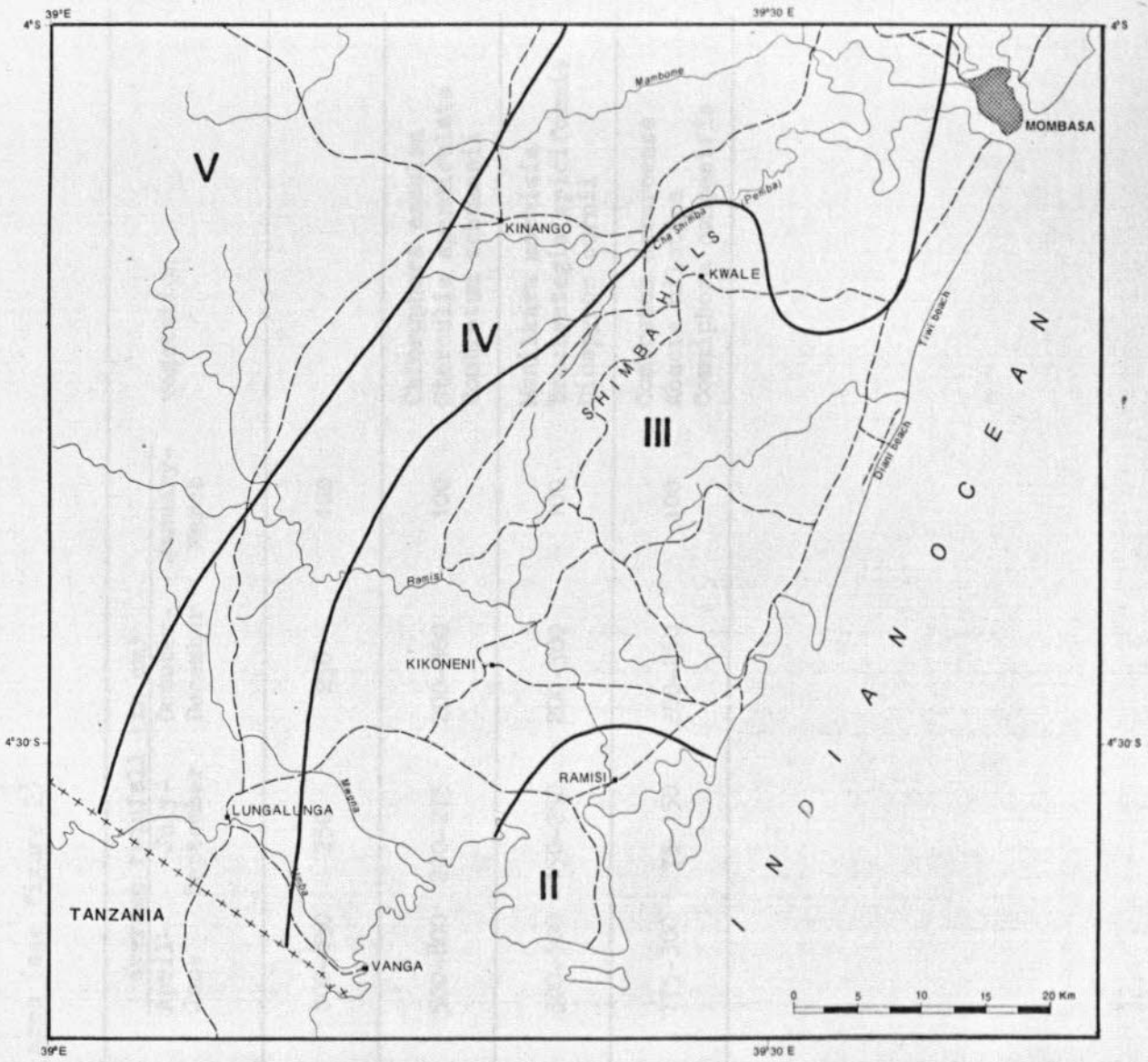
The delineation was done by the KSS staff following the method they had developed in earlier surveys and is an adaptation of the ideas put forward by Pratt et al (8). The boundaries of the zones are shown in Fig. 2. In Table 1, which accompanies Fig. 2, the boundary criteria of the ecological zones (i.e. the r/Eo ratio) and some seasonal rainfall averages are given.

From Table 1 it can be seen that the major differences between the ecological zones are the average amounts of rainfall in the periods April-June and July-September. With all four zones the rainfall decreases from east to west. For practical purposes Ecological Zone II can be lumped together with Zone III. Zone III is considered to have medium to high agricultural potential. Zones II and III cover by far the greater part of what are known as the crop lands, which can roughly be divided into the Kwale crop lands in the north-west and the Kikoneni crop lands in the south-east. For a further sub-division of the crop lands see Fig. 3. West of Zone III lies Zone IV, which covers only a narrow strip of land. This area is called the Kinango marginal lands. From an ecological point of view these lands have a medium to low potential for arable farming, but a rather high range potential. To the west of Zone IV is Zone V. This zone covers a substantial area, with a low potential for arable farming but a moderate potential for ranching. The area is part of the Kwale range lands.

For information concerning the soils of the area, the reader is referred to the forthcoming report Soils of the Kwale-Mombasa-Lunga lunga area, Reconnaissance Soil Survey Report No. R3, Kenya Soil Survey, Nairobi (9). This report contains all information concerning the ecological and soil conditions relevant to the suitability classification of the land for certain defined types of land utilization.

As indicated earlier the present report broadly describes the socio-economic conditions in the survey area and defines the relevant types of land utilization. It should be noted that, except for the obvious socio-economic considerations, this classification is almost exclusively based on ecological considerations. The soil characteristics and the technical suitability of each identified tract of land are dealt with in the above-mentioned report "Soils of the Kwale-Mombasa-Lunga lunga area".

Fig. 2 ECOLOGICAL ZONES IN THE KWALE SOIL SURVEY AREA



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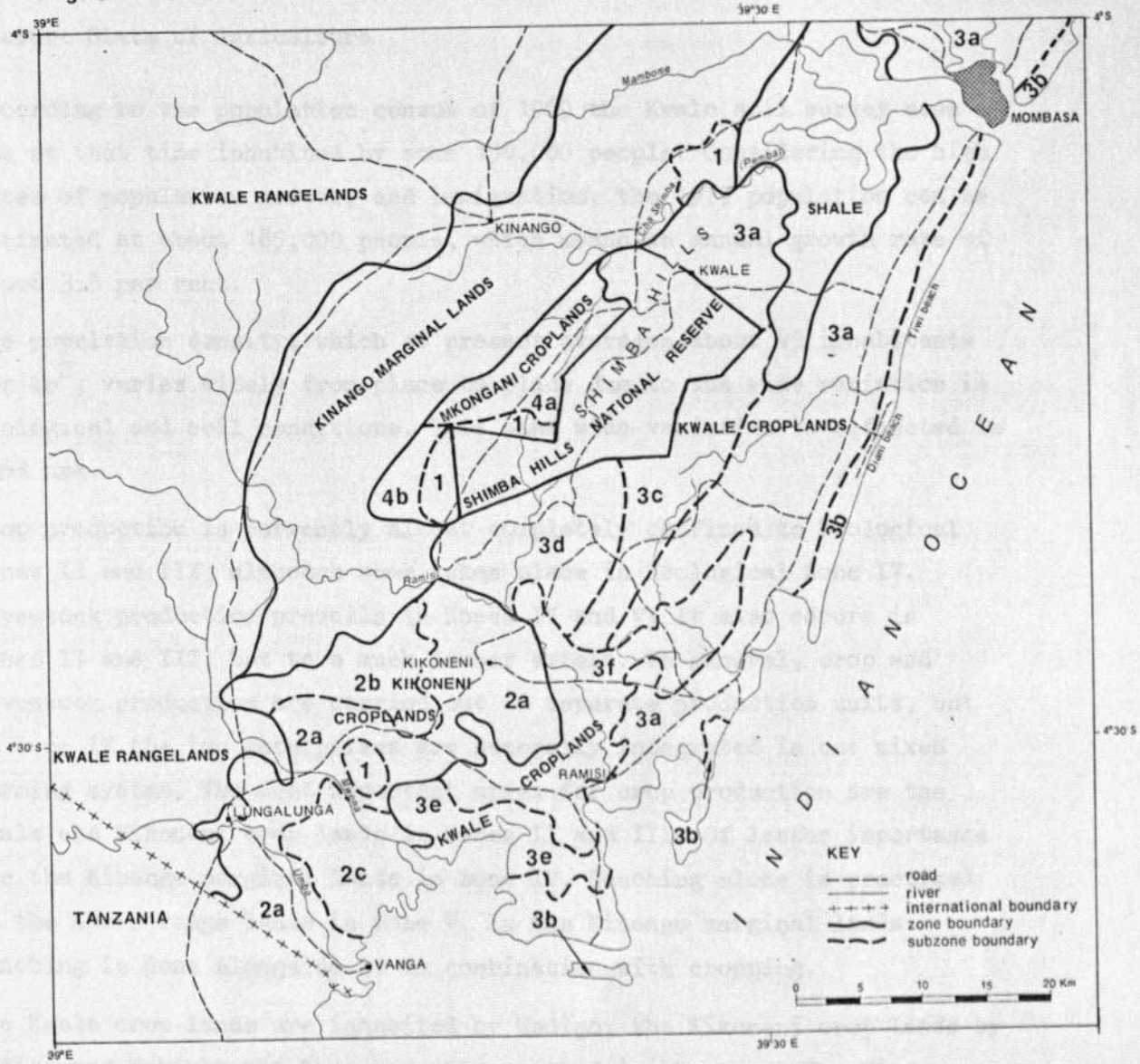
Misc. Paper No. 4

Table 1. Ecological zones of the Kwale area (see figure 2)

Zone	ratio r/E_o (in %)	average annual rainfall (in mm)	average annual evaporation E_o (in mm)	average rainfall (in mm) April-June	July-September	October-December	January-March	vegetation
II	67-69	1400-1450	2100	800-850	250	250	100	
III	52-67	1100-1400	2000-2100	500-800	200-275	200-300	100	Chlorophora excelsa Sterculia apendiculata Combretum schumanii
IV	37-52	850-1100	2100-2200	300-500	150-250	200-300	100	Manilkara mochisia Brachystegia spiciformis Diospyros cornii
V	26-37	600-850	2200-2300	175-300	75-150	200-250	100	Combretum hereroense Acacia nilotica Commiphora campestris

Fig. 3 LAND USE ZONES IN THE KWALE SURVEY AREA



SUBZONES

1	gazetted forest
2a	Kikoneni croplands sensu stricto
2b	Jombo croplands
2c	Clay grasslands
3a	Kwale croplands sensu stricto
3b	Kwale coastlands
3c	Shimba Hills croplands
3d	Lukore croplands
3e	Majoreni croplands
3f	Mwachande sands
4a	Mkongani croplands north
4b	Mkongani croplands south

From: D.O. Michieka, B.J.A. van der Pouw, J.J. Vleeshouwer (1977)
Soils of Kwale-Mombasa-Lungalunga area

Drawing No. 77035
Misc. Paper No. 4

The final synthesis between land evaluation and the relevant social and economic factors should result in an economic land evaluation. A preliminary attempt to that effect is given in the report "Soils of the Kwale-Mombasa-Lunga lunga area" in a chapter on recommended land use.

Present State of Agriculture

According to the population census of 1969 the Kwale soil survey area was at that time inhabited by some 150,000 people. Considering the high rates of population growth, and immigration, the 1975 population can be estimated at about 185,000 people, which means an annual growth rate of about 3.5 per cent.

The population density, which at present averages about 45 inhabitants per km^2, varies widely from place to place due to the wide variation in ecological and soil conditions. This same wide variation is reflected in land use.

Crop production is currently almost completely confined to Ecological Zones II and III, although some takes place in Ecological Zone IV. Livestock production prevails in Zones IV and V. It also occurs in Zones II and III, but to a much lesser extent. In general, crop and livestock production are carried out in separate production units, but in Zone IV the two enterprises are generally integrated in one mixed farming system. The most important areas for crop production are the Kwale and Kikoneni crop lands in Zones II and III. Of lesser importance are the Kinango marginal lands in Zone IV. Ranching alone is practised in the Kwale range lands in Zone V. In the Kinango marginal lands ranching is done alongside or in combination with cropping.

The Kwale crop lands are inhabited by Wadigo; the Kikoneni crop lands by Wadigo and Wakamba who have recently settled in the area. The Kinango marginal lands and the Kwale range lands are almost exclusively inhabited by Waduruma. The Wadigo and the Wakamba practice arable farming; the Waduruma are range subsistence cultivators. The Wakamba have introduced more advanced farming methods, from upcountry.

Agriculture in the Kwale and Kikoneni crop lands can be characterized as "Smallholder rain-fed arable farming - traditional technology". Farms in the area are small, averaging 3 ha in the Kwale crop lands and 4 ha in the less densely populated Kikoneni crop lands. The major crops are cashewnut, coconut, and maize. The tree crops cover about two-thirds of the cultivated area. Maize and some minor food crops are grown on the remaining part. At present about 40 per cent of the gross area of the crop lands is under cultivation. This percentage could be increased in the future but the maximum will be 60 because of unfavourable soil conditions in large parts of the area and the need for the preservation of protective forest. On large parts of the uncultivated area livestock is grazed by non-resident Waduruma herdsmen. Crop (and livestock) production is generally practised at a traditional level and operations are largely manual. However, most of the immigrant Wakamba apply intermediate technology, including animal traction. Due to the generally low standard of husbandry, yields are low. Capital intensity is low, 150 to 200 shillings per ha for investment costs and some 50 to 70 shillings per ha for recurrent costs. Labour intensity is high, 350 to 400 man-equivalents per 1,000 ha. Average farm incomes are currently of the order of 2,500 shillings per annum, which roughly equals the average rural family income in Kenya in 1975.

In the Kinango marginal lands mixed farming is practised at a low level of technology. In general terms the type of land utilization may be characterized as "Smallholder rain-fed mixed farming - traditional technology". Farms are small, 2 ha cultivated land on the average. The Wadurama practise some crop growing, but keep livestock on a much larger area. The main crops are: maize, cashewnuts and coconuts. The annual crops, mainly maize, cover some 80 per cent of the area under cultivation; the remaining part is under tree crops. At present only 10 per cent of the gross area of the marginal lands is cultivated. This could be increased in the future, but only to 20 per cent because of the lack of suitable soils. Crop and livestock production is on a low level of technology and all operations are manual. As a result of the low standard of husbandry, yields are low.

Capital intensity is low, only 150 shillings per ha. This is mainly due to the moderate stocking rate, which is 1 Stock Unit[1] per 4 ha. Recurrent costs are 10 to 15 shillings per ha. Labour intensity in the marginal lands is also low, only 50 to 75 man-equivalents per 1,000 ha. Farm incomes are currently of the order of 2,000 shillings per annum.

In the Kwale range lands ranching is the main economic activity. The Waduruma herdsmen graze rather large herds of Zebu beef cattle, sheep and goats. As improved grazing has been introduced in large parts of the area, this type of land utilization can be characterized as "Extensive range management". The level of technology applied is low to moderate. Due to the unfavourable natural conditions and the generally poor standard of husbandry, output is low. Capital intensity is low; investment costs vary between 70 shillings per ha for unimproved grazing to some 120 shillings per ha for improved grazing. Recurrent costs are low, 10 to 15 shillings per ha. Labour intensity is very low, only 5 to 10 man-equivalents per 1,000 ha. To obtain a family income of some 2,000 shillings, which is hardly enough for their subsistence, each family needs a farm area of some 150 ha.

Large-scale farming is practised on rather limited areas in the crop lands. Large-scale sugarcane production is done on an area of some 4,500 ha near Ramisi. Some rather large tree crop estates occur along the coast.

Irrigated farming is negligible. The only irrigation scheme is found near Vanga, in the south of the soil survey area.

Forestry is of minor importance. A total area of less than 30,000 ha is kept under forest. It plays a role in the tourism industry.

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1 *In Kenya S(tock) U(nit) has been defined in relation to the grazing requirement of livestock. One S.U. equals a mature bull. In view of the composition of the livestock herd in the Kwale soil survey area 1 head of livestock is equal to 0.60 to 0.65 S.U. on the average. Sheep and goats are counted as 0.10 S.U. per head.*

Constraints to development

To give an idea of the major constraints to agricultural development in the Kwale soil survey area, the various resources used in agricultural production and their limitations will be reviewed. The resources are: Climate, Land, Labour, Capital, and Management.

Climate

In the Kwale soil survey area there is a wide variation in climate. The major factor responsible for this is rainfall. Average annual rainfall varies from 1,200 to 1,400 mm along the coast to 600 mm along the western edge of the area. Average potential evaporation ranges from 2,000 to 2,300 mm per annum (see Table 1). The rainfall pattern is bimodal in the whole area although, more inland, rainfall distribution over the year is better than along the coast. In a coastal belt of some 10 km more than half the annual rainfall falls in the period April-June. The remaining rainfall is irregularly distributed over the other 9 months of the year.

The conditions for perennial crop growing are therefore far from optimal, even in the coastal area. Hence, the production potential for perennials such as sugar cane, coconut, and cashewnut, which are currently widely grown in the coastal area, is only moderate. From the coast westwards the production potential for most perennials decreases drastically in accordance with the rainfall gradient.

The production potential for annual crops is rather high in the coastal belt, moderate to high in most of the crop lands, moderate to low in the Kinango marginal lands, and low to very low in the Kwale range lands.

Range potential in the soil survey area varies from very high along the coast to low in the north-west, with carrying capacities of 625 Stock Units and 85 Stock Units per 1,000 ha respectively. With proper range management the present carrying capacity of the range lands could be increased by some 30 per cent.

Land

Although considerable pressure on the land is being felt in some places due to the natural increase in population and to immigration, land is at present not in short supply. Nor in the coming decade is the availability of land expected to become a serious constraint, since there is ample scope for extension of the cultivated area, and since opportunities to intensify the land use in the future are abundant.

Therefore, land availability is not considered to be the "minimum factor" in farm development in the Kwale soil survey area in the present report.

Full details of the soils of the survey area will be given in the forthcoming report "Soils of the Kwale-Mombasa-Lunga lunga area" (9). In the present report, only some of the soil qualities that could hamper further agricultural development will be discussed.

One of these qualities is soil fertility. Many of the soils of the croplands are of medium to low fertility. The same applies to the soils of the Kinango marginal lands. Consequently, these soils require rather high fertilizer inputs to produce a good crop. In view of the high price of fertilizer, soil fertility could be a draw-back to rapid agricultural development. The more so, because the effect of fertilizer strongly depends on the general standard of husbandry.

Other land qualities that might hamper agricultural development are the availability of water and the moisture retention capacity of the soil. Water resources in the survey area are scarce and unevenly distributed. This hampers the settlement of immigrants, especially in the Kikoneni crop lands, and gives rise to overgrazing and soil erosion around the livestock watering points in the Kwale range lands. An extra draw-back is that the development of the available water resources is generally (very) expensive. This, added to the general scarcity of water, prevents its use for irrigated crop production. Consequently, the irrigation potential of the area is very low.

For rain-fed agriculture the rather low moisture retention capacity of many of the soils in the survey area seriously limits their production potential.

Another land quality that could hamper agricultural development in considerable parts of the survey area is the difficulty of access. This problem, however, has already drawn the attention of the authorities and, as a result, road development is an important part of the current District Development Plan for Kwale.

Two other aspects of the resource land are land adjudication and land tenure. Land adjudication is in progress throughout the area. In the crop lands difficulties could be encountered due to the serious fragmentation of holdings and to the complicated land tenure system.

Labour

Considering the small size of the holdings and the labour-extensive cropping pattern, labour supply in the Kwale crop lands is abundant. And, although the farm sizes and cropping patterns differ, the same applies to the Kinango marginal lands. In the Kikoneni crop lands, the larger farm sizes and the inclusion of a high proportion of annual (food) crops in the cropping patterns require a much higher input of labour. It is therefore not surprising that in that area animal traction is in use. Animal traction has been introduced by the immigrant farmers, who previously gained experience with this type of mechanization up country. Large-scale introduction of animal traction in the Kwale crop lands is not considered to be feasible, because of the small farm sizes and the high proportion of perennial (tree) crops in the cropping patterns. In the Kinango marginal lands animal traction could be feasible if the cultivated area per farm were to be enlarged.

Tractorization could play a role in places, especially for the land preparation for annual crops. Because of the high cost, however, it should be coupled with improved husbandry all along the line. In the small-scale sector tractorization will only be feasible if organized by contractors.

In the grazing area there is no labour problem whatsever, since livestock enterprises are considerably less labour-intensive than crop enterprises. Consequently, there is a labour surplus rather than a labour shortage.

In the large-scale arable farming areas the supply of labour seems to be adequate, but labour productivity could be increased considerably through selective mechanization, especially in sugar cane growing.

Labour productivity in the small-scale arable farming areas is at a reasonable level, but is rather low in the grazing areas.

Capital

To develop agriculture in the survey area, considerable capital inputs are required, both in the public and in the private sectors. In the public sector capital investment is needed to improve the infrastructure of the area. This includes roads, water supply, processing and marketing facilities. In the private sector the shift from traditional to intermediate technology or from intermediate to advanced technology will require sizable capital outlays for the procurement of machinery, modern farm requisites and inputs. Especially in the small-scale farming sector the financing of this development will be beyond the capacity of the individual smallholder. The supply of credit to individuals or, more practically, to groups of farmers is the only adequate answer to this problem. When landadjucation has been completed, the small-holders will be able to provide sufficient security through their title deeds.

If the supply of credit to smallholders is to be really effective, it must be coupled with considerable efforts in agricultural extension and farmer guidance.

In the livestock farming sector credit supply on a commercial basis is almost impossible because of the low creditworthiness of the (semi-) pastoralists. To raise the standard of living of the people in this sector, the Government should finance the necessary investment completely from public funds.

Management

The level of technical know-how in the survey area is generally low. This is partly due to the tradition-bound attitude of many of the farmers, which seriously hampers development. The standard of management in the area is generally low. This applies to the large-scale and small-scale arable farming sectors, as well as to the livestock farming sector.

In the large-scale sector attention should be given to the training of estate managers, and in the small-scale sector to the extension and training of the farmers. To facilitate this, the farmers should be organized in (informal) groups.

It should be realized that the upgrading of the standard of management of the numerous smallholders is a gigantic task, but is of vital importance for the agricultural development of the area. For, in the prevailing situation the (general) standard of management can safely be considered the "minimum factor" for farm development.

3. LAND UTILIZATION TYPES

For the land evaluation of the Kwale soil survey area, the area was divided into a number of more or less homogenous evaluation areas. The decision was primarily based on ecological conditions. Various development alternatives or land utilization types were considered. Within a specific evaluation area, each relevant land utilization type was evaluated independently of alternative uses of the same land.

The land utilization types that have been considered for the Kwale soil survey area are:

- Smallholder rain-fed arable farming - traditional technology
- Smallholder rain-fed arable farming - intermediate technology
- Smallholder rain-fed mixed farming - traditional technology
- Smallholder rain-fed mixed farming - intermediate technology
- Extensive range management
- Large-scale sugarcane production under rain-fed conditions - intermediate and advanced technology
- Large-scale tree crop growing under rain-fed conditions - intermediate technology
- Smallholder irrigation
- Forestry
- Tourism

All the land utilization types are described in the following pages. Although, those based on traditional technology were not considered for the future. They are described merely to provide background information as they are commonly found in the surveyed area. The variants based on a higher level of technology are expected to develop in the course of time.

To characterize each of the various land utilization types, a number of distinct factors (or key attributes) were selected. They are: kind of produce, capital intensity, labour intensity, source or farm power, technical know-how, farm size, land tenure and price structure[1)]. In addition, the most important constraints to (further) development are listed.

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1) *All prices given in this report are valid for 1975!*

3.1. Smallholder rain-fed arable farming - traditional technology

General

This land utilization type is found in the coastal zone south of Mombasa and in the adjacent crop lands of Kwale, Kikoneni, and Mkongani[1]. Although these farming areas are situated at low altitude, ranging from sea level at the coast to some 440 metres on the Shimba Hills, ecologically they have a medium to high agricultural potential because of their relatively high rainfall. As can be seen in Fig. 2 the greater part of the crop lands lies in Ecological Zone III, a smaller part, around Ramisi, lies in Zone II, and another, around Lunga lunga, in Zone IV. Data concerning annual rainfall and annual potential evaporation are summarized in Table 1. The average evaporation in the period of greatest rainfall (April-June) is of the order of 450 mm. The probability that rainfall in April-June will equal or exceed two-thirds of the potential evaporation ranges from 90 to 100 per cent along the coast to 60 to 70 per cent along the western boundary of the crop lands (7).

The gross area of the district's crop lands (excluding the Mombasa North and South crop lands) is roughly 155,000 hectares[2], of which about 65 per cent is suitable for cultivation. At present a good 70,000 hectares, or some 45 per cent, are actually cultivated[3] (11), so land is not (yet) in short supply although the land available for expansion is of a lesser quality.

In 1969 the area was inhabited by about 110,000 people[4] (12). From population projections by the Central Bureau of Statistics the 1975 population can be estimated at a good 130,000 people (13), about 90 per cent of whom are engaged in agriculture.

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1) *For the purpose of the present report, also reckoned amongst the Kwale crop lands are the Kwale coast lands, the Shimba hills crop lands, the Lukore crop lands, the Mwanchande sands, and the Majoreni crop lands; the Kikoneni crop lands embrace the Jombo crop lands, and the Mkongani crop lands the areas Mkongani North and Mkongani South (see Fig. 3).*

2) *This area differs considerably from that mentioned in the District Development Plan for Kwale District (10) because in our case soil conditions are not taken into account.*

3) *See Annex II.*

4) *Including the population of the Matuga Shales (7,500) and the clay grasslands (2,000), who largely depend on the crop lands for their living.*

Population density varies, mainly due to rainfall distribution, the highest densities being found in the areas near the coast. Average density is about 80 people per km^2.

The population of the area is growing rapidly. In the period 1962-1969 the growth rate was about 4.5 per cent per annum[1)]. This exceptionally high rate was partly due to immigration (10, 14, 15). For the period 1970-1980 a lower, but still impressive, growth rate has been projected, i.e. 3.5 per cent per annum[1)]. The projected drop in the growth rate, which is rather drastic, is obviously based on the assumption that immigration into the crop lands will decrease during the current decade.

The major ethnic group is the Wadigo, who occupy by far the greater part of the area. Throughout the crop lands, and in particular along the border of the Kinango marginal lands, some Waduruma are found. In recent years groups of Wakamba have been moving in, especially into the northern part of the Kikoneni crop lands, the Jombo crop lands and around Shimba Hills (10). They are settled in schemes of the Ministry of Lands and Settlement. Technical aid is given to these schemes by staff of the Ministry of Agriculture (16).
Both the Wadigo and the Wakamba practise arable farming, whereas the Waduruma are range subsistence cultivators.

The immigrants are, in general, considerably more progressive than the indigenous farmers. However, amongst the original population small groups of progressive individuals are gaining influence. They are playing a leading role in modernizing society.

Produce

According to a survey conducted in May 1976 (11) - in the middle of the rainy season - tree crops are widely grown in the crop lands. They occupy about two-thirds of the area under cultivation. On the remaining part of the cultivated area, annual (food) crops are grown. The most important tree crops are cashew nut and coconut which together constitute about 90 per cent of all tree crops. The area under cashew is about twice the area under coconut.

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1) *Calculated on the basis of "Population Projections by District, 1970-1980". (13).*

Other tree crops are mango and citrus (11, 16). Bixa, a shrub - like perennial crop, is grown on a small but gradually increasing area.

The major annual crops are maize and cassava. Maize is by far the dominant one, covering almost 90 percent of the area under annual crops (11)[1]. Other annual crops are rice, sesame, groundnuts, cow peas, pigeon peas, grams, and sweet potatoes (16).

Inter-cropping is widely practised, resulting in complicated cropping patterns. As a result data on crop distribution vary substantially from one source to another (see Annex III).

The cropping pattern described above applies to the small-scale farming area which, occupies about 90 per cent of the area under cultivation. (Large-scale farming of sugar cane and tree crops will be discussed separately, being alternative land utilization types).

Within the crop lands the crop distribution varies from place to place, but there is a distinct decrease in the ratio of tree crops to annual crops from the coast westwards. In the Kwale crop lands the cropping pattern is roughly 80 per cent tree crops and 20 per cent annual crops. In the Kikoneni crop lands only one-third of the cultivated area is under tree crops. The Mkongani North cropping pattern resembles that of Kikoneni, while in the Mkongani South area it is more or less like that of Kwale.

Farmers generally grow traditional varieties. In the framework of the Special Rural Development Project for South Kwale, however, the introduction of improved planting material is emphasized. To this end tree crop nurseries have been established at the Agricultural Research Stations at Mtwapa, Matuga, and Msambweni. They produce mainly coconut seedlings, but also mango and citrus (17). Seed of improved maize varieties "Katumani composite" is also being distributed, but only a small percentage of the maize area is planted with these varieties (16).

Because of the low standard of crop husbandry, yields are generally low (10, 18, 19). Fertilizer is rarely used, and pest and disease control leaves much to be desired (16, 18).

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1) *The area under cassava might have been underestimated because of the practice of intercropping in the tree crop areas.*

Rhinoceros beetle is by far the most devastating pest in coconuts. According to Bulder (18) the crop is heavily infested and over 15 per cent of the palms have already been destroyed. The low standard of field hygiene is considered the major cause of this pest (18, 19). Other serious pests are cashew weevil in cashew nuts and stalk borer in maize. Among plant diseases, cassava mozaic and coconut bole rot are the most damaging (16).

No yield data are available. Yield estimates were therefore derived either from related data that were available (marketed produce, food requirements, etc.) or from literature on relevant crops under similar conditions. The yield of cashew nuts was thus estimated at 500 kg per ha (11, 16, 19, 20, 21, 22, 23); coconut at 400 kg copra per ha (18, 19, 24); and maize at 1,350 kg per ha (19, 25). In general, yields will be highest at the coast and will gradually decrease inland because of the lower rainfall.

Over 80 per cent of the cashew nuts are classified as first grade and are exported (unshelled). The quality of the copra is generally moderate to low because most of it is sun-dried. Kiln drying is unpopular because of the added expense, which is not compensated by an adequate premium.

Livestock does not play a significant role in the present land utilization type because few Wadigo have stock (26). Nevertheless, there are an estimated 60,000 S.U. in the crop lands (10) but most of these belong to Waduruma herdsmen who live in the adjacent Kinango marginal lands and in the Kwale range lands. The greater part of the livestock herd consists of Zebu beef cattle. About 10 per cent of the livestock units are sheep and goats[1)]. Because of the favourable ecological conditions in the crop lands, the carrying capacity is high, e.g. 1 S.U. per 1.6 ha (27), and consequently the net returns per ha are also relatively high, being of the order of 15 to 20 per cent of the net returns per ha from crops.

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1) 10 sheep or 10 goats = 1 S.U.

Capital intensity

Capital intensity on the average small-holding is low, only 150 to 200 shillings per ha. This total per ha investment can be broken down as follows: farm equipment 20 per cent, (small) stock 65 per cent, and working capital[1] 15 per cent. This amount obviously excludes any investment in land, farm buildings, or trees. The investment in trees is low in terms of money, because of inter-cropping with food crops in the early stages of tree development (19). However, to cover the investment in time for crop maintenance throughout the lifetime of the trees, the compensation rates for land adjudication are fixed at 100 shillings for a mature cashew or coconut tree (28).

This works out at some 6,500 and some 12,000 shillings per ha for cashew and coconut plantations respectively.

The recurrent costs are estimated at 50 to 70 shillings per ha.

It should be noted that capital intensity on the farms of the settlement schemes in the Kikoneni crop lands is notably higher than average because many of these farmers employ animal traction and use more agricultural inputs than the indigeneous cultivators (14, 15). Capital intensity on the Wadigo farms is somewhat below average.

Labour intensity

The labour intensity on the smallholdings is high, 350 to 400 man-equivalents per 1,000 ha, because land preparation for food crops is mainly done by hand. The labour intensity of the major tree crops is considerably lower, namely about 250 to 300 man-equivalents per 1,000 ha (29). However, the inclusion of food crops such as maize and cassava in the cropping pattern has a strong heightening effect on the average per ha labour intensity (25).

Despite the higher percentage of food crops in the cropping pattern the per ha labour intensity on the Wakamba farms is about 30 per cent lower because of the use of animal traction for land preparation.

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1) *Working capital has been arbitrarily defined as 50 per cent of the annual cash expenditure.*

Farm power

On the traditional Wadigo smallholdings, crop cultivation is entirely by hand, with the jembe as the most important and the most widely used implement (26). On the Wakamba farms in the settlement schemes, animal traction is commonly used (14). Tractors are virtually not used.

Technical know-how

The level of technical know-how of the indigeneous cultivators is low and, consequently farming practices are poor (18, 26). The immigrant farmers obviously have a higher level of technical know-how. This is partly attributed to the fact that the general level of education of the immigrant people is higher than that of the indigeneous population (14, 26).

Farm size

The average cultivated area in the crop lands is about 3.5 ha, although farm sizes vary widely throughout the area. Results of a 10 per cent sample of the titles registered under the land adjudication programme in the crop lands indicate that some 50 per cent of the farms are smaller than 2 ha (10, 17). Another noteworthy feature of the farm size distribution is that the average farm size in the Kwale crop lands is between 3.0 and 3.5 ha, whilst that in the Kikoneni crop lands is about 4.5 ha (11, 12, 13).

In considering the notable differences in average farm size in the Kwale and Kikoneni crop lands, it should be realized that population density in the Kikoneni crop lands is only half that of the Kwale crop lands. However, it should also be observed that, to date, shortage of land is not an absolute contraint to the expansion of the cultivated area in the Kwale crop lands (11, 12, 13). And since labour is not in short supply either, socio-economic restraints must be responsible for the smaller farms.

Apart from the cultivated farm area, the average farmer in the crop lands makes use of 1 to 2 ha grazing land.

Land tenure

Land adjudication in the crop lands is in progress and large parts of the land have already been adjudicated. It will not be easy to complete the work, however, because land adjudication is complicated by two particular features of the Wadigo land tenure system.

The first of these is that, according to Wadigo customary law, clan land can only be owned by members of the clan. Nevertheless, the clan elders can give right of occupancy to a stranger from another clan. In such cases the stranger can cultivate the land, even plant tree crops. If, later on, the stranger wants to leave the land, he will be compensated for his trees in accordance with a well established local evaluation system. It is obvious that such a system complicates land adjudication, since many people are declaring their claims on trees on many different farms (14). An official compensation regulation has therefore been drafted to facilitate land adjudication in Wadigo land (28).

The second feature of land tenure concerns the land rights of the immigrants, who are mainly Wakamba. Many of these farmers have acquired land from individual Wadigos by paying them money, called "Kilemba" by the Wadigo. In the early seventies the usual sum of money was about 1,000 shillings. By now it will certainly be higher. In return for this money the Wakamba farmers acquire a piece of land of 2.5 to 3.0 ha (14).

The problem is that the above transaction is looked at differently by the two parties. The Wakamba claim that they bought the land from the individual Wadigo to whom they paid the money. The Wadigo on the other hand claim that they only rented the land to the Kamba. Renting of land to strangers, they argue, is part of their tradition, but selling of land is not. Moreover, selling of land would require the authority of the clan elders. And this, the Wadigo claim, was not given (14, 26).

Whether this is a case of genuine misunderstanding between Wakamba and Wadigo, or whether it is a case of 'underhand' transactions between individual Wadigos and Wakambas is not relevant. The problem is there and will undoubtedly cause trouble and hamper the progress of land adjudication. In some cases it has already (26). Unfortunately, the problem is not unique to the Kwale and Kikoneni crop lands; similar problems have also been encountered in the Kapenguria area (30).

Farm income

Net farm incomes in the crop lands are at present of the order of 2,400 shillings per annum of which about 50 per cent originates from tree crops, more than 40 per cent from food crops and less than 10 per cent from livestock production.

Assuming an average family of 6 persons per farm, this would suggest an average per capita income of some 400 shillings per annum, which is equal to the national average rural per capita income (31).

Concerning the variation in per capita incomes throughout the crop lands no concrete information can be given, although it seems likely that income in the Kikoneni crop lands will be higher than in the Kwale crop lands. This is partly because of the larger average farm size and partly because of the better cultivation methods applied by the Wakamba immigrants. On the other hand, the ecological conditions for crop and livestock production in large parts of the Kikoneni crop lands are less favourable than in the greater part of the Kwale crop lands. This might partly counterbalance the factors that are working in favour of a higher per capita income in the Kikoneni crop lands. The notable differences in cropping patterns between the areas could also contribute.

Markets and prices

Marketing and processing facilities for cashewnut show a favourable development. A cashewnut factory has been built in Kilifi, which is about 60 km north of Mombasa. Moreover a cashewnut factory with its associate bixa plant are now being built near Riwi, about 15 km south of Mombasa, in the surveyed area. This factory will become operational in 1979/1980. However, marketing and processing facilities for citrus fruits, copra and mango are insufficiently developed and require attention. The system of all-weather roads should be extended and their quality improved to facilitate marketing of produce. The problem is recognized and is receiving attention in the framework of the Special Rural Development Programme for Kwale (10, 17).

As for the prices paid for produce, it should be observed that the producers' price for cashew nuts, of which until recently about 90 per cent were exported, has long been considerably below export parity. In 1975 the difference was of the order of 25 per cent. This is fostered by the existing monopoly in processing and trade. The producers' price for copra is fair, and their price for maize is even above the export parity because of the high production costs on the large-scale farms, where a substantial part of the maize is produced (32, 33, 34).

If the farmers were to obtain a fair price for their cashew nuts, farm incomes could increase by an average of 10 per cent.

Constraints

The major constraints that hamper further development of agriculture in the crop lands are (14, 15, 17, 18, 26):

1. Tradition-bound attitudes and lack of technical know-how, which inhibit the development of modern farming;
2. The irrational settlement pattern and the complicated land tenure system;
3. The lack of an adequeate road system, resulting in problems in the supply of inputs and the marketing of produce;
4. The lack of adequate processing and marketing facilities;
5. The lack of adequate credit facilities;
6. The lack of water, especially in the unsettled areas in the crop lands;
7. The shortage of adequately equipped extension staff to teach the farmers better husbandry.

3.2. Smallholder rain-fed arable farming - intermediate technology

General[1]

This land utilization type is well suited to the conditions prevailing in the high to medium potential areas of Ecological Zones II and III,

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1 *See also the description of the preceeding land utilization type "Smallholders rain-fed arable farming - traditional technology" in the present report.*

i.e. in the whole of the Kwale, Kikoneni and Mkongani crop lands (see Figures 2 and 3). In these areas neither rainfall nor temperature regime would hamper a more advanced type of farming. On the short and medium term, however, socio-cultural constraints will only allow the introduction of intermediate technology. At the same time advanced technology might gradually be adopted, but only by a relatively small number of progressive farmers. The great majority of the population will need considerable time to reach that stage of development.

At present intermediate technology is hardly applied in the crop lands, except by farmers in the settlement schemes. They use animal traction for land preparation and crop cultivation, and apply other modern farm inputs as well (16, 26). The occurrence of this type of farming in the largely traditionally farmed crop lands is partly due to the fact that the immigrant farmers come from more densely populated areas, where a more intensive type of farming already existed. Another reason is the technical assistance given to the settlement schemes by the Ministry of Agriculture (16). In the course of time, however, agriculture in the whole of the crop lands will have to be intensified to cope with the rapid growth in population and the resulting pressure on the land. Thus, also the tradition-bound farmers will be forced to employ a more advanced technology merely to maintain their present standard of living, let alone improve it. In surmounting the many difficulties standing in the way of a modernization of agriculture in the crop lands, the Agricultural Extension Service and other Government agencies will have a vital role to play.

Development will first and foremost be directed towards the improvement of (tree) crop production, but will also exploit the possibilities of raising livestock production. In this respect the development of tree-crop-cum-dairy farming systems, which have proved economically viable and attractive, should be promoted wherever possible (35). Opportunities for livestock development within the Digo farming system, however, will be limited since grazing grounds are becoming scarcer as population growth is forcing the people to bring more grazing land under cultivation. Besides, most of the grazing grounds in the crop lands are already in use by the Duruma (and the Kamba). Thus, also in the future, livestock keeping will remain a sideline for the majority of the crop land farmers.

The development strategy as stipulated in the District Development Plan for Kwale District, 1974-1978 (10), rests on better crop husbandry in the settled areas, the introduction of new farming systems, the opening up of the relatively undeveloped but populated areas through provision of infrastructural and producer services, the gradual introduction of livestock (in the Digo farming system), and improved range management. In the adjudicated areas an intensive (i.e. group approach, not individual) extension and credit effort will focus on farm planning, conservation, and the introduction of mixed farming systems[1]. On-farm demonstrations will be held using volunteer groupings so as to cover both small and medium farms with on-farm training (10).

Produce

At present tree crops are grown on two-thirds of the cultivated land, the remaining part being planted with annual food crops. The major tree crops are cashew and coconut and by far the most important food crop is maize. Assuming that in the future the present cropping pattern will be broadly maintained, emphasis should be placed on improving the productivity of the tree crops. Also the introduction and/or further development of other economically attractive tree crops, such as mango, citrus and bixa, should be promoted. Moreover, economically viable crop rotations with maize as main crop should be adopted. Suitable crops for this purpose are: simsim (interplanted), groundnuts, pigeon peas, green and black grams (interplanted), with chillies or sunflower as alternatives to groundnuts on parts of the crop land areas. Cassava could also be grown as a food crop (10).

In the process of farm planning, anti-erosion measures, such as strip cropping and contour ploughing with cultivation kept to the minimum, should be introduced (10).

All the above mentioned activities fall within the framework of the Special Rural Development Programme for South Kwale.

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1 *In view of the rapid growth in population and possible grazing rights of the Wadurama, this will only be applicable in parts of the crop lands.*

The Programme also includes the establishment of tree crop nurseries at Mtwapa, Matuga and Msambweni, the stimulation of agricultural growth points, the initiation of Extension experiments, and the establishment of Agricultural Service Centres (17). In addition, research aimed at the development of a high yielding variety of cashew nut is being done and the propagation of this variety was scheduled from 1975 onwards. Ambitious plans for the rehabilitation of the coconut plantation, which is heavily infested with Rhinoceros beetle, are being developed (18). For food crop development, hybrid maize seed is being distributed by the Ministry of Agriculture (16).

If agriculture in the croplands starts improving through the above mentioned efforts and reaches an "intermediate stage" of development, considerably higher yield levels than at present can be expected. If intermediate technology were to be applied, the cashew nut yield could be an estimated 1,100 kg per ha (19, 23, 25), coconut some 1,000 kg copra per ha (18, 19, 25) and maize some 2,700 kg per ha (25, 36, 37).

Intermediate technology implies:

- for cashew nut: the use of selected planting material (35, 38), better tree spacing (39, 40, 41), some measure of weed control (19, 42), a certain measure of disease and pest control (19, 23), and timely harvesting (19, 23);
- for coconut: use of selected planting material (10, 19), correct tree spacing (19, 24), bush control (24), disease and pest control by proper sanitary and other measures (18, 19, 24), some fertilisation (19, 24), timely harvesting and improving the production of copra (19, 24);
- for maize: use of selected and possibly hybrid seed, full plant population, timely planting, adequate weeding, a modest fertilizer input (25, 36), and rotation with other annual crops (10, 25).

It is obvious that the shift from traditional to more advanced agriculture over such a large area as the crop lands will take a considerable time. This is particularly so for cashew and coconut. As they are perennials with a long bearing life, their improvement can only be realized gradually.

With regard to livestock development, it should be noted that dairy cattle could be kept in well established and well maintained cashew and coconut plantations at a stocking rate of 1 S.U. per 4 ha. To raise livestock production in the grazing areas, emphasis should be placed on upgrading the livestock herd, including dairy cattle in the herd, and improving the grazing areas, e.g. by practising rotational grazing. The latter measure could increase the present stocking rate of 1 S.U. per 1.6 ha (8, 27) to over 1 S.U. per ha in parts of the crop lands, thus increasing the returns per ha considerably (37).

Capital intensity

Capital intensity of this type of farming is rather low, some 350 shillings per ha. This total can roughly be broken down as follows: farm equipment 15 per cent, livestock 50 per cent, and working capital 35 per cent. This excludes any investment in land, buildings, and trees. The practice of intercropping in the early stages of development keeps the investment in trees low in terms of money (19), although the investment in time and the earning capacity of tree crops is duely reflected in the compensation rates for cashew and coconut. These compensation rates, officially fixed for the purpose of land adjudication, are roughly 6,500 shillings per ha for pure stands of cashew, and 12,000 shillings per ha for coconut.
Recurrent costs are estimated at some 150 shillings per ha.

On farms where privately owned animal traction is used, capital intensity is about 25 to 50 per cent higher than without.

Labour intensity

Despite the assumption that land preparation for food crops and part of the maintenance of tree crops will be mechanized, labour intensity of this type of farming will be high, namely some 400 man-equivalents per 1,000 ha.

Farm power

Since the future grazing land in the crop lands will be confined to some 275,000 ha and a considerable part of this area has already been claimed, the possibilities of promoting animal traction are limited.

In any case, the small size and the specific cropping pattern of the Digo farms in the Kwale crop lands do not warrant the promotion of privately owned draught animals (43). Animal traction should only be promoted on the bigger farms in the Kikoneni croplands, where a relatively large part of the area is under annual crops. In the Kwale crop lands communally-owned or contractor-owned tractors could be used for the land preparation of food crops and for (part of) the maintenance of tree crops.

Technical know-how

The level of technical know-how necessary for this "intermediate" type of farming is moderate. Better husbandry is of greater importance than the application of (large quantities of) modern farm inputs. To convince farmers of the profitability of good husbandry and to teach them better methods, considerable efforts will be required from the governmental agricultural services.

Farm sizes

The possibilities of enlarging the size of the farms are limited because of the pressure of population. Future farm size will, therefore, be much the same as at present, namely an average of 3 to 4 ha cultivated area, with farms in the densely populated Kwale croplands generally smaller than those in the less densely populated Kikoneni croplands.

Apart from the cultivated area the average crop land farmer might use about 1 ha grazing land.

Land tenure

To allow the development of this more advanced type of farming, land adjudication will have to be completed and the land rights of immigrants clearly defined. Rules and regulations must be drafted for the renting and leasing of land so that the development of such land is not hampered.

Farm income

Net farm incomes could be of the order of 4,000 shillings, of which over 90 per cent will originate from crops and the rest from livestock. Assuming that an average family consists of 6 persons, this implies an average annual per capita income of 600 to 700 shillings. Differences in ecology, soils, population density, and socio-cultural factors will undoubtedly result in a wide variation of per capita income.

Markets and prices

Marketing of agricultural produce and the supply of inputs will have to be facilitated by a sufficiently developed road system and an adequate network of collection and distribution centres. Also required are processing facilities for produce.

Wholesale prices for agricultural produce and inputs should be in line with world market prices, and marketing costs should be kept as low as possible. Excessive profits of "middlemen" should not be allowed, because these are made at the expense of the producers. Farm gate prices for produce and inputs should be fair in order to stimulate production.

Constraints

The most important constraints that could hamper the development of a more advanced type of agriculture in the croplands are:

1. Lack of technical know-how.
2. Lack of agricultural research and extension.
3. Lack of capital resources.

3.3. Smallholder rain-fed mixed farming - traditional technology

General

This land utilization type is commonly found in the Kinango marginal lands (see Figure 3), which cover the eastern part of the hinterland of the Kwale District.

Meteorological data indicate that the Kinango marginal lands have only medium to low potential for arable farming, but a good potential for livestock farming. The stocking rate is assessed at 0.25 Stock Units (SU) per ha (8). As can be seen in Figure 2 the greater part of the area lies in Ecological Zone IV and a smaller part in Ecological Zone V.

Data on annual rainfall and annual potential evaporation are summarized in Table 1. The average potential evaporation in the period of greatest rainfall (April-June) is some 460 mm. The probability that rainfall in April-June - the growing season for annual crops - equals or exceeds two-thirds of the potential evaporation ranges from 60 to 70 per cent in the east of the Kinango marginal lands and from 40 to 50 per cent in the west (7).

The gross area of the Kinango marginal lands is roughly 68,500 hectares, of which about 20 per cent is suitable for cultivation. A recent survey revealed that at present some 7,500 hectares are under cultivation[1] (11). So it seems that there is still considerable scope for expansion although it should be realized that cropping in this area is a marginal and risky undertaking.

At the time of the 1969 census, the area's population was some 21,000 (12). Population projections of the Central Bureau of Statistics indicated that the 1975 population would be some 26,000 (13). It is estimated that about 95 per cent of the people depend on agriculture for their living.

Population density is about 35 to 40 people per square kilometre.

Population growth in the period 1962-1969 was about 3 per cent per annum. For the period 1970-1980 an annual growth rate of 2.7 per cent has been projected[2].

The Kinango marginal lands are mainly populated by Waduruma, who are engaged in mixed farming, growing food crops and keeping livestock, mainly for subsistence.

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1 *See Annex II.*

2 *Growth rates are calculated on the basis of 'Population projections by district, 1970-1980 (13).*

Produce

A survey conducted in May 1976 (11) revealed that annual crops and tree crops are grown throughout the Kinango marginal lands. However, in contrast with the crop lands, annual crops predominate, covering some 80 per cent of the cultivated area. The major crop is maize, which may take up well over 95 per cent of the area under annual crops. Other crops are: cassava[1], pulses, and simsim. Tree crops are grown on some 20 per cent of the cultivated area. As in the crop lands, the two main tree crops are cashewnut and coconut. Together they cover almost 100 per cent of the area under tree crops, with about 80 per cent under cashewnut and the rest under coconut (11). See also Annex III.

In the Kinango marginal lands the standard of husbandry is generally low. Little use is made of improved planting materials, fertilizers, or agrochemicals for pest and disease control (16, 18). A start has been made with the distribution of improved maize varieties, but the area under improved maize is still very small (16).

Because of the low standard of field hygiene, the coconut plantations are infested with the Rhinoceros beetle (18, 19). Other major pests are cashew weevil on cashewnut and stalkborer on maize. Amongst the plant diseases, the most damaging are cassava mozaic and coconut bole rot (16).

No exact yield data are available, but in view of the lower and more erratic rainfall and higher evaporation in the marginal lands, as compared with the crop lands, it is assumed that yields are some 20 per cent lower than in the crop lands. This assumption results in the following yield estimates:

cashewnut	:	400 kg nuts per hectare
coconut	:	300 kg copra per hectare
maize	:	900 kg grain per hectare

These estimates represent average yields. Owing to the rainfall gradient, it can be expected that yields will be highest in the east and will gradually decrease towards the west.

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1 *Because of intercropping, the area under cassava might have been underestimated.*

The quality of the (marketed) produce is satisfactory for cashewnut and maize, but only moderate to low for copra because most of the copra is sun-dried.

Livestock keeping is an integral part of the farming system. The average Duruma family living in the Kinango marginal lands owns an estimated 6 S.U. The herd consists almost exclusively of local stock (Zebu). Cattle are predominant; only 10 to 15 per cent of the herd is small-stock.

Since the carrying capacity of the (unimproved) marginal lands is only moderate, i.e. 0.25 S.U. per ha (8,27), not all the stock can be grazed in these lands. Part of the herd has to be grazed in the adjacent crop lands. The conditions in the marginal lands are better suited to beef cattle than to dairy cattle.

Amongst the livestock diseases, the most serious are Foot and Mouth disease and Trypanosomiasis. Trypanosomiasis is enzootic in the area. Drugs are used for its prevention and cure.

The average net production value per S.U. is estimated at some 150-200 shillings per annum.

Capital intensity

Capital intensity on the average mixed farm is low, only about 150 shillings per ha. This excludes any investment in land and/or farm buildings. The total per ha investment can be roughly broken down as follows: farm equipment 5 per cent, livestock 90 per cent[1], and working capital 5 per cent. The per ha investment in livestock reflects the carrying capacity of the marginal lands, which is only moderate. The amount invested in farm equipment and working capital is very low, because all farm work is done by hand and hardly any (modern) farm inputs are used. Recurrent costs are estimated at 10 to 15 shillings per ha.

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1 *This includes the related investment in dams, boreholes, and dips which is estimated at some 50 shillings per S.U.*

Labour intensity

Labour intensity is low, only 50 to 75 man-equivalents per 1,000 ha. This is because most of the farming area is used for livestock keeping, which requires only 20 per cent of the total labour as against 80 per cent for crop growing. The average labour intensity for crop enterprises is about 600 man-equivalents per 1,000 ha, while for livestock enterprises it is only 10 to 15 man equivalents.

Farm power

On the traditional Duruma farms virtually all work is done by hand. The most widely used implement for crop growing is the jembe (26).

Technical know-how

The level of technical know-how is low, resulting in poor husbandry. And, since the natural conditions in the marginal lands are indeed marginal for crop growing, it is doubtful whether the farmers' present performance can be improved without substantial help from the Government.

Farm size

The average farm size in the marginal lands is estimated at some 22 ha, of which only 2 ha are cropped. The rest are range lands. Since the range lands in the marginal lands and those in the crop lands are generally in communal use, it is more correct to speak of the average farm(ing) area per family than of the average farm size.

Noteworthy is that neither land nor labour is an insuperable constraint to an expansion of the cultivated area in the Kinango marginal lands. The (main) reason why crop production has not been expanded is probably that the Waduruma are first and foremost stock people. Nor should it be forgotten that under the present conditions in the marginal lands the labour productivity of crop production is only half that of livestock production. Moreover, crop growing requires a far greater labour input than does livestock keeping.

Land tenure

Unlike the crop lands and range lands, the Kinango marginal lands have no high priority for land adjudication. Few farmers, therefore, possess a title deed. For the time being this situation will hamper the supply of institutional credit.

Farm income

Net farm incomes in the marginal lands amount to 2,100 to 2,200 shillings per annum, which is only slightly lower than the average farm income in the crop lands. About half of this income originates from crop growing, the other half from livestock production.

Assuming an average family of 6 persons, the annual per capita income is some 350 shillings, which is slightly less than the national average for rural areas.

Markets and Prices

Marketing of cashewnut and copra is hampered by the inadequate road system, which is to be improved under the District Development Plan, 1974-1978 (10). This will greatly facilitate the marketing of all agricultural produce. The marketing of maize presents no problems, since most, if not all, maize can be sold locally or bartered for livestock produce with people from the adjacent range lands.

The prices paid for maize and copra are generally fair. For cashewnut, however, prices have long been far below export parity. In 1975 farmgate prices were about 25 per cent too low. But, since cashewnut is of minor importance in the marginal lands, its low price has a negligible effect on the farm income.

Constraints

The major constraints that hamper further development of agriculture in the marginal lands are:

1. The low level of technical know-how;
2. The lack of water in some places and the resulting overgrazing in others;
3. The lack of an adequate road system, hampering the supply of inputs and the marketing of produce;
4. The lack of adequate marketing facilities;
5. The lack of adequate credit facilities, aggrevated by the absence of land adjudication;
6. The shortage of adequately equipment extension staff.

3.4. Smallholder rain-fed mixed farming - intermediate technology

General

Even though this land utilization type is well suited to the ecological conditions prevailing in the Kinango marginal lands (most of which lie in Ecological Zone IV, see Section 3.3.) it is rarely practised in the area. The present predominant land utilization type is described in Section 3.3. Information on rainfall and evaporation, cultivated areas, livestock keeping, and population is given in the sub-section "General" of Section 3.3.

Produce

Information on the present farm production in the Kinango marginal lands is given in the sub-section "Produce" of Section 3.3. To raise the present, largely traditional mixed farming to a level of intermediate technology, an appropriate development strategy has to be worked out.

The strategy should rest on better crop husbandry and improved range management. New mixed farming systems should be introduced which include a greater variety of crops and are more beef-orientated than the present system. Suitable crops with a potential for development are pulses, simsim, capsicums, sunflower, and cassava. Fodder crops such as sorghum have a high potential to support the ranching sector of the farming system (10).

Crop diversification will lower the risk of complete crop failure, while a proper crop rotation will maintain soil fertility and combat diseases and pests. Attention should also be given to soil conservation.

Better husbandry includes: the use of improved planting material, timely planting, better weeding, and better crop hygiene. For livestock, it means rotational grazing and better disease control.

The development should be backed by vigorous extension efforts and supervised credit schemes, which should focus on farm planning, soil conservation, and husbandry improvement. Agricultural extension and supervised credit should be presented to more or less organized groups of farmers (in the adjudicated areas). Another necessary measure is the extension and improvement of the (farm) road system.

If the above development strategy were followed, the yields of the major crops, maize and cashewnut, could be increased to 1,350 kg grain per ha and 700 kg nuts per ha.

The present net production value per S.U. could be increased to 250 shillings and the stocking rate increased by some 30 per cent.

Capital intensity

Capital intensity on the improved mixed farm in the marginal lands is rather low, only 300 shillings per ha. This amount excludes any investment in land and/or farm buildings. The total per ha investment can roughly be broken down as follows: farm equipment 5 per cent, livestock 85 per cent[1], and working capital 10 per cent. Recurrent costs are estimated at some 20 shillings per ha.

Labour intensity

Labour intensity on the average mixed farm is low, 50 to 75 man-equivalents per 1,000 ha. This is because by far the greater part of the farming area is used for livestock keeping, which requires only 20 per cent of the total labour as against 80 per cent for crop growing.

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1 *This includes the related investment in dams, boreholes, and dips which is estimated at some 50 shillings per S.U.*

The average labour intensity for the crop enterprises is about 600 man-equivalents per 1,000 ha; for livestock enterprises it is only 15 to 20 man-equivalents.

Farm power

Although it will not be easy to convince the Duruma farmers to use their catlle as draught animals and to train them to do so, it may be assumed that in the course of time animal traction will gain popularity in the marginal lands. Tractor use will be limited, because the costs will be too high in comparison with the (extra) benefits.

Technical know-how

The level of technical know-how required to apply intermediate technology in farming is moderate, but to attain this level the Duruma will need substantial assistance from the Government through agricultural extension and supervised credit.

Farm size

The average size of the improved farms would initially be equal to the size of the unimproved farms, about 22 ha. Although it is possible, it is unlikely that the average cultivated area per farm will increase substantially above the present 2 ha. In the course of time the average farm(ing) area will decrease due to population growth. This decrease will probably first be realized at the expense of the grazing area.

Land tenure

Land adjudication is a prerequisite for the development of traditional Duruma farming, the more so since the supply of institutional credit to small farmers generally requires a title deed as security.

Farm income

Through the introduction of intermediate technology, net farm incomes in the marginal lands could increase to 3,000 to 3,500 shillings. About 50 per cent of this income would be derived from crop growing and the rest from livestock production. Assuming an average family of 6 persons, the annual per capita income would then be 500 to 600 shillings.

Markets and prices

Marketing of produce should be facilitated by the extension and improvement of the (farm)road system in the marginal lands. Market facilities for the newly introduced crops should be created. Produce prices should reflect the true value of the produce to the national economy.

Constraints

The major constraints to further development of agriculture in the marginal lands are:

1. The marginal ecological conditions;
2. The traditional values of the Duruma people, who place livestock-keeping higher than crop growing;
3. The lack of adequate technical know-how;
4. The shortage of extension staff to teach the farmers a more advanced technology.

3.5. Extensive range management

General

This land utilization type is commonly found in the Kwale range lands, which are situated in the western part of the Kwale soil survey area, west of the Kinango marginal lands (see Figure 3). Most of the ranches, however, are still in an early stage of development (16, 44).

The range area concerned falls in the better part of Ecological Zone V (see Figure 2). Data on annual rainfall and annual potential evaporation are summarized in Table 1. Rainfall in the period April-June ranges from 175 to 300 mm. The average evaporation in that period is about 460 mm. The probability that rainfall during the period April-June is equal to or more than two-thirds of the potential evaporation ranges from 40 per cent in the east to 10 per cent in north-west (7).

The area is only locally suitable for crop growing, although this remains a marginal and risky undertaking because of the low rainfall. The potential for livestock keeping is moderate. According to a recent survey in the Mwereni Ranch area, the area's carrying capacity is 1 S.U. per 8 ha (44). This is considerably higher than the average capacity for Ecological Zone V, which is assesses at 1 S.U. per 12 ha (8, 27).

The Kwale range lands, as far as they are situated in the Kwale soil survey area, comprise about 145,000 ha. Almost all of the land suitable for grazing is used for that purpose.

At the time of the 1969 population census the area was inhabited by some 20,000 people (12). On the basis of the population projections of the Central Bureau of Statistics the 1975 population is estimated at about 24,000 people (13). About 95 per cent of the inhabitants are assumed to depend on agriculture for their living.

Population density in the area is low, 15 to 20 people per square kilometre.

Population growth in the period 1962-1969 was about 3 per cent per annum. For the period 1970-1980 an annual growth rate of 2.7 per cent is projected.[1]

The Kwale range lands are the domain of the Waduruma, who are basically range-subsistence cultivators (45). However, under the prevailing ecological conditions they occupy themselves almost exclusively with livestock keeping.

The Kwale range lands have recently been divided into a number of ranches of varying size.

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1 *Growth rates calculated on the basis of "Population Projections by District, 1970-1980" (13).*

Some of these ranches lie (partly) in the Kwale soil survey area: the Ndavaya Ranch (28,000 ha), the Mwavumbo Ranch (24,000 ha), the Lunga-lunga Ranch (40,560 ha), the Mwereni Ranch (45,600 ha), and the Samburu-South Ranch (44,000 ha). The Lunga-lunga Ranch is a company ranch. The other ranches are group ranches. In the course of establishing the ranches, their grazing land is adjudicated (see under Land tenure).

To illustrate ranching in this part of the Kwale range lands, the SRDP-supported Mwereni (Group) Ranch will be described. This ranch covers some 45,600 ha, and is for the greater part situated in the Kwale soil survey area. It is populated by some 12,850 people. By the end of 1974 the livestock population was 7,000 cattle, 2,900 sheep, and 4,635 goats. Since the carrying capacity of the area has been assessed at 1 S.U. per 8 ha, the area could accommodate some 5,500 S.U.[1] still leaving room for subsistence cropping. The current animal population has been estimated at 5,200 S.U., implying a rough balance with the current carrying capacity. Though overstocking is not a problem at present, overgrazing occurs in places because many cattle are concentrated along the Lunga-lunga-Mariakani milk routes. Considering that improved grazing arrangements could probably increase the current carrying capacity by some 30 per cent, there seems to be ample scope for development.

However, there are a number of problems. One is that the area is highly infested with tse-tse fly and that its eradication is not thought to be feasible because of the complexity and the enormous cost of such an operation. Moreover, the necessary bush-clearing might, according to Halpin (46), cause an irreversible trend to soil erosion.

So the only choice seems to be between the fly and serious erosion. Erosion must be ruled out since it would lead to ecological disaster. The question is thus whether it is possible to live with the fly. This is in the last instance an economic problem. Halpin is rather sceptical about the development of the Mwereni Ranch area.

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1 *In assessing this capacity, it has been assumed that the whole area is suitable for grazing.*

But according to the local veterinary officer, the incidence of tse-tse does not in itself prohibit development, since, with adequate prevention, deaths can be avoided/or at least kept at a low level (44). The whole question is somewhat dubious and requires further investigation.

Another apparent problem is that the area, although not overstocked, would seem to be highly overpopulated in proportion to its production potential. At the present price level for animal produce, the 5,200 S.U. in the area can only provide some 1,800 people with the minimum subsistence requirements, estimated at some 2,000 shillings per family of 6 persons. These make up only 15 per cent of the area's population. Assuming that another 5 per cent make a living by providing services to the others, about 80 per cent, or the great majority, has to rely upon other sources of income. These might include crop growing in the ranching area, but in view of the area's limited potential for crop growing, it is likely that many people depend on sources outside the area for their living.

An organizational problem connected with the foregoing is that livestock ownership among the inhabitants is most unequally distributed. The majority of the people who have been registered as members of the group ranch own no livestock and, even within the group of 200 or so livestock owners, the variation in stock-ownership is considerable as half the livestock is apparently held by fewer than 30 families. The diverse issues raised by this ownership structure will be dealt with in the sub-section Land tenure. Yet another problem concerns the economic viability of the ranching project. The changes to be introduced to raise the 'earning capacity' of the Mwereni area require considerable investment, particularly in water supply, upgrading of animals, and a system of rotational grazing to preserve and improve pasture. Together with the bulls for breeding, the necessary capital investment in the ranch will amount to roughly 600,000 shillings, of which about half will have to be spent on water supply. This implies an investment of 13 shillings per ha, or more than 100 shillings per S.U., which is very high in view of the present productive value of the livestock.

It is intended that the cost of this investment will be covered by sales of cattle from a central herd, run with improved management practices on a commercial basis.

This central herd is to be formed through contributions by the group ranch members and is to include 15 to 20 per cent of the S(tock) U(nits). The problems connected with forming this central herd will be discussed in the section Land tenure.

Produce

At present the Mwereni ranch area is stocked with some 5,200 S.U., consisting of some 7,000 head of cattle, 2,900 sheep, and 4,625 goats. At the present off-take levels the animal production will amount to some 140,000 kg of beef, 9,000 kg of mutton, and 14,000 kg of goat meat. These totals concern live weights and include the ranch population's own consumption and the meat of fallen animals. In addition some 450,000 litres of milk will be produced over and above the suckling requirements of calves.

If the area is stocked at 'full capacity' and range management practices are improved, the total production could ultimately be increased to some 500,000 kg of beef, 18,000 kg of mutton, and 29,000 kg of goat meat, provided that the ratio catlle: sheep: goats is not altered. Total milk production would then amount to some 370,000 litres[1]. If livestock production were to be combined with bee-keeping, an estimated 85,000 kg of honey could be collected from the area.

Capital intensity

Capital intensity in terms of investment per ha are low for this type of farming. At present total investment can be estimated at some 70 shillings per ha. When all the intended improvements have been realized, total investment per ha will amount to some 100 to 120 shillings per ha. This amount can be broken down as follows: livestock 75 per cent, fixed assets (boreholes, dams, dips, firebreaks, bomas, etc.) 15 per cent, and working capital 10 per cent. Current expenditure is estimated at 15 to 20 shillings per ha.

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1 *Since the area is unsuitable for milk production the present preoccupation with milk production is being phased out and replaced by beef production. Cow numbers and thus milk production, will be reduced accordingly.*

The increase in per ha investment will be due to a small increase in stock (about 5 per cent), a substantial increase in (live)weight of the stock (about 40 per cent), and a very large increase in infrastructural services (about 400 per cent).

To provide an idea of the necessary capital investment, the following breakdown is given:

Item	Amount in 1000 Shs
Water	280
Dips	56
Firebreaks	77
Bomas	32
Housing	53
Machinery, equipment, and tools	39
Others	7
TOTAL	544

Together with the cost of bulls for breeding, the additional capital investment in the ranch can be taken at some 600,000 shillings.

All in all the investment in ranch development does not seem to be high in terms of invested amount per ha. However, if one considers the total investment required to provide subsistence to one head of population, the amount is very high indeed: at current prices, it would be of the order of 1,500 shillings.

It should be realized that the above figures apply to the Mwereni Group Ranch only. Elsewhere, even on an adjacent ranch, the level of investment might differ considerably. There is a wide variation in local conditions, particularly in the availability of water for human and animal consumption. Besides the provision of adequate drinking water supplies, bush clearing requires major investments in many range areas.

Labour intensity

Labour intensity of extensive range management is very low, if one considers the required labour per ha. However, to eke out a living from ranching is certainly no easy task and becomes harder as the production potential of the grazed range areas is lower and as water is scarcer (45). Assuming that one man can handle some 40 head of livestock or some 200 head of small-stock in the day time and that one night watchman is required per 150 head of livestock, the total labour requirement at Mwereni can be estimated at some 5 to 10 man-equivalents per 1,000 hectares. Since the number of hectares required to provide a subsistence income for an average family is at present of the order of 150 ha, it would seem that the available family labour is not fully employed.

Source of farmpower

Extensive range management is a completely man-operated enterprise, since the use of machinery for bush control or the use of trucks for transport is too expensive. Moreover, labour is amply available in the range areas at low opportunity costs.

Technical know-how

The level of technical know-how in the range area is generally low, in so far as modern techniques of livestock production and range management are concerned. On the other hand, the herdsmen have a profound knowledge of the ecological environment, which they have preserved and utilized to their benefit by intelligent management based on experience and founded in tradition. However, if the population of the range area exceeds a critical level, the traditional knowledge will no longer be adequate and other techniques of production as well as other types of management will be required to feed the increased, and ever increasing, human and animal populations.

To enable the application of more advanced husbandry, substantial investments will have to be made.

A more centrally organized type of management will be required to preserve the range lands, to increase their productivity, and to guard the precarious balance between stocking rate and grazing potential. It goes without saying that in establishing group (or cooperative) ranches the variations in ecological environment should be taken into account to assure a proper rotation system for grazing. Moreover, since the feasibility of the substantial investments required to improve the production potential of the range lands is, to a certain extent, subject to economics of scale, larger ranching units, such as group or cooperative ranches, are a must.

Farm size

As indicated above, economics of scale play an important role in the feasibility of range land development. This is not only because infrastructural services and overhead costs can be spread over a large number of hectares, but also because larger areas facilitate the establishment of a proper rotational grazing system. The Mwereni Group Ranch is large enough in this respect and could according to Livingstone (44) be subdivided without problems into two range areas of some 20,000 hectares each.

Land tenure

Land adjudication for ranching schemes involves some specific problems, because grazing grounds have always been used on a communal basis. In the case of the Mwereni area, which has long been grazed by Duruma herdsmen, few options remain open as to the type of ranch to be established, provided that improved ranching is approved in principle. These options are: the cooperative ranch and the group ranch.

On both types of ranches the grazing area is communally owned and utilized. The basic difference is that on cooperative ranches the herd is communally owned whilst on group ranches the herds are individually owned. Cooperative ranches are generally established on Government-owned land or on County Council gazetted areas.

The livestock for cooperative ranches is often provided by the Government. Group ranches generally originate through a unanimous agreement between the traditional users of the area. In that case customary law is then legalized through the land adjudication process. Group ranches are preferable, since they have proven to be the most resilient (47). They are supposed to be governed by a committee elected from among the participants and to employ a professional manager. Since this type of manager is very scarce, officers of the Range Management Division of the Ministry of Agriculture generally provide management (on a part-time basis) as well as extension.

In the Mwereni area the Government has taken the initiative to organize the 'resident' Duruma herdsmen in a group ranch. The area has been adjudicated and a beginning has been made with the improvement of infrastructure. However, the Mwereni area is not a group ranch in the normal sense, since the intention is to operate a cooperative central herd on a commercial basis. The initial central herd is to be formed by contributions of cattle, while an IDA loan, raised on the security of the collective land title, is to be used to buy in cattle for fattening or breeding, thus expanding the size and especially improving the quality of the herd.

It is intended that the cost of the infrastructural investment will be covered by sales of cattle from the central herd. Despite the nominal ownership of the central herd stock by individuals, these contributions will be regarded as 'shares' as in a genuine cooperative. Decision making concerning central herd stock (including their sale) is to be done by a committee, independent of the contributors. Outside the central herd, which will ultimately amount to 15 to 20 per cent of all stock, ranch members will also individually own cattle. So, the Mwereni ranch combines basic elements of a group ranch and a cooperative ranch (44).

Especially in the case of Mwereni, the above mixture of elements is very confusing since, as was said earlier, only a small proportion of the inhabitants of the Mwereni area are livestock owners. And only <u>they</u> can contribute to the central herd. On the other hand all inhabitants are, as group ranch members, co-owners of the range land.

The question arises how the proceeds of the central herd, but also of the other privately owned livestock, will be distributed among the ranch members.

In other words, what remuneration is due to stock and what to land? Another question related to this one is: Who will benefit from the (public) investment in range land improvement: the stock owners only or all ranch members?

It is obvious that all inhabitants of the range lands are entitled to use any services, such as water supply, provided through public investment. But from a traditional point of view it is not at all obvious why the non-stock owners amongst them should be entitled to any remuneration for the range land, of which they are co-owners, but which they do not use themselves. De facto, the land adjudication did not change anything. Traditionally, all inhabitants of the range lands were entitled, by customary law, to graze their cattle on these lands. And after the land adjudication process they still are. The difference, is that the right of use is now legalized. For the stock-owners it will therefore be hard to understand why this will imply that they now have to pay land rent to non-stock owners. On the other hand, it seems in general fair to give all co-owners of the land, cq. all group ranch members, an equal share of the proceeds of their common resource base. And, consequently, the Government is right in trying to introduce a remuneration system that takes account of the (equal) land rights of all inhabitants of the range lands. However, in pursuing this objective the first problem encountered is to convince all people concerned, especially the (big) stock-owners, of the fairness of the issue. The second problem is to assess the level of the land rent and to implement its collection and redistribution. To solve the latter problem in fairness, an intimate knowledge of local conditions is a must.

In introducing structural changes in the traditional land utilization system it should also be taken into consideration whether, and if so in how far, these changes will influence the present system of income distribution in the range lands. This system, which is governed by local customs, is fairly effective.

It implies the allotment of parts of the big herds to clan members who do not own stock. In exchange for their services as livestock guardians, they may have the milk of the cattle as remuneration.

Anyhow, introducing structural changes in the land utilization system, and consequently in the income distribution, is a delicate matter, which should be handled with great care and will take considerable time.

In conclusion, it is suggested that any land suitable for cultivation should be given on long lease to particular families to avoid disputes concerning their use in future. These beneficiaries are also liable to pay a certain land rent to the community, which will probably differ from that due for grazing land.

In the case of the Mwereni Ranch it should be realized that only a minority of the population, now and in the future, can make a living from the proceeds of the range lands. It is therefore questionable whether the registration of all inhabitants of the area as group ranch members, with equal rights to the proceeds of the land proper and with a say in the management of the cooperative central herds, is the right approach to ranch development. It is considered that the establishment of a cooperative ranch of livestock owners only (with open membership of course), paying a nominal land rent to the non-livestock owning majority of the inhabitants of the range lands would have been more appropriate.

Farm income

For the Mwereni ranching area, present 'farm income' from livestock keeping has been assessed at some 600,000 shillings net. This is sufficient to provide 300 families, each with an average of 6 persons, with a subsistence income of 2,000 shillings per annum. This number includes less than 15 per cent of the total population of the Mwereni area.

The above assessment of present 'farm income' from livestock keeping was made on the basis of the following assumptions:

a) the livestock herd consists of cattle, sheep, and goats in the following numbers: 7,000, 2,900, and 4,625 respectively[1];

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1 *This is equivalent to 5,200 S.U. (see also sub-section "General".)*

b) the annual production of cattle, sheep, and goats is 20 kg, 3 kg, and 3 kg live weight per head respectively;
c) the average yearly milk yield per head of cattle is 65 litres;
d) the prices of beef, mutton, and goat meat are: 2.0, 2.5, 2.5 shillings per kg live weight and that of milk 0.7 shillings per litre;
e) the direct production costs are 10 per cent of the gross value of production.

The resulting gross and net production values from livestock on the 45,600 ha Mwereni Group Ranch are some 655,000 shillings and some 590,000 shillings respectively. The value added per ha is thus about 13 shillings per year.

With improved range management production could be increased considerably. The carrying capacity could be raised by one-third, e.g. from 5,500 S.U. to 7,300 S.U., and the productivity per S.U. could be increased by some 30 to 40 per cent through improved stock husbandry, good breeding stock, proper disease control, etc. In total the production per ha could be increased by 80 to 90 per cent, resulting in a possible total 'farm income' from livestock of some 1.1 million shillings net, or some 24 shillings per ha.

If bee-keeping were to be combined with extensive range management, an estimated 85,000 kg of honey could be produced. Valued at 3 shillings per kg, gross income from bee-keeping could amount to some 255,000 shillings and net income to some 200,000 shillings.

Adding the possible incomes from livestock and bee-keeping, the total 'farm income' under improved range management could amount to some 1.3 million shillings net or about 28 shillings per ha, which would imply a doubling of the present production level.

Thus with improved range management, the Mwereni Ranch area could provide some 3,900 people with a subsistence income from livestock keeping (and bee-keeping). This number, however, is still only 30 per cent of the present registered group ranch members. The question therefore once more arises whether the present approach to ranch organization is the most appropriate.

Price structure

Prices of livestock produce have long been kept on a lower level than domestic demand would permit and also below export parity (48). It goes without saying that such a price policy is an obstacle to the development of ranching, which is in that way artificially kept at a sub-optimal level. However, since domestic, as well as world demand for meat is expected to increase in the future, prices are bound to go up and, consequently, ranching will become more profitable. This also implies that large areas at the margin of the livestock economy can also be brought into use. Since this will also yield a number of specific problems related to livestock farming under ecologically and/or technically more difficult conditions, it seems sensible to focus range management research on these problems. Specific problems that certainly qualify for further investigation are: range management under arid conditions, the production and conservation of livestock feed in these marginal areas, and research on economic methods of bush-clearing and bush-control (49).

Constraints

The major constraints to development of the Mwereni Ranch and similar areas are:

1. Overpopulation in terms of people and/or livestock;
2. Low level of technical know-how;
3. Poor status of infrastructure, especially water supply;
4. Lack of adequate credit facilities;
5. Lack of adequate marketing facilities;
6. Low prices;
7. Lack of extension staff and range managers;
8. Organization problems.

3.6. Large-scale sugarcane production under rain-fed conditions - intermediate and advanced technology

General

This land utilization type is found in the coastal zone, around Ramisi. Data on annual rainfall and annual evaporation are presented in Table 1. The average rainfall in the period April-June ranges from 800 to 850 mm. The average potential evaporation in that period is of the order of 450 mm. The probability that rainfall in April-June will equal or exceed two-thirds of the potential evaporation ranges from 90 to 100 per cent (7).

As can be seen in Figure 2, the Ramisi area lies in Ecological Zone II, indicating a high agricultural potential. The potential for sugar cane, however, is medium to low rather than high. This is partly due to the unfavourable rainfall distribution (i.e. too much rain in April-June, too little rain during the rest of the year, see Table 1) and partly to the infertility and poor water holding capacity of the very sandy soils (9).

The gross area of the Ramisi sugar estate was some 4,600 ha in 1975, but there are tentative plans for gradually increasing the area to approximately 6,900 ha by 1981 (10).

In 1975 the estate employed some 2,900 people, exclusive of the factory workers. Assuming that the entire male labour force of the labourers' families resident on the estate are employed it can be concluded that some 12,000 people depend, wholly or partly, on sugarcane growing for their living. This number does not include the outgrowers and their families, who may number some 2,500.

Produce

At Ramisi, current cane production is almost entirely under rain-fed conditions. Plant cane is ready for harvest at 15 months, and ratoon cane at 12 months.

The crop is grown in a 5 year cycle of one plant crop and three ratoon crops before replanting. Between two subsequent production cycles a green manure crop is often grown.

Cultivation and tillage practices for both plant and ratoon crops are generally below standard. The principal variety grown at present is Co 421. Scant attention is paid to the quality of seed cane used in the replanted areas and ratooning is frequently extended at the expense of yield per unit area. Major nutrient levels in the area are low to very low, which, in combination with inadequate fertilizer application, is considered a major limiting factor to both cane yields and the production of high quality juice (50). The level of fertilizer application is significantly below optimum, owing to high cost. Fortunately, damage from the incidence of pests and diseases is at a relatively low level and the use of chemicals for pest and disease control is hardly needed (50).

Systems for harvesting and off-loading cane are inadequate, and much of the equipment is unsuitable and in a poor state of repair. According to a recent study by Tate and Lyle a restructuring of the cane harvesting and off-loading systems is essential if cane supplies to the factory are to be maintained. It is also considered essential that harvesting and transport of cane (from the nucleus estate as well as from the outgrowers) should be the responsibility of a central agency (50).

Due to the apparent shortcomings in field management and to the earlier mentioned low soil fertility, yield levels are low. Cane production at the Ramisi Estate in 1974 amounted to 45 tonnes per ha for plant cane and 31 tonnes per ha for an average ratoon crop. And since one plant crop and 3 ratoon crops are generally grown in a 5-year production cycle the average production will be of the order of 35 tonnes per ha per crop or a little over 28 tonnes per ha per year. Sugar content in the cane is very low, only 7 per cent. Nutrient deficiency in the soil and delays in the transport of harvested cane to the factory are probably largely to blame for this.

If advanced technology were to be applied in sugarcane growing at Ramisi yield levels could be increased to some 50 tonnes per ha per crop or some 40 tonnes per ha per year.

However, to achieve such an increase, or even to maintain production at the present levels, major inputs and improvements will be necessary. These are (50):

1. Additional management resources and extension services;
2. Improvement in cultivation practices, the application of fertilizers, and the selection of varieties;
3. Coordinated planning of harvesting and cane transport;
4. The deployment of correctly designed agricultural machinery of all types;
5. A single line of management control for all farming operations, including technical operations, finance and credit administration and advisory services. Except for part of the technical operations, these services should also be made available to the outgrowers;
6. Improvement of drainage where necessary.

These measures, combined with technical and managerial improvement in the factory, should increase sucrose extraction to at least 10 per cent.

In this way Ramisi Estate could contribute to meeting the growing demand for sugar in the country, which is expected to double in the 1975-1985 period. Apart from increasing the output per ha, the area under sugarcane should be expanded. Expansion is economically feasible at Ramisi, since at present the Ramisi sugar factory is largely underutilized. The capital cost of bringing new adjacent areas under sugar production is expected to be of the order of one half to two-thirds of the capital cost of developing totally new sugar projects (50).

If the plans for the rehabilitation and expansion of sugar production as proposed in the recent Kenya Sugar Industry Expansion Study (50) are put into practice, a combination of the two approaches, i.e. increasing the output per ha and enlarging the area under sugarcane, could increase sugar production from some 12,000 tons to some 30,000 tons in 5 years. The output of the outgrowers is included in these figures.

Capital intensity

Capital intensity of large-scale mechanized sugarcane production is very high, amounting to 5,000 to 6,000 shillings per ha.

This amount does not include the cost of land, land improvement, infrastructure, and buildings, nor the cost of sugar extraction. The total investment can be broken down as follows: 70 per cent machinery, small 25 per cent working capital and 5 per cent miscellaneous.

The recurrent costs are estimated at some 2,500 shillings per ha.

If the improvements as envisaged are realized, the above investment will have to be increased to 7,000 to 7,500 shillings per ha.

The recurrent costs of improved sugarcane production are estimated at 3,000 to 3,500 shillings per ha.

Labour intensity

In spite of the rather high degree of mechanization of large-scale sugarcane production, labour intensity is still very high, viz. some 600 man-equivalents per 1,000 ha, because the cane is harvested by hand.

After the introduction of advanced technology, labour intensity is expected to fall to some 400 man-equivalents per 1,000 ha[1], because of better machinery and more efficient labour organization. The resulting decrease in employment at Ramisi will be off-set by the increase in employment opportunities resulting from the expansion of the area under cane.

Farm power

Land preparation is at present completely mechanized; some operations are done by crawler tractors, others by wheeled tractors. The re-ridging of the ratoon crops has also been mechanized. Although harvesting is done by hand, the transport of cane from the field to the factory is by tractor. If advanced technology were to be applied, land preparation would be intensified.

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1 *If the cane were to be burned prior to harvesting the labour intensity could even fall to 300 to 350 man-equivalents per 1,000 ha.*

Technical know-how

The level of technical know-how required for succesful large-scale mechanized sugarcane production is high. At present the management of the nucleus estate is not up to standard and the level of technical know-how of the outgrowers leaves much to be desired (50).

To increase the productivity of sugarcane growing at Ramisi, the management of the estate should be strengthened and the outgrowers provided with extension services and credit facilities.

Farm size

In the case of Ramisi Estate, optimum farm size mainly depends on two factors: the capacity of the existing sugar factory and the productivity of the land. At present the factory is largely underutilized, so that there is room for both an increase in the productivity of the land and an expansion of the area. Taking into account the expected increase in productivity through the introduction of advanced technology, the nucleus estate could be expanded from the present 4,600 ha to some 6,900 ha, without requiring much additional investment in the existing sugar factory. This would bring the total area under sugarcane in the survey area to a good 8,000 ha (10, 50).

Land tenure

Since all the land belonging to the estate and that of the outgrowers has already been adjudicated, land tenure does not constitute any problem for sugarcane growing.

Farm income

Labour income at Ramisi in 1975 was of the order of 1,200 to 1,300 shillings per ha, or some 2,000 shillings per worker.

Assuming that in an average family of 6 persons, 1.5 persons are employed in sugarcane production, the average family income of an estate labourer can be assessed at some 3,000 shillings per annum. Assuming further that the women will produce some food crops on their own or estate land the average per capita income is estimated at some 600 shillings per annum. The present performance of large-scale mechanized sugarcane production at Ramisi is very poor. The last few years the estate has even been running at a loss. However, if advanced technology were to be applied, a handsome profit of 10 to 15 per cent of the gross value would be possible under the prevailing prices for inputs and produce.

The per capita incomes of the outgrowers' families depend on the size of their farms. It can safely be assumed that in general their incomes will be considerably higher than the incomes of the subsistence farmers in the adjacent areas.

Markets and prices

In 1975 the price received for sugarcane was in line with the world market price for sugar, as was the ex-factory price of sugar (50). However, since these prices were based on efficiently operating sugar factories, the profitability of the sugar companies has been very low and provided neither an adequate return on invested capital nor reserves for the the replacement of equipment (50).

Constraints

The major constraints to further development of sugar(cane) production at Ramisi are (50):

1. The marginal ecological conditions;
2. The low soil fertility in large parts of the area;
3. The lack of capital resources;
4. The lack of adequate management resources and extension services.

3.7. Large-scale tree crop growing under rain-fed conditions - intermediate technology

General

This land utilization type is found in the coastal zone south of Mombasa. The area lies for the greater part in Ecological Zone III, and for a smaller part in Ecological Zone II (see Figure 2), thereby indicating a medium to high agricultural potential. Data on annual rainfall and annual potential evaporation are summarized in Table 1. In the period April-June average rainfall is 700 to 800 mm. The average potential evaporation in that period is of the order of 450 mm. The probability that rainfall in April-June will equal or exceed two-thirds of the potential evaporation is 90 to 100 per cent (7).

Ecologically the area is only moderately suited to coconut growing, but very well suited to cashewnut (18, 19) and other tree crops such as mango and citrus (10, 19).

Produce

To explain large-scale tree crop growing under rain-fed conditions, a representative tree crop estate of 1,000 ha with a cropping pattern of 25 per cent cashew and 75 per cent coconut will be described.

At present the standard of husbandry is suboptimal. The greater part of the plantation is planted with traditional varieties. Fertilizer is rarely used, and pest and disease control leave much to be desired. As a result yields are moderate to low. Cashew may yield some 750 kg per ha and coconut some 600 kg of copra. Over 80 per cent of the cashewnuts are classified as first grade and are exported (unshelled). The copra is processed on the estate. Its quality is moderate.

If intermediate technology were applied, considerably higher yields then at present could be obtained. The cashew nut yield could be an estimated 1,100 kg per ha (19, 23, 25) and coconut some 1,000 kg per ha (18, 19, 25).

Intermediate technology here implies:

- for cashewnut: the use of selected planting material, correct tree spacing, adequate weed control, a certain measure of disease and pest control, and timely harvesting;
- for coconut: the use of selected planting material, correct tree spacing, bush control, disease and pest control by proper sanitary and other measures, some fertilization, timely harvesting, and improved copra production.

It is obvious that the shift from the present way of production to a more advanced system will take considerable time. Both cashew and coconut are perennials with a long bearing life, so their improvement can only be realized gradually.

A further improvement could be the introduction of dairy cattle in the farming system. Research has proved that the combination of coconut and dairy enterprises, as well as of cashew and dairy, is considerably more profitable than coconut and/or cashew alone (35).

Capital intensity

Capital intensity of large-scale tree cropping is rather high some 1,500 shillings per ha. This amount excludes any investment in land, buildings, and trees. The practice of intercropping in the early stages of development keeps the investment in trees low (19). The recurrent costs are estimated at 800 to 900 shillings per ha.

If intermediate technology were applied, capital intensity would be 2,000 to 2,500 shillings per ha, broken down as follows: machinery and equipment 60 per cent, working capital 30 per cent and miscellaneous 10 per cent. Investment in land, buildings, and trees is not included. The recurrent costs would be 1,300 to 1,400 shillings per ha.

Labour intensity

Because copra production is done on the estate, labour intensity is high, namely 400 to 450 man-equivalents per 1,000 ha. Since the adoption of intermediate technology will be coupled with a slight increase in mechanization labour intensity will stay at the same level, in spite of the general intensification of the production.

Farm power

By far the greater part of the work will be done by hand. Only a few tractors will be needed for preparing the land for new plantings, for gyro-mowing of the undercover, and for some transport.

Technical know-how

With intermediate technology, the level of technical know-how is moderate to high.

Farm size

The size of this type of estate could be from 100 ha upwards.

Land tenure

This type of farming requires clearly defined land rights, but with land adjudication in the coastal zone nearing its completion, land tenure problems do not exist.

Farm income

Incomes accruing to labour are of the order of 2,000 shillings per worker. Assuming that an average family of 6 persons provides 1.5 workers, average family incomes will amount to some 3,000 shillings a year. Assuming further that the women will produce some food crops on their own or estate land an average annual per capita income of some 600 shillings could be obtained.

The remuneration of the factor management can tentatively be estimated at 5 per cent of the gross production value.

Profit margins will largely depend on the standard of management and on the related level of technology. At present the profitability of large-scale tree crop growing is low to moderate. With intermediate technology a profit of some 15 per cent of the gross value of production will be possible.

Markets and prices

Marketing and processing facilities for cashew nut and copra are still insufficiently developed although progress is being made. The price for cashew nuts, of which until recently about 90 per cent were exported, has long been considerably below parity. In 1975 the difference was about 25 per cent. This is due to the existing monopoly in processing and trade. In the near future the situation might change considerably because of the recently built cashew nut factory at Kilifi and another one at Tiwi, which will start operating in 1979/1980.

Taking into account the moderate quality of the produce, the producer's price of copra is fair.

Constraints

The major constraints hampering the further development of this type of farming are:

1. The lack of capital resources;
2. The lack of adequately trained management.

3.8. Smallholder irrigation

General

Irrigation projects are classified as smallholder irrigation projects if project management is limited to a minimum and if the participants have the freedom to cultivate whatever they want. This implies little Government involvement.

In the Kwale soil survey area the potential for small-scale irrigation schemes is limited. At present flash flood irrigation is practised on a small area near Vanga with water from the Umba river. The scheme requires survey and modernization, and an experimental intake is to be constructed under a District Development Committee Grant. Comparatively small areas in the coastal crop lands are supplied with sprinklers for supplementary water.

Other than the above, no expansion of irrigation is possible as most of the water sources are seasonal and impounding sites non-existent. However, there are plans to investigate possibilities for holding back and spilling water by using collapsible hydraulic (butyl) structures (10). These investigations might open up new perspectives for irrigated agriculture in the Kwale area.

The Vanga Irrigation Scheme covers an area of some 700 ha, which in general is cultivated for rice. At present almost all of the produce is consumed locally (16), but it is expected that after the scheme has been improved considerable surplusses can be marketed.

The improvement of the Vanga Scheme is part of the small-scale irrigation program being implemented by the Kenya Government. The aim of the program is to improve the standard of living in poor farming communities through the development of the available water resources. Government financial support to this program is channeled through the District Development Committees. Technical support is given by various Government agencies, coordinated by the Land and Farm Management Division of the Ministry of Agriculture.

Since little is known about the exact state of affairs in the Vanga scheme, small-scale irrigation will further be discussed in general terms.

Produce

Provided that soil conditions are suitable, many small-scale irrigation schemes can produce vegetables such as tomatoes, sweet peppers, chillies, onions, cabbages, etc. The lack of sufficient market demand within economic reach of the schemes however, will be a strongly limiting factor. Other food and cash crops, such as rice, maize, beans, and cotton also qualify to be grown under irrigation, but the net returns per hectare are generally considerably lower than those of vegetables.

Vegetables could easily yield between 5 and 10 tons per hectare, and tomatoes even 15 to 25 tons or more.

Rice and maize yields of up to 5 tons could be expected, provided that pest and disease control is well organized and the general standard of husbandry is moderate to high. Tobacco can also yield a good return if management standards are fairly high.

In many cases double cropping could be practised, and in a few even triple cropping.

Capital intensity

Investment costs of small-scale irrigation projects vary considerably from place to place, and depend on topography, soil type, availability of water, etc. Other important factors, are the quality of the existing technical infrastructure and the availability of (local) contractors to assist in the construction of the schemes.

Total investment costs can roughly be estimated at 1,500 to 2,500 shillings per ha. If the irrigation water has to be pumped into the canal, another 750 to 1,000 shillings per ha might be needed. Recurrent costs might vary between 1,000 and 1,500 shillings per ha per annum for grain crops, depending on the cost of pumping. Recurrent costs for vegetable growing might easily be twice as high.

Labour intensity

Small-scale irrigation schemes offer ample employment opportunities. Assuming two crops of rice a year, the total labour requirements would be some 500 man-equivalents per 1,000 ha. If a variety of vegetables were to be grown, the total labour requirements may be as high as 1,250 man-equivalents per 1,000 ha or even considerably more.

Farm power

Even though farms in small-scale irrigation schemes will be small, a certain measure of tractorization (about one tractor per 60 ha) will be needed, because double or triple cropping requires rapid land preparation between successive crops. Weeding and harvesting should be done by hand, making the best use of the available family labour.

Level of technology

The level of technology required for successful irrigated farming is rather high, especially if vegetables are grown. Therefore, it will be necessary to guide new irrigation farmers, at least during the first few seasons. Later these farmers should get regular advice from the local extension agents and/or from extension specialists. Emphasis should be placed on a limited number of extension themes which are crucial for the success of irrigated farming.

Farm size

Farms in small-scale irrigation schemes are generally small, since the value added per ha is high in comparison with non-irrigated farming and since the labour requirements per ha are also high. If grain crops such as rice and maize were to be grown, the average farm size could be about 1.5 ha. Vegetable farmers could easily do with half that area. In relevant cases consideration should be given to decreasing the number of irrigated hectares per family to promote integration of irrigated and dry farming and/or livestock keeping.

Land tenure

Land in small-scale irrigation schemes should be adjudicated as soon as possible after the construction of the projects, so as to stimulate the farmers to make the most of their new opportunities. Land adjudication is also beneficial in that farmers who have a title deed have access to institutional credit.

Farm income

Based on observations in various small-scale irrigation projects in Kenya, the average gross value of production from grain crops is estimated at 4,000 to 6,000 shillings per ha per annum. Based on data concerning the related production costs, the value added is calculated at 3,000 to 4,500 shillings per ha per annum.

For vegetables, the gross value of production could easily reach some 12,000 shillings and the value added 7,000 to 10,000 shillings per ha per year. Depending on the choice of crops, the latter values could even be considerably higher.

Markets and prices

Marketing of produce could be hampered by inadequacies of the road system. Vegetable growing on a substantial scale is only possible if the distance to a major marketing centre is not too far.

Constraints

The major constraint to the development of small-scale irrigation schemes in the Kwale soil survey area is the limited availability of water resources.

Of secondary importance are:

1. High investment costs;
2. Lack of irrigation management capacity;
3. Insufficient technical know-how for vegetable growing;
4. Shortage of extension staff.

3.9. Forestry

General

In the Kwale soil survey area, only some 7 per cent of the gross area is under indigenous forest. The area under plantation forest is at present still very small but the Shimba Afforestation Scheme, which will ultimately cover more than 20,000 ha, will radically change the situation. Currently the gazetted forest areas comprise some 28,500 ha, of which area the Shimba Hills National Park covers about two-thirds, i.e. 19,250 ha. In addition, there are some 6,300 ha of mangrove forest along the Coast, which are gazetted and worked.

Almost all forest lies in Ecological Zone III.

The total revenues from forestry in 1974 were only 200,000 shillings (10), so its direct economic importance is but modest. The indirect (economic) benefits of protective forest, however, may be very high. The efforts of the forest department is doing all within its present capacity to improve and conserve this vital resource are therefore highly commendable.

Attention is drawn to the need for the protection of flora and fauna in non-gazetted areas, especially in the tourist areas along the coast. In catchment areas inland, there should be a stricter control on charcoal burning, quarrying on protected hills for road gravel, and depletion of non-protected stands of timber (10, 51).

Fuel wood and additional building pole plantation should be planned and secured for development in the not too distant future.

If well managed, plantation forest in the Kwale area might yield some 14 m^3 of soft wood per ha per year (51), which, valued at 1975 prices, might give some 500 shillings (10).

Because of lack of data it is impossible to give any clear idea about the possible yields of the various sub-areas, about the investments needed to open up the areas, or about the total exploitation costs. The latter will, however, be substantial, eventhough the areas are relatively accessible.

3.10 Tourism

General

The Kwale coastlands have a vast potential for tourist development. There are fine beaches all along the coast over a distance of some 30 km, and the hinterland with its famous wild parks is very attractive. Currently there is a limited, but flourishing, tourist industry and plans for its expansion are in an advanced stage. The existing tourist facilities along the south coast comprise about 1,350 hotel beds and 50 cottages. If the development plan prepared by the Kenya Coast Planners is implemented, there will be an additional 2,250 hotel beds in 1984 and

another 4,250 in 1994, bringing the total number to some 7,850 by the end of the project (52). However ambitious this development plan may be, it is foreseen that the expanded hotel accommodation in 1994 will still only meet less than half of the total demand from tourists.

The area designated for development lies in both Diani and Tiwi locations. Besides planning the tourist facilities, which are to be constructed over the period 1976-1994, the Kwale Coast Planners have also identified the full needs of the support population, including housing, physical infrastructure, and social services. The project aims at maximizing the economic benefits of tourist development, taking into account ecological, social, and cultural constraints. It also aims at spreading these benefits over a large number of people. Thus the Diani (Beach) Project will have a significant impact on the economy of the Kwale district.

Produce

The produce of the tourist industry are the services (e.g. recreational facilities) provided to (foreign) tourists. The latter buy those services for an amount of 150 to 200 shillings per person per day on the average (31). Since the average stay of the tourists is about 12 days, gross expenditure per tourist might be over 2,000 shillings. This estimate is based on gross spending by tourists. No reduction is made for the costs of imported goods and services used in the tourist trade or any other costs. Nor do the figures include international air fares paid to local and foreign carriers. The growth rate of tourist expenditure over the next decade is estimated at 10 per cent. Whether this rate of growth will be achieved, depends greatly on the recovery of the economies of the major industrial countries, from which most of the tourists come.

Capital

Capital intensity of the tourist industry is high. Average investment per hotel bed is currently of the order of 150,000 shillings. Only a few per cent of this amount is required for the establishment of communications, sewage and waste disposal, housing of personnel and social services. The remainder is for the construction of hotels and amenities.

The recurrent costs are also high, in local as well as in foreign currency.

Labour intensity

Labour intensity in the tourist industry is high, about 1.8 man-equivalents per hotel bed. This figure excludes construction workers (52).

Level of technology

The tourist industry requires well-educated and well-trained people at all levels. Training of staff and personnel is a must.

Income

Gross annual earnings from tourism might be estimated at some 30,000 shillings per hotel bed. About half of this amount will have to be paid for the bed. A substantial part of the gross income per bed will accrue to the factor capital. Labour and management income per bed might be of the order of 4,000 to 5,000 shillings per year. Average per capita income might be 500 to 600 shillings per annum.

Constraints

The major constraints hampering the development of the tourist industry along the Kwale coast are:

1. Inadequacy of water supply, power, and telecommunications;
2. Shortage of trained local personnel;
3. Economic malaise in the industrial countries.

4. SUMMARY

In the following table the key attributes for the various land utilization types discussed in this report will be summarized:

QUANTIFIABLE FACTORS FOR THE VARIOUS LAND UTILIZATION TYPES

Land utilization type	Produce	Capital intensity	Labour intensity	Farm power	Level of technical know-how	Farm size	Land Tenure	Farm income/ value added	Price structure
1. Smallholder rain-fed arable farming, traditional technology	Cashewnut, coconut, copra, mango, citrus, bixa, maize, cassava and a little livestock produce	Investment[1]: Low, 150 to 200 shs/ha, because of inter-cropping in the early stages of tree development. Recurrent costs[2]: 50 to 70 shs/ha	High, 350 to 400 man-equivalents per 1,000 ha, because landpreparation for food crops is done by hand	Almost completely manual	Low	Average: 3 to 4 ha (65% tree crops, 35% food crops)	Land adjudication in progress. Non-adjudicated land is frequently leased to immigrants. This might cause problems in future	Average: 600 to 650 shs/ha from crops and a few hundred shillings per holding from livestock	Farmgate price of cashewnut is far too low, because of monopoly in trade and processing
2. Smallholder rain-fed arable farming, intermediate technology	Cashewnut, coconut, copra, mango, citrus, bixa, maize, cassava and a little beef and dairy produce	Investment[1]: Rather low, 350 shs/ha, if inter-cropping in the early stages of tree development is practised. Recurrent costs[2]: 150 shs/ha	High, approx. 400 man-equivalents per 1,000 ha, despite a certain degree of mechanization	Land preparation for food crops and part of (gyro) mowing is mechanized	Moderate	Average: 3 to 4 ha (65% tree crops, 35% food crops)	- do -	Average: approx. 1,300 shs/ha from crops and a few hundred shillings per holding from livestock	- do - The price of milk is overvalued; that of beef is undervalued
3. Smallholder rain-fed mixed farming, traditional technology	Maize, cassava, beef, mutton, goatmeat and milk	Investment[1]: Low, 150 shs/ha (incl. dams, boreholes and dips) Recurrent costs[2]: 10 to 15 shs/ha	Low, 50 to 75 man-equivalents per 1,000 ha	Completely manual	Low	Average: 20 to 25 ha, of which only about 2 ha are cultivated	Land adjudication in progress	Average: 80 to 100 shs/ha (50% of total income from crops and 50% from livestock)	- do -

[1] Excluding land and buildings

[2] Excluding family labour

Land utilization type	Produce	Capital intensity	Labour intensity	Farm power	Level of technical know-how	Farm size	Land Tenure	Farm income/ value added	Price structure
4. Smallholder rain-fed mixed farming, intermediate technology	Maize, cassava, oil crops, fodder crops, beef and some dairy produce	Investment[1]: Rather low, 300 shs/ha (incl. dams, boreholes and dips) Recurrent costs[2]: Approx. 20 shs/ha	Low, 50 to 75 man-equivalents per 1,000 ha	Partly mechanized, partly manual	Moderate	Average: 20 to 25 ha, of which about 2 ha is cultivated	Land adjudication is a prerequisite for development	Average: 130 to 150 shs/ha (50% of total income from crops and 50% from livestock)	The price of milk is overvalued; that of beef is undervalued
5. Extensive range management	Beef, mutton, goatmeat, milk and honey	Investment[1]: Low, 100 to 120 shs/ha (incl. dams, boreholes and dips) Recurrent costs[2]: 15 to 20 shs/ha	Very low, 5 to 10 man-equivalents per 1,000 ha	Completely manual	Low to moderate	Minimum 20,000 ha per ranch. Per family at least 150 ha are required at present	Land adjudication is a prerequisite for ranch development. Choice between group and cooperative ranch should depend on the situation	At present 13 shs/ha from livestock keeping only. In future 28 shs/ha (85% from livestock and 15% from beekeeping) possible	Beefprices are generally undervalued
6. Large-scale sugar cane production under rain-fed conditions-intermediate and advanced technology	Sugarcane	Investment[1]: High, at present 5 to 6,000 shs/ha; in future to be increased to 7 to 8,000 shs/ha. Recurrent costs[3]: At present 2,500 shs/ha; in future 3 to 3,500 shs/ha	At present very high, some 600 man-equivalents per 1,000 ha; in future still some 400 man-equivalents per 1,000 ha	Strongly mechanized, although harvesting is by hand, now and in the future	High	Several thousands of hectares, depending on productivity of the land and capacity of the factory	No problems	At present labour income 1,200 to 1,300 shs/ha or some 2,000 shs per worker. Remuneration of capital negative. In future 10 to 15% profit possible.	Cane prices are fair, but should be increased to stimulate production. Sugar price in line with world market price.

[1] Excluding land and buildings

[2] Excluding family labour

[3] Including hired labour

QUANTIFIABLE FACTORS FOR THE VARIOUS LAND UTILIZATION TYPES

Land utilization type	Produce	Capital intensity	Labour intensity	Farm power	Level of technical know-how	Farm size	Land Tenure	Farm income/ value added	Price structure
7. Large-scale tree crop growing under rain-fed conditions-intermediate technology	Coconut, copra, cashew-nut and, to a lesser extent, citrus, mango and dairy produce	Investment[1]: Rather high, 2,000 to 2,500 shs/ha Recurrent costs[2]: 1,300 to 1,400 shs/ha	High, 400 to 450 man-equivalents per 1,000 ha	Partly mechanized, partly manual	Moderate to high	From 100 ha upwards	No problems	Labour income some 2,000 shs/ha. Remuneration of invested capital can be fair	Cashewnut prices are presently undervalued
8. Smallholder irrigation	Grain crops, cotton, vegetables	Investment[1]: High, 2 to 4,000 shs/ha Recurrent costs[3]: 1 to 3,000 shs/ha depending on crops grown	Very high, 500 to 1,000 man-equivalents per 1,000 ha	Land preparation mechanized. Other activites manual	Rather high	Small, 1 to 2 ha is sufficient.	Land adjudication is a prerequisite for the development of irrigated agriculture	For grain crops 3,000 to 4,500 shs/ha; for vegetables 7,000 to 10,000 shs/ha	No specific problems
9. Forestry	Timber, poles and fuel wood	Investment: Rather high Recurrent costs: Rather high	Moderate (if labour in related industries is included)	Partly mechanized, partly manual	High	Approx. 4,000 ha per sawmill	Government gazetted areas	Depending on "royalties"	No specific problems
10. Tourism	Tourists' spendings	Investment: Very high, some 150,000 shs per hotel bed Recurrent costs: high	High, 1.8 man-equivalents per hotel bed	N.A.	High	N.A.	N.A.	Per hotel bed 4,000 to 5,000 shs per annum labour income	N.A.

[1] Excluding land and buildings

[2] Including hired labour

ANNEX I: LIST OF PERSONS CONSULTED (Nov. '75 - March '76)

Ministry of Agriculture Headquarters, Nairobi:

Mr. D.M. Thairu, Director of Agric. Research;
Mr. S.N. Muturi, Ass. Director of Agric. Research;
Dr. Th. Wormer, Research Division;
Mr. N. Nightingale, Planning Division.

National Agricultural Laboratories, Nairobi

Dr. J.J. Njoroge, Director;
Mr. N.N. Nyandat, Head, Kenya Soil Survey;
Dr. W.G. Sombroek, Project Manager, KSSP.

Members of the Kenya Soil Survey:
Mr. R.F. van de Weg;
Mr. H.M.H. Braun;
Mr. D.O. Michieka;
Mr. F.N. Muchena;
Mr. B.J. van der Pouw;
Mr. J.J. Vleeshouwer.

Kwale Special Development Rural Project:

Mr. W. Swinson, Project Advisor;
Mr. P.M. Wambua, SRDP office, Msambweni;

Coast Province:

Mr. J.A. Mwinamo, Provincial Planning Officer;
Mr. M.M. Tsuma, Planning Officer;
Mr. T.C. Pandey, Rural planning advisor;
Mr. Nyamai, Provincial Crops Officer;
Mr. Ole Sedera, Provincial Range officer.

Kwale district:

Mr. Nyarangi, D.C.;
Mr. Anditi, District Agricultural officer;
Mr. Nguu, District Crops officer;
Mr. Aboud, District Range officer.

Mtwapa Research Station:

Mr. W'opindi, Agricultural Research Officer (tree crops)
Mr. Chogo, Arable crops officer.

Bamburi Portland Cement Co. Ltd.

Mr. R. Haller, agronomist

Kenya Coast Planners Ltd.

Mr. R.M. Rostock, Director

Institute of Development Studies, Nairobi

Mrs. M. Kempe, Research documentalist

ANNEX II - AREAS, POPULATION AND FARM SIZE

Table 1. Areas

Area	Gross area[1] (ha)	Cultivable area[2] (ha)	Cultivated area[2] (ha)
Kwale coast lands	15,000	6,000	5,240
Kwale crop lands	44,500	31,150	27,140
Shimba hills crop lands	13,000	7,800	4,150
Lukore crop lands	12,000	7,200	3,360
Mwachande sands	17,000	11,900	6,630
Majoreni crop lands	6,000	3,600	3,600
KWALE CROP LANDS	107,500	67,650	50,120
Jombo crop lands	7,000	5,600	3,790
Kikoneni crop lands	32,500	19,500	13,340
KIKONENI CROP LANDS	39,500	25,100	17,130
Mkongani North	6,500	3,900	2,600
Mkongani South	2,000	1,400	1,140
MKONGANI CROP LANDS	8,500	5,300	3,740
MATUGA SHALES	16,500	4,950	500
CLAY GRASS LANDS	7,500	0	0
KINANGO MARGINAL LANDS	68,500	13,700	7,540
KWALE RANGE LANDS	145,000	N.A.	N.A.

[1] Determined by planimeter

[2] According to Braun (11)

Table 2. Population

Area	Rural population 1969[1]	Rural population 1975	Growth rate 1969-1975[2] (%)
Kwale crop lands & Matuga shales (A)	86,631	104,653	+ 3.2
Kikoneni crop lands & Clay grass lands (B)	15,076	20,435	+ 5.2
Mkongani North & South (C)	5,870	7,091	+ 3.2
Kinango marginal lands (D)	21,458	25,622	+ 3.0
Kwale range lands (E)	20,323	24,267	+ 3.0
KWALE SOIL SURVEY AREA	149,358	182,068	+ 3.4

[1] 1969 - Population census

[2] Population projections by district, 1970-1980 (13)

Table 3. Farmsizes

Area	Cultivated area (ha)	Rural population in 1975	Ratio agric. pop./ rural population[1]	Average farm size, in ha
A	50,620	104,653	.90	3.2
B+C	20,870	27,526	.95	4.8
D	7,540	25,622	.95	1.9
E	0	24,267	.95	-
A-E	79,030	182,068	.92	-

[1] Estimated

ANNEX III - CROPPING PATTERNS

Areas	Cropped areas, in ha									Total
	Cashewnut	Coconut	Mango	Citrus	Bixa	Maize	Cassava	Other	Fallow	
Kwale coast lands	0	0	0	0	0	4,670	100	470	9,760	15,000
Kwale crop lands	12,760	8,140	1,360	0	0	810	270	3,800	17,360	44,500
Shimba hills crop lands	2,200	830	210	120	250	420	40	80	8,850	13,000
Lukore crop lands	1,500	360	70	130	420	850	0	30	8,640	12,000
Mwachande sands	2,850	1,190	130	0	0	800	0	1,660	10,370	17,000
Majoreni crop lands	1,910	960	160	0	0	100	30	440	2,400	6,000
KWALE CROP LANDS	21,220	11,480	1,930	250	670	7,650	440	6,480	57,380	107,500
Jombo crop lands	680	230	40	0	0	2,530	80	230	3,210	7,000
Kikoneni crop lands	2,270	1,600	130	0	270	7,600	400	1,070	19,160	32,500
KIKONENI CROP LANDS	2,950	1,830	170	0	270	10,130	480	1,300	22,370	39,500
Mkongani North	650	260	50	0	0	1,460	130	50	3,900	6,500
Mkongani South	380	380	10	100	20	170	60	20	860	2,000
MKONGANI CROP LANDS	1,030	640	60	100	20	1,630	190	70	4,760	8,500
MATUGA SHALES	0	0	0	0	0	500	0	0	16,000	16,500
CLAY GRASS LANDS	0	0	0	0	0	0	0	0	7,500	7,500
KINANGO MARGINAL LANDS	1,210	300	0	0	0	5,950	0	80	60,960	68,500
KWALE RANGE LANDS	0	0	0	0	0	0	0	0	145,000	145,000

Source: BRAUN, H.M.H., Land use in the Kwale survey area (11)

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