



## Country Pasture/Forage Resource Profiles

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### Kenya



by

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Kenya has a population of approximately 30 M and lies between latitudes 4° N and 4° S and between longitudes 34° E and 42° E. It is bordered by Tanzania to the south, Uganda to the west, Ethiopia to the north, Sudan to the north-west, Somalia to the east, and the Indian Ocean to the south-east. Its area is approximately 584,000 km<sup>2</sup> (see Figure 1). The country has climatic and ecological extremes with altitude varying from sea level to over 5000 m in the highlands. The mean annual rainfall ranges from < 250 mm in semi-arid and arid areas to > 2000 mm in high potential areas. Soils vary from the coral types on the coast to alluvial, swampy, and black cotton soils along river valleys and plains. The Kenyan highlands have fertile volcanic soils whereas soils in the semi-arid regions are shallow and infertile. Such diversity in climatic and edaphic conditions has encouraged the evolution of a wide variation in plant genetic resources.

Agriculture is very important in Kenya as 75% of the Kenyan population are dependent on agriculture for food and income, and it contributes 26% to the Gross Domestic Product (GDP) and 60% to foreign exchange earnings. However, only about one third of the total land area of Kenya is agriculturally productive, including the Kenyan highlands, coastal plains and the lake region. The other two thirds of the land area is semi-arid to arid, and characterized by low, unreliable and poorly distributed rainfall. These areas are used for pastoral farming. Livestock contributes about 26% of the total national agricultural production (Anon., 1991) (Table 1). Of the national cattle herd, dairy cattle (grade cattle) constitute about 3 M of the total 13 M cattle, 40% of which are pure-bred while 60% are cross-bred and produce 60% of the total milk output (Abate, 1992). About 80% of grade cattle are owned by smallholder farmers who produce about 76% of the total milk produced in the country. Dairy cattle are kept in areas receiving at least 800-1000 mm of rainfall per annum and where grazing is medium to high quality and production of fodder is practised. These areas are categorized as medium to high potential areas.

**Table 1. Kenya statistics for ruminant numbers, beef, veal, buffalo meat and**

**milk production, cattle imports and beef and veal imports for the period 1991-97**

Item	1991	1992	1993	1994	1995	1996
Cattle nos. (,000,000)	13.5	13.2	13	13	13.6	13.8
Buffalo nos.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Beef & veal prod. (,000 tonnes)	255	240	230	230	255	265
Beef & veal exports (mt.)	221	149	80	36	32	13
Buffalo meat prod.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Milk prod. (,000 tonnes)	2366	2338	2248	2267	2335	2445
Cattle imports (head)	5	n.r.	4	n.r.	195	n.r.
Beef & veal imports	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.

Item	1997	1998	1999	2000	2001
Cattle nos. (,000,000)	13.4	13.0	13.4	13.8	12.5
Buffalo nos.	n.r.	n.r.	n.r.	n.r.	n.r.
Beef & veal prod. (,000 tonnes)	270	270	279	287	290
Beef & veal exports (mt.)	119	230	273	60	n.r.
Buffalo meat prod.	n.r.	n.r.	n.r.	n.r.	n.r.
Milk prod. (,000 tonnes)	2466	2418	2481	2402	1952
Cattle imports (head)	n.r.	n.r.	89	n.r.	n.r.
Beef & veal imports	n.r.	n.r.	10	13	n.r.

Source: FAO Database 1998; n.r. = no record



**Figure 1. Map of Kenya**

Beef is a major source of animal protein. There are about 10 M head of beef cattle producing about 120,000 tonnes of beef per year, of which 50-60% come from the smallholder sector (World Bank, 1986). Beef production contributes about 56% of the total livestock marketed output in Kenya (Anon., 1991). Cattle are concentrated in medium to low potential areas where approximately 7 M sheep, 8 M goats and several thousand camels are also raised.

Kenya has varied land tenure systems ranging from freehold to communal ownership. In urban centres, land ownership is on a leasehold basis. The farm sizes have been declining due to sub-division creating small uneconomic plots. Kenyan rural areas are characterised by limited employment opportunities, low incomes and high incidence of poverty. There are on-going agricultural reform programmes geared towards a liberalised agricultural sector. These programmes are, however, hampered by poor support services which include access roads, market centres, and credit facilities among others. Currently there are two major strategies for promoting rural development. These include the *District Focus for Rural Development* and the *Rural Urban Balance Strategy* (Rok, 1997).

## 2. SOILS AND TOPOGRAPHY

Kenya is a country with varying climate, vegetation, topography, and underlying parent rock. Climate is the most important factor influencing soil formation. Climate affects the soil types directly through its weathering effects and indirectly as a result of its influence upon vegetation. In most parts of Kenya, soils are deficient in nitrogen (N), phosphorous (P) and occasionally potassium (K). In dry areas, the soils have low organic matter mainly because rainfall is low, variable, unreliable and, poorly distributed. To understand the soil distribution of Kenya, we may divide the country into the following broad regions: Humid, Sub-humid, and Arid.

### 2.1 Humid regions (The highlands)

These are areas with an altitude of over 1500 m which receive an annual rainfall of over 1000 mm. They have volcanic rocks and the soils are mainly loamy, and include the

highlands east and west of the Rift Valley and the Rift Valley floor. Other humid areas with an altitude less than 1500 m (humid lowlands) have sandy soils which are well drained and are of loamy, sandy clay texture e.g., along the Kenyan coast. The Taita Hills have fertile loam soils which are agriculturally productive. Alluvial soils (silts) are found along river valleys e.g., Tana and Sabaki Valleys. Sand dunes and mangrove swamps are found along the coast. The soils covered by mangrove swamps are deep, grey, saline and poorly drained.

## 2.2 Sub-humid regions (Lake region and western Kenya)

These areas receive slightly less rainfall than the humid areas. They have volcanic and basement rocks. They lie between 1000 to 2000 m. Rainfall is up to 1,000 mm per year and soils are red clay. Areas with sedimentary rocks occur in the lowlands at an altitude ranging from 1,000 m and have loamy sandy soils. Soils here vary greatly according to the prevailing parent material. In higher regions, soils are dark red clays which are fertile and well drained. In the Kavirondo Gulf, soils are sandy loam formed from sedimentary rocks. Alluvial deposits of eroded material from uplands are common along flood plains of rivers such as Nyando, Yala, Nzoia, and Kuja. In plains such as the Yala and Kano plains, peat swampy soils and black cotton soils dominate. Volcanic soils interspersed with fertile peat swampy soils are found in the uplands. Soils in these regions are generally productive.

## 2.3 Semi-arid regions (northern and north-eastern Kenya)

These regions receive on average 300-500 mm of rainfall per year and the soils are shallow and generally infertile, but variable. These soils have developed mainly from sedimentary rocks. Areas with an altitude above 1,200 m and receiving rainfall of up to 600 mm e.g., Marsabit, have fertile volcanic soils. To the north-east of Horr, black cotton soils are found. These soils become water-logged when it rains. Around Lake Turkana, the soils are dark red in colour. In north-western Kenya, and to the east of Lake Turkana, there are lava soils. These areas receive less than 250 mm of rainfall per year and soils are not fully developed because they lack vegetation or organic matter. Along the Turkwell and Tana River basins, the soils are alluvial.

## 3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Climate, vegetation and land use potential have been used to assess land suitability for different uses. The major elements of climate that affect herbage growth are the intensity and duration of rainfall; the relationship between annual rainfall and potential evapo-transpiration; and the year-to-year variation in rainfall. Kenya is divided into 7 agro-climatic zones using a moisture index (Sombroek *et al.*, 1982) based on annual rainfall expressed as a percentage of potential evaporation. Areas with an index greater than 50% have high potential for cropping, and are designated zones I, II, and III. These zones account for 12% of Kenya's land area. The semi-humid to arid regions (zones IV, V, VI, and VII) have indexes of less than 50% and a mean annual rainfall of less than 1100 mm. These zones are generally referred to as the Kenyan rangelands and account for 88% of the land area (Table 2).

**Table 2. Moisture availability zones in Kenya with rainfall and proportion of land**

Agro - Climatic Zone	Classification	Moisture Index (%)	Annual Rainfall (mm)	Land Area (%)
I	Humid	>80	1100-2700	

<b>II</b>	<b>Sub-humid</b>	<b>65 - 80</b>	<b>1000-1600</b>	<b>12</b>
<b>III</b>	<b>Semi-humid</b>	<b>50 - 65</b>	<b>800-1400</b>	
<b>IV</b>	<b>Semi-humid to semi-arid</b>	<b>40 - 50</b>	<b>600-1100</b>	<b>5</b>
<b>V</b>	<b>Semi-arid</b>	<b>25 - 40</b>	<b>450-900</b>	<b>15</b>
<b>VI</b>	<b>Arid</b>	<b>15 - 25</b>	<b>300-550</b>	<b>22</b>
<b>VII</b>	<b>Very arid</b>	<b>&lt;15</b>	<b>150-350</b>	<b>46</b>

**Modified from: Sombroek et al. (1982).**

The seven agro-climatic zones are each sub-divided according to mean annual temperature to identify areas suitable for growing each of Kenya`s major food and cash crops. Most of the high potential land areas are located above 1200 m altitude and have mean annual temperatures of below 18° C, while 90% of the semi-arid and arid zones lies below 1260 m and has mean annual temperatures ranging from 22° C to 40° C. There are four inter-connected factors that determine the long-term availability of grazing resources in pastoral production systems: (i) variability in rainfall; (ii) the efficiency with which rainfall is converted into useable forage; (iii) the use of grazing resources by the domestic and wild herbivores; and (iv) the relationship between quantity and quality of the resources.

#### **4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS**

There are about seven different livestock production systems in Kenya as shown in the manual of livestock production systems (Peeler and Omore, 1997).

##### **4.1 Cattle Systems**

**Small-scale dairy-meat production.** Small-scale dairy-meat production from the Small East African (SEA) zebu mostly takes place in high rainfall areas that are also suitable for smallholder exotic dairy cow production. These animals are raised for beef and milk. The Ministry of Agriculture, Livestock Development and Marketing (MALDM) estimate that all zebu milk is consumed in the home (MALDM, 1993), though farm gate sales are well recognized. Smallholders generally keep SEA zebu with other ruminant stock. Cattle are paddocked, tethered on the farm or taken to graze on roadsides or in communal areas. Cows are only milked for approximately the first 5 months of lactation. Calves are allowed to suckle after milking. The system has very few inputs, animal health interventions are rarely practised, and little concentrate feed or mineral supplements are purchased. The cattle are an integral part of a mixed farming system. The size of land holdings varies between 2 and 30 acres depending on geographic region. There are 5.3 M cattle in this system.

**Small-scale dairy production.** Small-scale dairy farming activity is mostly found in agro-climatic zone (ACZ) 1 - 4 in the Central and Rift Valley Provinces and the Coastal lowlands. There is a higher concentration of smallholder dairy farms in peri-urban areas with easy access to milk marketing channels. Small scale dairy farmers typically keep 2 or 3 dairy cows, with their followers, on approximately 1 hectare of land with other livestock, whilst also engaging in arable agriculture. Cattle on these farms are mostly genetically heterogeneous *Bos taurus* breeds, or cross-breds, containing a high proportion of *Bos taurus* dairy with infusion of *Bos indicus*. The Friesian breed predominates. The smallholder dairy producers practise zero-grazing, free-grazing or a combination of both. It is estimated that there are slightly over 2.5 M dairy cattle kept in

this system. Fodders, such as napier grass (*Pennisetum purpureum*) are grown.

**Large-scale dairy production.** Large-scale dairy farms are owned by both private firms and public institutions, such as the Agricultural Development Corporation (ADC). MALDM estimates that 500,000 dairy cattle are kept in this system. Friesian cattle are the dominant breed but Ayrshire and Channel Island breeds are also found. Some farms in the drier areas cross Sahiwal with *Bos taurus* breeds. Management systems vary greatly within this production system, from very low input, low milk output, extensive ranching systems (where beef is also an important product) to intensive zero-grazing systems based on irrigated legume production. Herds of 20 or more breeding females can be classified as large-scale. Many enterprises have in excess of 100 head of cattle.

**Large-scale dairy-meat production.** The vast majority of cattle kept in ACZ 5 - 7 are SEA zebras kept by pastoralists in mixed herds with indigenous breeds of sheep, goats, and camels in the northern rangelands. Pastoralists may be organized in groups or private ranches. In some areas, improved Boran and Sahiwal bulls have been introduced (Roderick, 1995). Milk production is generally for home consumption, whilst surplus cattle are sold to traders. About 10% of the adult animals are breeding males. Generally, veterinary drugs are the only purchased input. Production levels are largely dependent on rainfall to produce adequate forage and thus vary greatly from year to year. Herd sizes also vary greatly. There are about 4.5 M cattle kept in this system.

## 4.2 Small ruminant systems

**Large-scale small ruminant production.** The small East African hair-goat is predominant, however, in parts of the northern rangelands, the Galla goat is popular, and is becoming increasingly common in other areas. Fat-tailed sheep are predominantly found, especially the red Maasai and black headed Somali. In some areas, the genetic potential of the flock has been improved by the introduction of the Dorper breed. Sheep and goats are kept in mixed herds with cattle, and in the northern rangelands, with camels. Goats are the only source of milk for pastoralists who own no cattle and become more important when cattle milk production is low. Sheep are sometimes milked, but the practice is neither regular nor widespread. Otherwise, small ruminants are kept for subsistence meat production and are also sold for cash. Veterinary drugs are the only significant input (mainly anti-helminths). Herd sizes vary greatly. There are approximately 6 M large-scale dairy meat goats and 4.3 M large-scale meat sheep in Kenya.

**Small-scale small ruminant production.** The production systems are based on the small East African goat and fat-tailed sheep breeds, such as the red Maasai and the black headed Somali. Dorper and dorper crosses are also found in some areas. Goat production is in two systems - meat and dairy-meat production. Five percent of the total population is estimated to fall into the latter system. Smallholders without cattle are more likely to milk their goats. Nearly all smallholders practise arable agriculture and keep a mixture of ruminant and non-ruminant livestock. In general, sheep and goats will be grazed in small paddocks with cattle, but in some areas they will graze communally. Generally feed, minerals and veterinary products are bought. Crop residues may occasionally be fed. Breeding is not controlled and lambs and kids are born all year round. The average herd size is between 5 and 10. The estimated population is about 200,000 small-scale dairy-meat goats, 3.5 M small-scale meat goats, and 2.7 M small-scale meat sheep, totalling about 6.5 M small-scale small ruminants.

**Sheep production for wool and meat.** There are approximately 750,000 wool sheep in Kenya, of which two thirds are found in the Rift Valley. They are kept as part of a mixed farming system on both small and large-scale farms.

## 4.3 Socio-economic limitations

The livestock sub-sector, like the larger agricultural sector, is faced with various limitations. Smallholder farmers cannot access credit. There is limited application of

agricultural findings because of the high input costs of new techniques. Cultural constraints include those related to gender discrimination especially in the ownership, transfer and usage of land. Women in many societies in Kenya do not inherit land and, as a result, very few of them own land, even though they do most of the operations on the farm. The other cultural constraint is the traditional inheritance practice in which a parent gives land to each of his sons. This leads to land fragmentation into small uneconomic units. Poor infrastructure in many areas is also a hindrance to livestock development. Poor market outlets and poor management, especially in the marketing of milk, has discouraged many farmers. Lack of commercial orientation is a constraint because beef cattle are kept by pastoral communities with sociological attachments to their livestock. Currently the primary objective is to promote increased investment in the livestock sub-sector, to ensure domestic self-sufficiency and export. Government efforts include provision of infrastructure, construction of cattle dips, sinking bore holes and organisation of markets, especially for beef animals.

#### **4.4 Other constraints to increased livestock production**

Livestock nutrition is one of the most important constraints on increased livestock production, especially during dry season when forage quality and quantity is low. In this period, water is also limiting because most springs are seasonal. This affects all livestock feeding systems including cut and carry, tethered or free grazing systems. In beef production systems, over-stocking leads to over-grazing and land degradation especially in communal pastures. In many livestock systems, poor breeding results from inadequate artificial insemination (A.I.) and lack of improved breeding bulls. This is worsened by high calf mortality, long calving intervals and mastitis as a result of poor livestock management. Other constraints include diseases transmitted by ticks and tsetse flies, viral diseases, bacterial diseases, endoparasites and wildlife derived diseases, as over 70% of Kenya's wild game is found in range areas outside the national parks. Contagious caprine pleuroneumonia is a serious disease in goats and is endemic in certain parts of the country. Through research, the Government has developed various technologies and has intensified its extension services on veterinary and animal production. Technologies on disease control include vector chemical control, chemoprophylaxis and immunization. Technologies on proper livestock management and livestock nutrition have been developed and are being extended to farmers by extension officers, in order to improve farmers' awareness and management skills.

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## **5. THE PASTURE RESOURCES**

### **5.1 Historical background**

Eastern Africa is recognized as the centre of origin and distribution of 8 to 10 of the most economically important tropical and sub-tropical pasture species contributing 20 - 25% of the total sown pasture species (Hartley and Williams, 1956). East Africa's indigenous grasses are outstanding in yield and quality in tropical and sub-tropical regions of the world, having demonstrated their wide adaptation in many other sub-tropical countries under different ecological conditions. Pioneering work in natural grasslands research in Kenya started in 1927, when a botanical survey for the entire country was carried out and this culminated in the classification of the country into eight regions based on natural vegetation types. This was to form the basis for agricultural development, not only for pasture but also for other major crops as well (Edwards, 1940). The high rainfall areas were recommended for intensive farming with suitable pasture species while the low rainfall region, in the medium to low altitudes, was recommended for extensive farming and rangeland management.

Since 1951, rapid progress has been made in forage collection and introduction of pasture grasses and legumes. Pasture research in the 1970s tended to continue an interest in ley grasses and the accumulation of germplasm; during the late 1970s to the early 1980s, there was greater emphasis on relevant research on the needs of the smallholder farmer in the high and medium potential areas and in marginal agrarian

areas. The richness of grass species collected (594 accessions) in Kenya offered an excellent starting point for selecting several species and better varieties. For example, in *Chloris gayana*, Elmba rhodes was selected from Mbarara rhodes, and Boma rhodes was selected from Masaba rhodes; in *Setaria sphacelata*, Nasiwa setaria was selected from Nandi setaria; and in *Pennisetum purpureum*, Clone 13 was selected from French Cameroon accessions.

During the Kenya/FAO project on Forage Collection and Evaluation (1974 - 1987), a total of 202 grass and 164 legume accessions were collected from various parts of the country. Some of the grass species collected included *Panicum maximum*, *Cenchrus ciliaris*, *Chloris gayana*, *Digitaria milaniana*, *Enteropogon macrostachyus*, *Cynodon dactylon*, *Eragrostis superba*, *Leptochloa obtusifolia*, and *Setaria sphacelata*. The legume species collected included *Glycine wightii*, *Clitoria ternatea*, *Crotalaria* spp., *Lablab purpureus*, *Rhynchosia* spp. and *Stylosanthes guianensis* among others. Some promising fodder trees and forbs were also collected. The project also introduced from abroad several useful forage materials with two main objectives, (a) to introduce promising forage crops of exotic origin, and (b) to re-introduce forage crops which had originally been taken from Kenya and had been improved elsewhere resulting in superior types. A total of 93 grass accessions were introduced/re-introduced, with special emphasis placed on *Cenchrus ciliaris* and *Panicum maximum* for improving our rangelands; *Festuca arundinacea*, *Lolium multiflorum*, *L. perenne*, *Phalaris arundinacea*, and *Sorghum* spp. for improving forage in high altitude zones of Kenya. A total of 188 legume species were also introduced comprising mainly *Stylosanthes guianensis*, *S. humilis*, *S. scabra*, *Medicago sativa*, *Glycine wightii*, *Lablab purpureus*, *Trifolium pratense*, and *T. repens*. The introduced forage crops (grasses and legumes) were mainly from North and South America and Australia (Ibrahim, 1988). These forage materials were tested and evaluated in various agro-ecological zones of Kenya and the promising ones were recommended for growing in those regions. Seed samples for most of the forage materials collected and evaluated have been stored in the National Gene Bank at Muguga for future use.

## 5.2 The cold and wet high altitude region

This is a relatively small area with an altitude range from 2400 to 2500 m. The annual rainfall is over 1200 mm in 4 out of 5 years and occasional frosts are experienced. The zone covers Mau Narok in the Rift Valley, the upper Cherangani hills and upper Mt. Elgon in Western Kenya, and the upper Nyandarua, Nyeri, Kiambu, and Aberdare Range in Central Kenya. Much of Mt. Kenya which falls under this zone is forested. Most of the area was formerly occupied by European settlers and dairy grade cattle, sheep, wheat and pyrethrum mixed farming are well established. Where the forest was cleared, the ensuing grassland was predominantly kikuyu grass (*Pennisetum clandestinum*) and themeda grass (*Themeda triandra*) in natural association with legume clovers such as Kenya purple clover (*Trifolium burchellianum*), Kenya white clover (*T. semipilosum*) and Louisiana white clover (*T. repens*). Grassland research for high altitude areas focused on exotic species from temperate countries. While cocksfoot (*Dactylis glomerata*), rye grass (*Lolium perenne*), tall fescue (*Festuca arundinaceae*), and clovers have been shown to be promising, they are all short-lived and kikuyu grass usually supersedes them within two to three years after establishment. Furthermore, they do not set much seed in Kenya and hence practically all seeds are imported. Other fodder crops used include oats (*Avena sativa*), kales (*Brassicacae*), fodder beets and turnips.

## 5.3 The cool and wet medium altitude region

This region lies within an altitude range of 1800 to 2400 m and is characterized by high rainfall of over 1000 mm p.a. in 4 out of 5 years. The region includes Trans Nzoia, Nandi, Kericho, Kisii and Narok districts in Western Kenya, and Nyandarua, upper Kiambu, Nyeri, Kirinyanga, Muranga, Embu and Meru districts in Central Kenya. The majority of Kenya's dairy cattle area is concentrated in this zone. Being a mixed farming area (dairy cattle with maize, coffee, tea, pyrethrum), the zones could be self-sufficient in production of pastures, fodder, and legumes and energy sources for supplementary

feeds. The natural flora contains a number of useful pasture species such as setaria (*Setaria sphacelata*), kikuyu grass, themeda grass, *Glycine javanica*, Kenya white clover and Kenya purple clover. Two species already in commercial use in Kenya are Nandi setaria, introduced from Baraton Nandi district, and Kenya white clover introduced from Kabete in Kiambu district. These two species perform best above 2000 m, but below this, Rhodes grass (*Chloris gayana*) varieties - Boma, Elmba, Masaba, Mbarara - and *Desmodium* spp. grow well. Other recommended grasses include setaria varieties Nandi and Nasiwa; coloured guinea (*Panicum coloratum*), star grass (*Cynodon plectostachyus*), molasses grass (*Melinis minutiflora*), kikuyu grass, and congo signal (*Brachiaria brizantha*). Louisiana white clover has also been shown to grow well throughout this region. Useful fodder species include napier grass (*Pennisetum purpureum*) giant setaria (*Setaria splendida*), giant panicum (*Panicum maximum*), guatemala grass (*Tripsacum laxum*), sudan grass (*Sorghum sudanense*), columbus grass (*Sorghum almum*), maize (*Zea mays*), oats (*Avena sativa*), sweet potato (*Ipomea batatas*), and edible cana (*Cana edulis*). Useful legumes include lucerne (*Medicago sativa*), stylo (*Stylosanthes guianensis*), dolichos lab-lab (*Lablab purpureus*), lupins (*Lupinus albus*), velvet or mucuna beans (*Stizolobium* spp.) and vetch (*Vicia* spp.).

#### 5.4 The warm and wet medium altitude region

This region has the greatest potential for dairy development. It is characterized by annual rainfall of over 1,000 mm in 4 out of every 5 years, and can be as high as 2500 mm. The rainfall comes in 2 seasons in western, eastern and central Kenya, while in areas west of the Rift valley, only one long rainy season is experienced per year. The region includes the most densely populated Taita Hills, Meru, Embu, Kirinyaga, Muranga, Kiambu and Nyeri districts in eastern and central Kenya. In western Kenya, the region covers Bungoma, Kakamega, Busia, Siaya, Kisumu, Kisii and South Nyanza districts.

Despite high and reliable rains, good soils and high population density, crop and animal productivity in some areas in this zone is below its potential. Crops like maize, sorghum, millet, cassava, beans etc. give low yields while dairy production is predominantly from zebu cattle whose production potential is very much less than that of exotic high grade cattle. The challenge, therefore, is the simultaneous introduction of high quality and productive pasture species, as well as a dairy breed with high milk yield potential, in order to make full use of improved leys provided. Stringent measures against bovine diseases must be enforced.

Of the indigenous flora, useful genera of pasture grasses and legumes include *Setaria*, *Chloris*, *Cynodon*, *Paspalum*, *Brachiaria*, *Hyparrhenia*, *Themeda*, *Echinochloa*, *Entolasia*, *Glycine*, *Lotononis* and *Alysicarpus*. For planted leys, Rhodes grass varieties (Pokot, Masaba, Mbarara, Boma Elmba); and setaria varieties (Nasiwa and Nandi) in mixtures with green leaf desmodium (*Desmodium intortum*), silverleaf desmodium (*Desmodium uncinatum*), *Glycine javanica*, *Neonotonia wightii*, *Stylosanthes guianensis*, and *Lablab purpureus*, have been observed to form excellent mixtures under grazing. Other species such as molasses grass, coloured guinea, guinea grass, and star grass have also been recommended for this zone. Recommended fodder crops include napier grass, giant setaria, giant panicum, guatemala grass, sudan grass, columbus grass, sweet potato, and the tree legumes *Leucaena* spp., *Calliandra calothyrsus*, *Sesbania sesban*, and are used as cut-and-carry for zero or semi-zero grazing.

#### 5.5 Warm and dry medium altitude region

This zone has the same rainfall probability (500 - 760 mm) as the hot and dry coastal hinterland, but the climate is modified by distance from the sea and altitude which ranges from 1000 to 1800 m. The region includes the arable parts of Kitui and Machakos districts, the dry lower parts of Meru, Embu, Kirinyaga and Isiolo in central Kenya and two small dry pockets of arable land in western Kenya (Homabay areas in South Nyanza and Uyoma in Siaya District). Central Kenya areas experience two effective rainfall seasons per year while the Western Kenya areas have only one effective

rainy season each year. Among the useful legumes of the region are *Glycine javanica*, *Stylosanthes* spp. and *Lotononis* spp. Useful grasses are *Panicum maximum*, Rhodes grass, and *Cenchrus ciliaris*. Suitable commercial varieties are the Makueni guinea grass introduced from Makueni into Machakos district on the basis of drought tolerance and good seed yield, and *Glycine javanica*.

### **5.6 The hot dry coastal hinterland**

This region extends inland from the hot humid coastal strip on the southern half, while in the northern section of the region, it includes the coastline. In the south-west, the region extends further inland in a belt around Taita Taveta. This portion is slightly modified due to distance from the sea. The region's mean annual rainfall is between 500 - 750 mm. The altitude ranges from sea level to 1000 m. Though some crop cultivation occurs, the area is too dry for high yields to be obtained and the low quality grasses cannot sustain high yielding grade cows. The region is suitable for beef rather than dairy production. Likoni and Makueni guinea grasses, in combination with siratro on coastal land and *Stylosanthes guianensis* for inland areas, are the best choices of forage. Rhodes grass ex-Tosi has been introduced and is showing promise. *Glycine javanica*, *Stylosanthes mucronata*, *Panicum* spp. and *Eragrostis* spp. are naturalized in the area.

### **5.7 The hot and humid coastal strip**

The coastal strip is approximately ten miles (16 km) wide and runs parallel to the coast from Vanga to Malindi. The region includes parts of Kilifi and Kwale districts of Coast Province. Annual rainfall is between 760-1270 mm falling in two seasons a year. Further to the north-east, the strip is slightly drier. The Shimba Hills in Kwale district is the only high elevation land rising to 150 m. The main agricultural enterprises are based on tree crops (coconut, cashewnuts and mango) and pasture development in this region is integrated with tree crops. The dominant coconuts with their open shade is probably the best tree crop under which grass/legume leys can thrive. Though hot and humid throughout the year, productive grade dairy cows can thrive in the region if livestock diseases can be controlled and the level of nutrition kept high. Species of *Stylosanthes*, *Vigna* and *Glycine* occur naturally. One developed variety of Likoni guinea (*Panicum maximum*) originated from the Likoni area in this region. *Macroptilium atropurpureum* (cv. Siratro), originating from Central America and bred in Australia, seems to be promising in this area. High yielding fodders such as napier grass, leucaena and calliandra also grow here and can be used by small-scale livestock farmers.

### **5.8 The semi-arid and arid rangelands**

These areas cover about 80% of the land surface and are occupied by about 20% of Kenya's population. They are in agro-climatic zones IV, V, VI and have an average rainfall ranging from 300-800 mm per year. Rangelands are further characterized by poor vegetation cover, fragile soils, high temperatures and frequent wind storms. Crop production is very limited but the rangeland supports cattle, sheep, goats and camels. It is also estimated that about 50% of wildlife outside the national parks is found in these range areas. Pasture resources can be developed in a number of ways including (a) improving the distribution of water points and reducing overgrazing; (b) increasing primary production by intensifying land use, reseeding denuded rangeland and conserving forage; and (c) by balancing the livestock population and the available feed resources. Some of the naturalised herbage grass species commonly found in the Kenyan rangelands include *Themeda triandra*, *Sporobolus fimbriatus*, *Cenchrus ciliaris*, *Digitaria milaniana*, *Digitaria abyssinica*, *Eragrostis superba*, *Eragrostis cilianensis*, *Eustachyus paspaloides*, *Aristida adscensionis*, *Aristida kenyansis*, *Panicum maximum*, *Cynodon* spp., *Bothriochloa insculpta*, *Heteropogon contortus*, and others. Some of the naturalised legumes include *Stylosanthes scabra*, *Macrotyloma axillare*, *Leucaena leucocephala*, and *Acacia* spp. This area includes the marginal areas of west Pokot, parts of Marakwet, Keiyo, Baringo, and Kajiado.

## 6. PASTURE SEED PRODUCTION

Kenya has a well established seed company, Kenya Seed Company (KSC) which produces seed grown by contracting farmers and also imports legume seeds, mainly from Australia, which are needed by Kenyan farmers. About 47,000 kg of pasture seed was produced in 1997, 75,000 kg in 1996 and 86,000 kg in 1995 (Table 3). The legume seeds imported are mainly lucerne (*Medicago sativa*), stylo (*Sylosanthes guianensis*), desmodium (*Desmodium intortum* and *D. uncinatum*). In 1997 for example, the KSC imported 2400 kg of lucerne and 2000 kg of stylo seed from Australia. Most of the seed produced is used locally to develop pastures in the country. Only a small fraction of it is exported. For example, in 1997, KSC exported 1,000 kg of Rhodes grass to Uganda. Seed has also been exported to United Arab Emirates (Nyanjong`, 1998). The Kenya Government is charged with the responsibility of producing breeders seed through its research centres and supplying it to seed companies, including KSC. A separate body, Kenya Plant Health Inspectorate Services (KEPHIS) is responsible for seed inspection and ensuring that the seed quality is controlled to international standards. KARI's research centres dealing with pasture and forage research, produce both pasture seed and vegetative materials for on-farm research and for distribution to farmers. Range research centres harvest forage seeds for re-seeding denuded rangelands. Other international organizations such as the International Council for Research in Agroforestry (ICRAF) also develop appropriate fodder/legumes and make seed available to farmers. Several factors were responsible for the development of the seed industry in Kenya. These include: (a) establishment of Government research centres responsible for production of basic and breeders seed and maintenance of distinctness, uniformity and stability (DUS) of seed; (b) increased number of varieties available from research centres; (c) development of a seed certification and seed law enforcement programme by National Seed Quality Control Services (NSQCS) - the predecessor of KEPHIS; (d) development of seed cleaning, processing and packaging technology; (e) a better knowledge of seed quality; and (f) the emergence of the seed grower as a specialist.

**Table 3. Seed production (kg) and land area harvested (ha) of grass seed from farmers contracted by the Kenya Seed Company**

YEAR	1997		1996		1995		1994	
GRASS SPECIES	Yield	Area	Yield	Area	Yield	Area	Yield	Area
<b>Rhodes grass (<i>Chloris gayana</i>)</b>	<b>22,773</b>	<b>535</b>	<b>67,178</b>	<b>864</b>	<b>38,314</b>	<b>423</b>	<b>30,913</b>	<b>690</b>
<b>Var. Boma Rhodes</b>								
<b>Var. Elmba rhodes</b>	<b>8,134</b>	<b>80</b>	<b>3,735</b>	<b>38</b>	<b>8,030</b>	<b>179</b>	<b>19,533</b>	<b>530</b>
<b>Var. Mbarara rhodes</b>	-	-	-	-	<b>4,858</b>	<b>70</b>	<b>7,239</b>	<b>159</b>
<b>Var. Pokot rhodes</b>	<b>568</b>	<b>4</b>	<b>1,068</b>	<b>8</b>	-	-	-	-
<b>Setaria grass (<i>Setaria sphacelata</i>)</b>	<b>1,649</b>	<b>20</b>	-	-	<b>3,288</b>	<b>35</b>	<b>1,512</b>	<b>93</b>
<b>Var. Nandi setaria</b>								
<b>Var. Nasiwa setaria</b>	-	-	<b>953</b>	<b>20</b>	-	-	-	-
<b>Congo signal (<i>Brachiaria brizantha</i>)</b>	<b>600</b>	<b>16</b>	<b>620</b>	<b>16</b>	-	-	<b>162</b>	<b>5</b>
<b>Coloured guinea (<i>Panicum coloratum</i>)</b>	<b>1,048</b>	<b>40</b>	<b>1,286</b>	<b>40</b>	<b>228</b>	<b>14</b>	<b>2,540</b>	<b>50</b>
<b>Columbus grass (<i>Sorghum almum</i>)</b>	<b>4,000</b>	<b>10</b>	-	-	<b>8,159</b>	<b>6</b>	-	-

## 7. OPPORTUNITIES FOR IMPROVEMENT OF PASTURE RESOURCES

There are a number of important features of the Kenyan environment which promote programmes to improve pasture resources, namely:-

- **The Government of Kenya and the donor community are willing to fully support agricultural projects** that focus on poverty alleviation and sustainability of agricultural production while protecting the environment and conserving the natural resource base. Pasture resource improvement is significant and many donors are committed to funding it.
  - **There is basic research infrastructure.** The Kenya Agricultural Research Institute (KARI) was established by an Act of Parliament and was charged with the mandate of agricultural research. KARI consists of many research centres throughout Kenya. Most research centres are fully equipped and have personnel and resources to carry out pasture research both on-station and on-farm.
  - **Kenya has a well organized agricultural extension system** that is operational at national, provincial, district, divisional, and farm level. There are many Farmer Training Centres (FTCs) in various parts of Kenya where farmers are trained on various aspects of farming including improvement of the pasture resource. There are also agricultural colleges and universities training cadres of agricultural personnel on various technologies. Many research and extension personnel have been exposed to the Farming Systems Approach to Research, Extension and Training (FSA-RET) which has been adopted by KARI when carrying out adaptive research. All donors supporting agricultural research are in agreement with KARI regarding the need to improve research activities following FSA-RET methodologies.
  - **International networks are also in place in Kenya.** KARI is well connected to the network of international agricultural research organizations as shown by the large number of collaborative research activities (including pasture) that are being conducted. There are also many other potential collaborators interested in pasture improvement and dissemination of pasture technologies at the grass-root farm level. Non-governmental organizations (NGOs), farmers groups, universities, etc., all manifest their interest in collaborating in on-farm research to address priority development issues.
  - **Relevant technologies for the improvement of pasture resources have been developed** and are available for small, medium and large-scale farmers. Promising pasture grasses, legumes and fodder seeds are available for intensive and extensive pasture improvement in various agro-ecological zones. Various management and utilization packages exist (Orodho, 1983). Notable break-throughs have also been made in the fields of animal nutrition, livestock management, disease control, artificial insemination practices, and improved livestock breeding.
  - **There is potential to improve pastures through breeding** by increasing diversity through germplasm introductions and hybridization of the already available varieties and species. A large number of pasture grasses, legumes and fodder species have been collected in Kenya and introduced over a long period of time. Most of this forage germplasm has been stored in the National Gene Bank.
  - **Kenya has eager farmers demanding new ideas and technology.** There is a market for client oriented agricultural innovations. The willingness of farmers to participate in on-farm trials and to learn, demonstrates their interest to contribute to the development and dissemination of new technologies on pasture improvement.
  - **There is opportunity to further improve pasture seed production technologies.** Pasture seed is available for improvement of pastures resources. KSC is importing, producing and distributing grass and legume seeds needed by farmers.
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## 8. RESEARCH AND DEVELOPMENT, ORGANIZATIONS AND PERSONNEL

The Kenyan Government recognizes the importance of agricultural research to meet National Food Policy Objectives which, at a minimum, aim at self-sufficiency in food production. The Kenya Agricultural Research Institute (KARI) was established with a specific mission and objectives. KARI under the Ministry of Research, Technical Training and Technology has its headquarters in Nairobi and several National Agricultural Research Centres (NARCs) and Regional Research Centres (RRCs) are located in various parts of the country. NARCs address research problems of commodities or factors of production, while the RRCs focus on identification and diagnosis of production problems in various agro-ecological zones and adapt technologies for increased production at the farm level.

Pasture and animal production research is carried out at various NARCs and RRCs including those dealing specifically with range research and arid land improvement. While most pasture research is undertaken by KARI, some limited pasture and animal production research work is carried out collaboratively with international organizations such as the International Livestock Research Institute (ILRI), the universities, and NGOs interested in pasture and livestock development. KARI is assisted by various donors who provide funds and technical back-stopping. Donors such as DFID, USAID, SIDA, GTZ, Rockefeller Foundation, the Netherlands, EU, FAO/UNDP, World Bank etc, fund research and development projects that improve Kenya's pasture resources. The Ministry of Agriculture, Livestock Development and Marketing (MALDM) is responsible for extension of developed technologies to the farmers. Through a Memorandum of Understanding, KARI works with MALDM in carrying out on-farm research jointly with farmers.

Below is a list of some of KARI's personnel carrying out pasture/fodder research in various NARCs, RRCs, and at KARI Headquarters:

**RRC, Kakamega:** Dr. A.B. Orodho, Mr. J. Wanambacha - Forage Agronomists; Dr. K. Otieno - Animal Nutritionist; Mr. D.K. Rotich - Animal Physiologist; Dr. A. Linyonyi - Veterinarian.

**NARC, Kitale:** Dr. F.N. Muyekho, Dr. J.L. Wandera, Mr. C.M. Lusweti, and Mr. J. Nandasaba - Forage Agronomists; Mr. E. Nyambati - Animal Nutritionist; Dr. G. Mulira - Veterinarian; Mr. C. Kute - Forage Breeder.

**RRC, Kisii:** Mr. D.M. Mbugua - Animal Nutritionist; Mr. J. Odongo - Forage Breeder; Mr. Ogidi - Veterinarian.

**RRC, Embu:** Mr. E. Kiruiro, Mr. J.N. Kang'ara - Animal Nutritionists; Mr. G. Karanja, Mr. Z. Nyaata - Forage Agronomists.

**NARC, Muguga:** Dr. F.N. Lusweti, Mr. J. Methu, Mr. N. Odongo, Mrs. I.A. Sanda - Animal Nutritionists; Mr. D.M. Mwangi - Forage Agronomist.

**RRC, Mtwapa:** Dr. Muinga - Animal Nutritionist; Mr. M. Njunie, Mr. Ali Ramadhan - Forage Agronomists; Dr. D.M. Mwamachi - Animal Health Scientist.

**NDFRC, Katumani:** Dr. F.P. Wandera, Mr. N. Njarui - Forage Agronomists; Dr. Bauni, Mrs. Wanyama - Animal Nutritionists.

**NAHRC, Naivasha:** Dr. T.A. Onyango, Mrs. J.W. Kiragu, Mr. J.N. Kariuki, Mr. J.M. Muia, Dr. Kaitho - Animal Nutritionists; Dr. I. Lokwaleput - Reproductive Physiologist; Dr. S.N. Sinket, Dr. Muhuyi - Animal Breeders; Dr. D.N. Siamba - Animal Health Scientist.

**NRRC, Kiboko:** Mr. Mnene, Mr. J.K. Mworira, Mr. Mbakaya - Range Ecologists.

**NSARC, Marsabit:** Mr. Ndathi, Dr. B. Woie - Range Ecologists.

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## 10. CONTACTS

The author of this profile was previously the Centre Director of KARI Regional Research Centre, Kakamega, in western Kenya and a part-time Lecturer in the Department of Range Management, Faculty of Agriculture and Animal Production, University of Nairobi, Kenya. He has recently retired but continues research on Napier grass stunting disease.

The author will be responsible for updating this Pasture Profile. He will be assisted by Dr. F.N. Muyekho who is currently the co-ordinator of pasture research previously based at KARI NARC, Kitale. For further information contact:

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