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COTTON PRODUCTION IN THE LAKE  
VICTORIA BASIN OF KENYA

By

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ABSTRACT

There appears to be a scarcity of reliable information readily available to the researchers and planners, in usable form, on the cotton crop, cropping conditions, ecological requirements, agronomic practices and socio-economic factors. In the present paper, the author has attempted to pull together the available data on the crop in the hope of alleviating some of these problems. The paper examines the reasons for lack of smooth progress in cotton production in the Lake Victoria Basin. It deals with origins of cotton and research development; morphology and development of the crop; cultivated commercial varieties of cotton; uses of the crop; environmental requirements; a historical perspective of cotton development; patterns of cotton production, and recent cotton production problems. Some maps and tables are provided wherever they serve to illustrate a problem.

There appears to be some confusion about the exact date of introduction of cotton in Kenya. Hay (1972) says that the introduction of cotton cultivation in Nyanza coincided with the initiation of the "Hut Tax" Regulations in 1900 and the completion of the Uganda Railway between Mombasa and Kisumu in 1901. This information is rather misleading because cotton grown in Kenya originated from Uganda, but cotton was not introduced into Uganda until 1903. Burrow (1975) suggested that cotton cultivation commenced in Kenya in 1904, although Ikitoo (1977) says that cotton has been grown locally in Lake Cotton Area since 1906. In view of these conflicting dates, it is perhaps more accurate to say that cotton cultivation in the area commenced between 1903 and 1907. Despite any discrepancy, the background information on the origin of cotton is likely to improve our knowledge of the primary and secondary environments from where the crop originated. This geographical knowledge is prerequisite for the purposes of hybridization of cotton varieties, although no research station was established in the area until 1951.

Kibos became the centre of research in Kenya with two sub-stations: Homa-Bay and Alupe. However, recently research has been expanded and more stations incorporated for Central and Eastern at Mwea and for the Coastal areas at Msabaha. Kibos Cotton Research Station was ostensibly geared to carry out research on agricultural enterprises including livestock, but now it concentrates on investigations on problems limiting cotton growth. Although most of the cotton growing problems have been identified, they have not been solved. The cotton growing problems studied at the research stations at the moment include insect pests, soil quality, rainfall unreliability, plant diseases and technical services.

Results of agronomic experiments conducted at the station show that optimum cotton yield is attributed to cotton planted at the onset of the long rains (late February to Mid-March). These results show that a crop yield of 1500 kg per hectare under rainfed conditions is possible if all the cultural recommendations are applied. In areas of montmorillonite soils (Black Cotton Soils) it is recommended that ridging, camber beds and broadcasting should be practised. Despite the applications of these recommendations, varied yields are still obtained, thus showing that some problems have not been identified.



In the past cotton breeders carried out experiments with varieties introduced from Uganda, Tanzania and United States, but now the variety collection has been expanded to include those originating from Central and West Africa, India and the USSR. These varieties provide a wide variation in morphological and physiological characteristics as well as crop quality.

In conclusion, it is clear that there was a considerable gap between the introduction time of cotton (1903-1907) and the time of establishment of research (1951) in the area. This delay perhaps retarded improvement of cotton production in the Lake Cotton Area until recently.

#### MORPHOLOGY AND DEVELOPMENT OF THE COTTON PLANT

There are two major components of the cotton plant: the root system and stem. The cotton plant usually develops a comparatively deep root system, although the actual depth of penetration is a function of the age and size of the plant, the level of the water table and the aeration and structure of the soil. On deep alluvial and irrigated soils, the primary root may reach a depth of approximately 3 metres when the plant becomes mature. The location of the greater portion of the root system is mainly determined by the amount of soil moisture. Plants growing in relatively wet soil or soil with a compacted zone near the surface have roots concentrated within the top 15 - 20 cm of soil, while root systems developed in well-structured soils with little <sup>moisture</sup> in the top layer, but having sufficient moisture in the sub-soil extend to a considerable depth. In view of the foregoing discussion, root growth may be limited by high water table, plough sole, dry soil, hardspan, heavy clays, regions of high salt content, gravel and sand strata and nematode in some parts of the Lake Victoria Basin.

Gossypium hirsutum, is a perennial plant that is normally cultivated as an annual crop in the Lake Victoria Basin. The plant consists of a very prominent, erect main stem (monopodial) containing true leaves and branches. Two types of branch are usually produced: monopodial vegetative branch arising from axillary bud and sympodial fruiting branch arising from extra-axillary bud. Vegetative branches are structurally similar to the main stem. However, the number of vegetative branches from none to several, is primarily a function of the environment and partly determined by the varieties. Consequently, the development of several vegetative branches are determined by wide spacing, high nitrogen content in the soil, available soil moisture and topping. At least 3-4 vegetative branches are desirable since they

substantially increase the framework of the plant on which flowers and bolls develop. Flowers are produced at intervals along the branch; the first flowers are formed on the lowest branches; at the positions close to the mainstem. From these flowers bolls develop and because they are produced in sequence, the bottom crop is often the earliest to mature and open becoming progressively later towards the top of the plant.

The germination under normal circumstances occurs after 2-3 days. From germination, the development of the cotton plant follows a time schedule which is determined by both climate and variety used. In environmental conditions such as those experienced in Lake Victoria Basin, the first flower unfolds 60-70 days after germination. The production of flowers continues for about two months, although only few bolls develop from those unfolding in the second month. On the other hand, the prevailing lower night temperatures experienced in Central and Eastern Provinces may delay the initial flowering by two weeks.

In conclusion, the development of cotton crops from seeds depends on environmental and plant physiological factors. Some of these factors have not been thoroughly understood, thus resulting in low cotton yields. Increased cotton production in the Lake Victoria Basin will continue to be gloomy unless farmers understand the exact nature of these factors.

#### CULTIVATED COMMERCIAL VARIETIES OF COTTON

Today most of the cotton-growing countries of the world have their own commercial varieties derived either from ancient or endemic stocks or from exotic stocks imported, particularly from the United States. The commercial cultivated varieties of cotton in Kenya have been selected by testing a wide range of materials introduced from various countries. The experiments carried out earlier in the Lake Cotton Area showed that four varieties thrived best and these were; Egyptian Abassi, Mitafifi, American Upland and Bukedi, named after Bukedi district of Uganda. However, Bukedi proved to be the most suitable variety in the area. In examining cotton materials for breeding, a very significant factor to be considered is the presence or absence of a diversity of hereditary forms. Heterogeneous materials possess the greatest possibilities for successful breeding. However, the introduced varieties require great care in breeding in order to retain all the valuable potential properties they originally possessed.

The early commercial varieties to Kenya have recently changed and UKA 59/240 obtained from research breeding stations in Tanzania and Uganda is cultivated in four Provinces: Nyanza, Coast, Central and Eastern. This variety is high yielding, resistant to bacterial blight and Jassids. Consequently BPA variety has been introduced as a substitute for BP52 from Uganda. It is recommended for its resistance to bacterial blight. Its lint is more superior to that of UKA and is suitable for manufacturing high quality cloth.

Kenya produces medium and short stapled cotton varieties which are greatly needed for the domestic markets. However, the variations in lint quality between varieties is also determined by the environment. Cotton grown at the coast and Hola has longer lint than the same variety grown in Western Kenya. Under irrigation the soil moisture is maintained at a constant level of continuous growth of the cotton plant, thus resulting in longer and finer lint (Brown, et al, 1972). But where soil moisture regime fluctuates as occurs frequently in rainfed cotton areas of the Lake Victoria Basin, differences in lint quality are inevitably expected. This latter case clearly suggests the need for irrigated cotton in the region in order to improve lint quality.

In summary, the necessity of radical change in varieties to correspond with the ecological conditions related to rainfall reliability and new demands of the cotton industry in the Lake Victoria Basin, means that we must make the widest possible choice of new breeding materials. The significance of exotic materials is that they perhaps provide the most desirable plant physiological and morphological characteristics, growth habits and crop quality which interest breeders.



#### USES OF COTTON

Cotton is probably the most important fibre of the world, although its competition with the synthetic products, for example, the manufacture of nylon and its derivatives has drastically reduced its demand in the World Market. The crop is grown chiefly for its fibre, which is used in the manufacture of cloth, blanket, thread and surgical lint. Cotton possesses a unique combination of basic properties which makes it the leading fibre in terms of quantities consumed. Generally speaking, cotton is washable and 25% stronger when wet than dry and no other fibre surpasses it in ability to withstand high heat during laundering and drying (Berger, 1969). Its excellent resistance to rubbing is also a major consideration where serviceability of outer garments is required. Consequently, it is an absorbent fibre, which is highly desirable for apparel as well as for other textile uses. But another aspect of cotton's versatility is its adaptability for use in textiles suitable for warm and cold weather wear. In short clothing uses vary from sheer, soft, crisp material to heavy coarse, strong fabrics. A part from these manifold uses, low-grade fibre, waste products and fuzz are consumed in the production of felts or batting used in mattresses and other bedding products and in upholstery for furniture. Lower quality cotton is used as a raw material in the manufacture of high-grade writing paper and rayon, and in the chemical industry, for making photographic and X-ray films.

Cotton seed is one of the several by-products that represent a large part of the value of the crop. But cotton seed may be conveniently divided into four major products: Cotton seed oil, cake and meal, cotton seed hulls and linters. The cotton seed is cleaned, crushed and subjected to high pressures to extract oil. The oil is the most valuable of the four products, accounting for 50-55% of the value of all of them (Berger, 1969). Cotton seed oil has approximately the same composition as olive oil and is used in making cooking, salads and lubrication. It is also manufactured into soaps, paints, deomargarine and mayonnaise. The second most valuable product is cotton cake or meal. The cotton seed cake is processed into cotton seed meal which is a valuable stock food and fertilizer. The meal makes a highly concentrated feed that contains 36-41% protein and 5-7% fat (Kipps, 1970). It is largely prized as a cattle feed and is used to some extent for horses and sheep. The cotton seed meal is used in the manufacture of feeds for monogastric animals like pigs and poultry (Baustad, 1974). Nevertheless, it is toxic to hogs and will cause death if fed in large quantities. It also causes digestive disorders in poultry and young animals when fed in large quantities. High-grade cotton seed



contains 7% nitrogen, 3% phosphoric acid, and 2% potash and is used in considerable quantities in the fertilizer industries, particularly when cattle feed are cheap. Cotton seed hulls are the least valuable of the four main products from cotton seed. Like meal, they are used almost entirely as a low-grade carbohydrate roughage for cattle and to some extent in the manufacture of paper, fibre-board, synthetic rubber, lubricating oils, fertilizers and certain types of plastics. Linters, on the other hand, have a wider variety of uses than any of the three cotton seed products already discussed. They are used in manufacturing rayon, explosives, film, shatter-proof glass, plastics and scores of other items. The development of cotton in Lake Cotton Area should not be frustrating since it has multiple uses, which is an insurance for its increased consumption.

#### ENVIRONMENTAL REQUIREMENTS:

Geographical differences in cotton production in the Lake Victoria Basin are probably determined by physiography, climate and soil. Physiographically the area is varied (Fig. 3), ranging from piedmont plains to extensive plains, plateaus, escarpments and highlands with undulating topography. However, only climate and soil are discussed below.

#### Climatic Requirements.

The high demands that cotton plant places on climate determine the areas where this crop can be grown commercially. Length of growing season, ranges in temperature, amount of sunlight and other climatic parameters limit the areas where cotton can be grown successfully in the Lake Victoria Basin. As a result of these climatic limitations the cotton cultivation in the area is confined to an elevation of not more than 1400 metres above sea level. At any stage of its development the cotton crop is very sensitive to frost. On the whole, cotton is mainly a crop of the plains (Berger, 1969). Perhaps this explains why it was first planted in the Kano plains from where it diffused to other parts of the Lake Victoria Basin. In other countries cotton is grown commercially at altitudes ranging from sea level to 1200 metres, some perennial varieties being found as high as 1800 metres above sea level. This latter case suggests that the present restriction of cotton to an altitude of 1400 metres in the Lake Victoria Basin is tentative because with further hybridization some strains could easily be grown beyond this limit. But if this does happen, then there will be competition between cotton, sugar, tea, coffee and other cash crops growing in the highlands. This situation can only be arrested by proper agricultural land-use planning.

The cotton plant makes little progress at temperatures below 15°C. The low temperatures, particularly at night, result in slow vegetative growth, an extended period of flowering, and prevent ripening of the boll to full maturity. In the Cotton Belt of the Lake Victoria Basin temperature is not a limiting factor unless cotton expansion goes beyond 1400 metres. Cotton had been tried successfully in the late 1950s and early 1960s in the lower areas of Belgut in Kericho District (Fig. 2) at perhaps a higher elevation than this.

Rainfall during the cotton growing season is of paramount importance. Although cotton can tolerate a wide range in annual precipitation, the distribution of this rainfall is the controlling factor in the production of cotton. Heavy rains are deleterious to young seedlings and mature bolls. During the period of vegetative growth, moderate rainfall is best preferably at night so as to have maximum sunshine during the day. However, this is a minor constraint in the Lake Victoria Basin where rain often comes in the afternoon accompanied with heavy thunderstorms. Thunderstorms are useful in replenishing the soil with atmospheric nitrogen. Experiments carried out in the area show that maximum yields are only obtained if the seed is sown at the time which allows peak rainfall to coincide with the maximum water requirement of the crop. Under normal conditions peak water requirement occurs between 70 and 120 days after germination during the time of Maximum flowering and greatest leaf area, that is when the cotton crop is planted early in the long rains. A drier period is required to allow the bolls to rippen and to be picked. Sharp changes from drought to moisture are undesirable in cotton production. Severe drought and excessive rain after cause shedding and rotting of bolls. These are natural phenomena which are extremely difficult to control, especially in the Lake Victoria Basin where the rainfall is relatively unreliable. In order to afford adequate soil moisture for cotton crop, a minimum of 500 mm of rainfall is required annually, with 175-200 mm being well-distributed over the growing season. Cotton does not fully develop in areas receiving less than this minimum, unless supplemented by irrigation. Rainfall in the various cotton growing areas of the Lake Victoria Basin differs perceptibly (Fig. 4). In the Lake Shore Savanna (1100-1200 m or 3700'-4000') the average annual precipitation varies from about 750-1000 mm, while the High Rainfall Savanna at 1200 - 1400 m (4000' - 4600') it ranges from 1000 - 1300 mm per annum. Nevertheless, these mean figures are not very meaningful for agricultural purposes. In agriculture what is more important is the time when the rain commences and its effectiveness for growing cotton. Ecological stress (drought) during the cotton growing cycle



could be alleviated by irrigation. But irrigation carries in its train a host of problems, especially increased salinity in areas where this has been unknown as is the case in irrigated cotton in Egypt. In addition, new breeding habitats for mosquitoes and snails may result in less salubrious ecological conditions due to increased malaria and bilharzia respectively. These environmental consequences of irrigation should be investigated during the initial stages of the Lake Victoria Basin Development Authority.

Soil Requirements:

Cotton grows on a wide range of soils, but it does best on a deep, friable soil with a good supply of organic matter and favourable moisture holding capacity. Sandy loams, loams and well-granulated clays loams are considered best for cotton cultivation. These soils occur in the Lake Cotton Area (Fig. 5). Free - draining alluvial soils are also suitable, but very sandy soils evident in some parts of the area make poor cotton land. Cotton grows over a wide range of pH, but the optimum lies between pH 5.2 and 7. Strongly acid and excessively alkaline soils render the soils unsuitable. These latter limiting chemical properties of the soil are uncommon in the Lake Victoria Basin. However, cotton is an exhausting crop, thus the extension of cotton planting to new areas of poorer soils and lower rainfall in the Lake Victoria Basin may be expected to result in the destruction of soil structure and low potential yields unless proper agricultural practices are carried out. Nevertheless, there is no low potential land and there is very limited medium potential land in the area (Table 1).

TABLE 1: LAND POTENTIALITY IN NYANZA AND WESTERN PROVINCES ('000s HECTARES).

<u>DISTRICTS</u>	<u>HIGH POTENTIAL</u>	<u>MEDIUM POTENTIAL</u>	<u>LOW POTENTIAL</u>
Kisumu			
Siaya	432	29	
South Nyanza	566	5	
Bungoma	253	-	
Busia	163	-	
Kakamega	325	-	



Two soil types, especially vertisol and nitosol, dominate most of the cotton growing areas in the Lake Victoria Basin. In South Nyanza and Kisumu-Siaya Cotton Belts, the heavy black cotton soil, which is in fact a vertisol predominates with its characteristic swelling and self churning properties due to the presence of 2:1 clay mineral montmorillonite. According to Prentice (1972) the heavy soils are often the more naturally productive for cotton, although the small-scale farmer tends to avoid them because of the physical difficulties in working them. By far the greatest problem on these heavy clays is that of water logging, thus improving their structure and internal drainage through application of Gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ), fertilizers, manures, deep ploughing, and other agronomic practices is prerequisite before realizing economic yields.

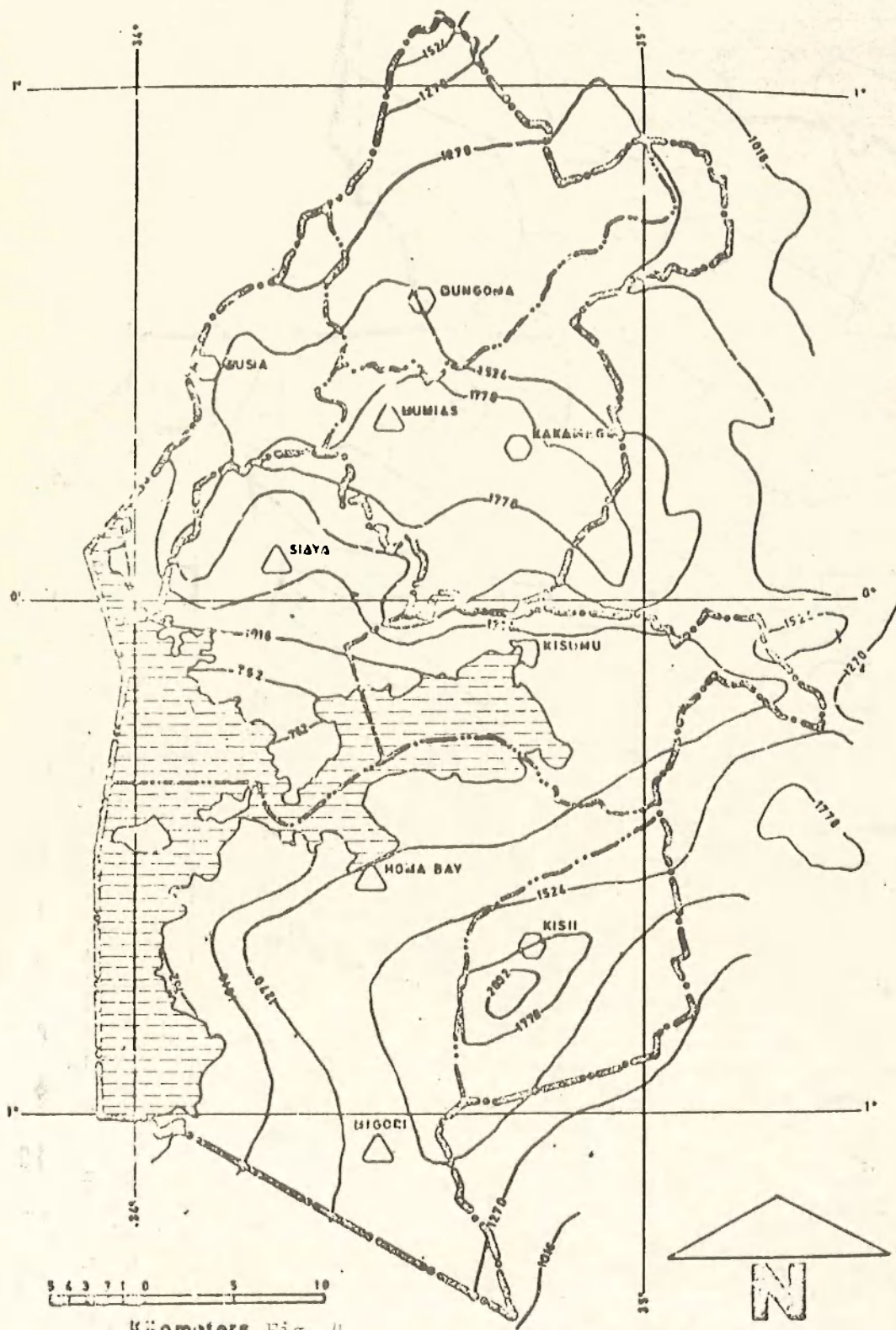
In Bungoma-Busia-Kakamega Cotton Belt the nitosol, which is a different soil type, prevails. The nitosol, though clay in texture behaves as a loam, a property which is imparted by cations of sesquioxides:  $\text{Al}_2\text{O}_3$  and  $\text{Fe}_2\text{O}_3$  aggregating the clay particles. These soils are better drained, thus higher yield is expected from them provided other conditions are favourable. Around mount Elgon the soils are volcanic in origin with varying proportions of halloysites and allophanes as the dominant minerals. On the basis of the foregoing discussion, it is clear that the Lake Cotton Area has three contrasting soil types which could be examined under the "concept of soil productivity". Cotton certainly grows differently in different soils, but as site is part of the concept "soil", comparisons of cotton yield have to be drawn with caution (Prentice, 1972). In summary, the discussion on the environmental requirements for cotton production highlights the need for re-examining the natural resources (climate, water and soil) for the purposes of increasing cotton productivity.





Fig. 3

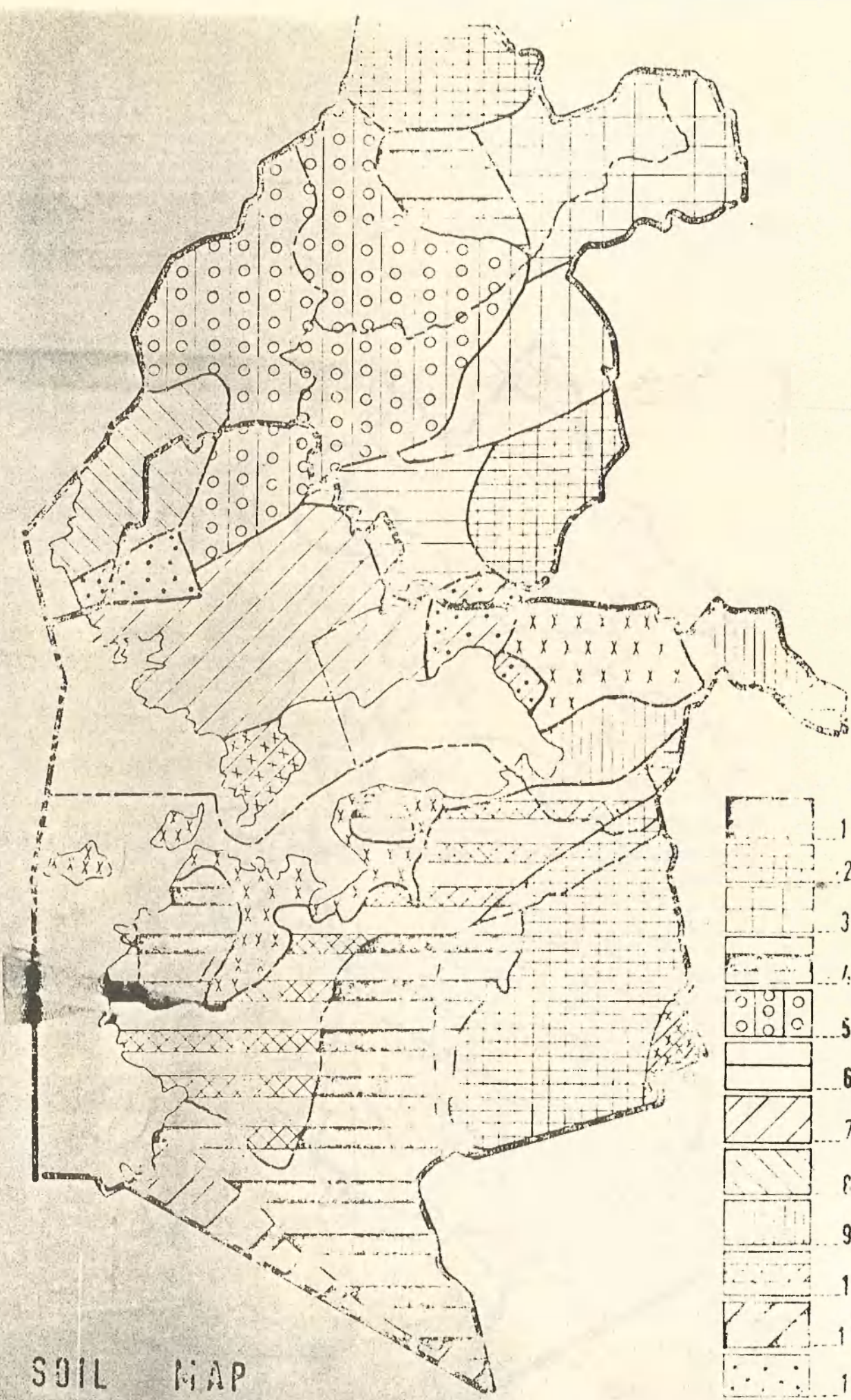




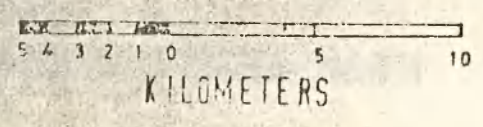
Kilometers Fig. 4

MEAN ANNUAL RAINFALL





SOIL MAP



- 1 [Blank box]
- 2 [Grid pattern]
- 3 [Blank box]
- 4 [Blank box]
- 5 [Circles in a grid]
- 6 [Blank box]
- 7 [Diagonal lines (top-left to bottom-right)]
- 8 [Diagonal lines (top-right to bottom-left)]
- 9 [Blank box]
- 10 [Blank box]
- 11 [Diagonal lines (top-left to bottom-right)]
- 12 [Circles in a grid]
- 13 [X marks in a grid]
- 14 [Blank box]



Key to Soil Map

1. Dark Peaty loams.
2. Dark Red Friable clays.
3. Dark Brown Sandy Loams with Red Friable Clays.
4. Stony Soils and Rock Outcrops with other Soils
5. Dark Brown Sandy Loams with Yellow - brown Sandy Loams.
6. Medium Humic Red Friable Clays.
7. Red to strong Brown Friable Clays.
8. Red Friable Clays with Strong Brown Friable Clays.
9. Grey Clays, Grey Compacted Loamy Sands, Peaty Swamps and Black Clays.
10. Red-brown clays and Grey clay with Yellow-grey Loamy Sands.
11. Dark Red Friable clays and Yellow-red Loamy Grits.
12. Peaty swamps, Alluvium and Lacustrine Deposits.
13. Black clays (in plains)
14. Dark Brown Sandy Loams.

A HISTORICAL PERSPECTIVE OF COTTON DEVELOPMENT

The historical background to cotton production in Kenya is well-documented (Fearn, 1956, 1961, De Wilde, 1967, Hay, 1972 and Brett, 1973) Between 1907 and 1978 there were ups and downs in the cotton production in the country. In 1908, there was less production because the advances that were given to growers earlier were stopped. In addition, the slaves who worked in most of the European cotton farms at the coast were liberated and there was a general lack of systematic help and encouragement by the government. On the other hand, the indigenous people at the coast were interested in growing food crops first. Less attention was given to cotton in the traditional agricultural system, thus resulting in low production. The Taita people, particularly felt prosperous to bother about cotton. Similarly the people of the Lake Cotton Area gave less prominence to cotton production, concentrating mainly on growing food crops. The high priority given to subsistence crops and the low prices, contributed to low cotton output despite attempts to promote its production by rigorous plans to exercise constant supervision of planting and weeding, and by heavy expenditure. In view of these problems, it should not be regrettable if the small-scale farmer is less industrious and progressive in cotton production.

Attempts to introduce cotton cultivation in Kano, Seme, Samia and Nyakach locations of the Lake Victoria Cotton Area between 1910 and 1913 failed except in Samia and Kano (Hay, 1972). Fearn, (1961) gave the following six reasons for this failure:

1. Where cotton was first cultivated.

The experimentation of cotton took place in the immediate Lake Shore locations where the ecological stress (drought) was relatively severe.

2. Method of introduction.

There was lack of traditional leaders, particularly chiefs in which smallholders had confidence. The colonial administration only found traditional hierarchy of chiefs in Samia location where cotton cultivation was declared most successful.



3. The Manner of introduction

Cotton was initially planted in communal plots along the roadside to facilitate supervision. But communal arable agriculture was contrary to the indigenous people's practices and this is likely to have contributed to their negative attitude to the crop.

4. Fitting cotton into the traditional agriculture

The degree of ease with which cotton cultivation could be best fitted into the existing pattern of subsistence agriculture and the additional work involved in doing so. Sorghum, elusine and Maize which are grown by the indigenous people involve too much work. Thus, it was perhaps not easy to incorporate cotton into the traditional farming system. Moreover, the traditional pastoralists only undertook crop cultivation for minimum subsistence needs. Consequently, in the variable conditions of rainfall in the Lake Cotton Area, it frequently happened that farmers had to plant foodcrop in the short rains (the time when cotton was sown) to supplement shortages due to inadequate long rains.

5. Government Policy

Perhaps the most important was lack of any real formulation of cotton policy in Kenya until 1923. The downward movement of prices certainly added to the difficulties of administrators in getting cotton planted.

6. Low response of the small-scale farmers to Monetary economy

The last factor accounting for the failure of Cotton can be traced from the slow response of the small-scale farmers to the opportunities afforded by the possession of money.

The reasons enumerated above indicate that cotton production is determined by environmental and socio-economic factors. But cotton growing has had a varied history owing mainly to price fluctuations and the preference of the smallholders for the production of food crops

(Gibb and Partners, 1956). However, the 1914-1918 war augmented the problems of the cotton industry, resulting in the Kisumu ginnery operating under capacity during the first two years of the war and eventually stopped functioning in the next three years. This cessation of activity is mainly attributed to the prohibition of seed cotton imported from Uganda.

During the 1920s great efforts were made to introduce cotton in South Nyanza, Bungoma and Kakamega, but they were unsuccessful chiefly because of the poor prices offered to the growers. Lower prices no doubt destroyed the incentives of European and African cotton growers, although available data clearly show that it is the latter growers who were seriously criticized for declining cotton production. The African farmers were logical to abandon cotton cultivation if they were actually depressed by low prices, a situation which continued to the present day. To make it worse in the 1920s the British East African Cooperation tried to visit and inspect every "Shamba" for the purposes of giving advice only at the coast where European farmers were found. This point strongly suggests that the government was less interested in the African cotton cultivation.

Cotton production was not only stagnant because of declining prices (van Zwanenberg and King, 1975) since the disappointingly low export, averaging only £3000 p.a. between 1923 and 1924 was attributed to the lack of cotton ginneries, particularly in the Lake Cotton Area where most of the crop was produced (Cone and Lipscomb, 1972). All the gins had been transferred from Kisumu to Uganda since movement of seed cotton from Uganda to Kisumu was prohibited in 1920, although half of the ginned cotton in Uganda continued to be exported to Kisumu until 1923. This marked the end of the first phase of cotton industry in the Lake Cotton Area, which had been largely confined to the ginning of cotton from Uganda.

Before introducing the next phase of cotton industry, it should be pointed out that sometimes if the cotton crop was seriously affected by diseases then total destruction of the crop was implemented. For instance a fungus attacked cotton along the Lake Shore Cotton Area because of heavy rain, the officials who made the investigation recommended the destruction of cotton in the whole area. In view of this, about 36 ha. of small-scale farms were destroyed and compensation of five rupees per 0.4 ha (1 acre) given to farmers. In such a situation



one wonders whether the farmers were satisfied with the compensation and whether they were interested in further cotton cultivation. During the 1920s the Egyptian Abassi was discarded and replaced by American Upland which gave a more satisfactory yields.

A more serious change in the government's policy for cotton production was established between 1923 and 1926 when the first agricultural extension officers were involved in cotton development in Lake Cotton Area. The real progress of cotton production in the area commenced in 1923 when enactment of the Kenya Cotton Ordinance was formulated. Under the Ordinance the Governor was authorized to formulate the rules controlling cotton industry. These rules controlled growing, marketing, ginning and maintaining quality of cotton. The control was further exercised through the Cotton Tax Ordinance of 1923, which made it compulsory for a licence to be obtained first for movement of ginned cotton by rail or sea and that the tax must be paid prior to the export of the ginned cotton. Subsequently, the 1923 regulations empowered the Agricultural Department to control the destruction of unsuitable seed and powers to enforce the destruction of the cotton plants after each season's harvest. According to these regulations cotton was given three grades: first, second and third qualities. But all cotton buyers had to be licensed by the District Commissioner, and licenses to gin and bale cotton were issued by the Director of Agriculture. The 1923 rules further provided for the maintenance of fibre quality during ginning processes and storing of unmixed seed for planting in the next season. During the cotton season detailed monthly returns were expected for all seed cotton purchases and for all cotton ginned and baled, according to the cotton quality. Moreover, the time for the sale of cotton was provided each year by the Government and the first month of the buying period was restricted to the sale of first quality cotton. Such rigid rules and the piecemeal responsibilities carried out by government administrators and agricultural officers may perhaps hinder the progress of producers and manufacturers. The new emphasis to promote cotton production failed to materialize because of price fluctuations from 30 cents per 0.45 kg. (1 lb) in 1923 to 12 cents per 0.45 kg. in 1927. However, the subsequent failure of American cotton crop caused a temporary rise in prices, which led to more confidence by the farmer to increase cotton production in 1928 and 1929. Furthermore, the farmers were



encouraged in the latter year by the government sending administrators to discuss agricultural matters at "Barazas". This helped in the dispersal of agricultural information and hence the smallholders improved cotton planting and weeding considerably. The best example of improvement in cotton husbandry was evident in Samia Location which was one of the most backward areas until 1926. Apart from damage caused by hail at Lukolis and heavy rain in Malakisi and North East Wamia which caused flowers and boll damage in Mid-December, the weather during 1929 was favourable. Nevertheless world prices dropped in 1930, thus farmers in the Lake Cotton Area received 12 cents per 0.45 kg. of cotton. However, cotton production received a tremendous emphasis due to locust invasion and famines of the early 1930s despite the low prices in order to enable smallholders to obtain cash to buy food.

There was further assistance between 1931-32 season when officers devoted their time in locust destruction and intensive campaign for cotton expansion. These campaigns made the farmers to increase their hectarages and the cotton planted in June gave excellent results. But excessive rains in November and December retarded picking and hail caused slight damage in the Lake Cotton Area. Apart from these problems the weather was quite favourable for cotton growing. At the coast during the same year the crop failed due to drought. In addition, low prices of about shs. 7.00-8.00 per 45 kg. (100 lb) for first grade cotton made farmers dissatisfied with growing the crop. However, in 1934 cotton production increased steadily in the area although the quality was impaired through careless handling.

In 1934, suitable cotton areas were found in Kitui, Lower Embu and Fort Hall and cotton was cultivated for the first time in Kitui, although the crop failed mainly because of drought. Two years later cotton was planted for the first time in Machakos, while there was increased cotton planting in Kitui, Embu, Meru and Fort Hall. During 1936-37 season, much production occurred in southern Lake Shore Zone and the prices received were extremely encouraging. But other parts of the Lake Cotton Area were affected by cold weather which lowered yields. At the coast the crop was a partial failure owing to drought in the early growing season. During 1937-38 crop failure was recorded in all cotton growing areas because of unfavourable weather. Drought caused premature flowering and boll shedding, particularly at the coast.



It was also found that red soils in dry areas did not suit cotton growth, hence from 1938 cotton was limited to the darker soils. All these problems including low prices resulted in low cotton yields in 1938-39 season.

Between 1939 and 1945 cotton production declined in all the provinces due to the Second World War and greater emphasis on food production. Many farmers concentrated on growing food crops such as cereals and oilseeds which were demanded greatly. But cotton production continued to decline after the war because the crops planted were affected by severe boll shedding despite the increased hectarages in the Lake Cotton Area. In 1949 the government announced higher prices before sowing time to make the growers increase their hectarages, thus production was double that of 1948. In addition to the higher prices the weather was also favourable to cotton. At the coast, however, increased hectarage resulted into low production due to low germination which was caused by moisture stress. However, the government tried to encourage the growers further by providing better storage and marketing facilities. During 1950-51, a further encouragement was seen in the work began by research officers on the improvement of cotton strains and cotton farming methods. The BP52 strain planted over a large area, successfully replaced S47 from Uganda, so in 1951 there was an increase in cotton hectarage at the coast, although in the Lake Cotton Area excessive rain made most cotton lands sodden with water which retarded the growth of cotton. In 1952, hectarage planted and production increased in the area, but the yield decreased due to late planting after drought in June and July and partly due to a high incidence of American bollworm, Lygus and blackworm. The Coastal cotton gave less production in 1952 because the seeds planted were of inferior quality due to the previous wet year, thus virtually all areas had to be replaced with cotton seed imported from the Lake Cotton Area. Cotton growing conditions remained the same in 1953-54 season in the area as 1952, but drought and attacks of American bollworm and Lygus seriously reduced production. At the coast, however, the crop was one of the best on record. Weather conditions improved and the quality also improved due to strict inspection at the buying posts. In 1954-55 season, in the Lake Cotton Area the cotton yield was affected by severe drought in July and August and by stainers and Lygus. At the coast also there was less yields and production due to drought and less hectarage planted in Malindi. Despite these environmental problems, Lake Cotton Area and Coast Province proved to be the best



suited cotton growing areas until 1954 when Swynnerton (1955) notes that:

"There is little likelihood of being able to extend cotton growing to other areas. Intensive experimentation is in train on improved strains, cultural methods and pest and disease control, an officer being posted from the Empire Cotton Growing Corporation to help with this work. Production will mainly be stepped up through the efforts of increased staff proposed in this plan who will aim, by applying the results of experimentation and by securing better cultivation and increased averages by African cotton growers, at doubling production".

The quotation is partly correct because until 1961 cotton production was limited to the Lake Cotton Area and the higher rainfall areas of the coastal strip. In the 1930s cotton growing was attempted in the Eastern and Central provinces but failed owing to unsurmountable insect pest problems. The crop was re-introduced in these provinces in 1961 and although the insect pest problems are as in the 1930s, control is now feasible through the use of insecticides (Muturi, 1976).

During 1956-57 hectarage increased in the Lake Cotton Area and decreased at the Coast, but the cotton crop was better than 1955-56 season because of early planting in Kano plains and the Lake Cotton Area as a whole. In 1957 the standard of cultivation deteriorated in the area because many farmers were said to be too lazy to pick the ripe cotton and so they left them to fall and rot on the ground. I strongly disagree with this view because it has already been observed that the farmers were depressed by low cotton prices, dissatisfied with the organization of the marketing system and were not provided with insecticides, thus there was no way of expressing their disappointment with the forced cultivation of the crop, but to let the crops decay in the fields. In fact good results were obtained in the same year by dusting with BHC and DDT on selected smallholdings in the Lake Cotton Area. During this time, the old variety N17 was replaced by the jassid resistant variety UK51 at the coast.

In 1958 the Nyanza people who rejected the idea of early cotton planting were affected by drought while at the coast good production was recorded, especially at Malindi. The 1959-60 season was very successful at the coast but the Nyanza crop was affected by drought. In spite of the drought in Nyanza an increased production was



realized because the early planted cotton crops were sprayed. Consequently, additional field staff employed by the Cotton Board to boost the extension work on cotton supplemented the promising results of 1959-60 season. Between 1961-65 cotton became the most important crop in Nyanza. However, in 1967 adverse drought and serious outbreak of spiny bollworm and stainers affected late crop in Eastern and central provinces and production declined. At the coast the farmers were dissatisfied with low prices and Malindi growers refused to harvest and in view of this 185,000 kg. were lost. Still in 1968, the farmers preferred to plant in late May and August regardless of efforts of agricultural field staff to encourage early planting. Only a handful of growers followed recommendations by planting in March and April. At the coast, cotton production declined in all areas except in Taveta and Lamu because loans for land preparation were not available. During 1969 at Kibos strong winds and heavy rainstorms caused serious reductions in cotton yields. At Busia there was increased yields due to the use of extensive lime and fertilizer application, which improved soil productivity.

In 1970, problems of seed distribution was great in Nyanza. Areas growing BP52 switched over to UKA59/240 and other areas such as Kendu-Bay, Homa-Bay and kibos Zones had to grow both varieties. For the first time in Nyanza, there was no free issue of seeds in 1971, instead shs. 5.00 per packet was charged and this was only enough to plant 0.4 ha. Most farmers had no money and so they were loaned by their Cooperative Unions. Upto 1972 the crop had been decreasing for the past three years (table 3) due to socio-economic factors: there was little change in cultural practices, farmers preferred late plantings and concentrated on subsistence crops, lack of capital resources, poor organization in the marketing arrangements, sheer knowledge on the economics of farming and competition for labour among several farm enterprises. The situation of labour problem facing small-scale farmer is well-illustrated by Kennedy (1964) who notes that:

"Since labour is the limiting factor, he concentrates on the relatively high returns to be derived from small inputs of labour on a large area, rather than the diminishing returns of high inputs on small acreage, this would seem to have an important bearing on the general level of husbandry that can be expected from the less affluent members of peasant farming community."



Similarly, Aldington (1971) attributed the poor performance of Kenya's cotton industry to current standards of husbandry and prices offered to farmers so that the farmers do not consider the cotton as a rewarding crop to grow. He further calculated the gross return per 0.4 ha. of cotton to be shs. 63.00 in 1968 and shs. 81.00 in 1969, but after deducting the cost of purchased inputs used which were probably low, he concluded that the average return to labour on this crop which was relatively labour-intensive must be very discouraging. Consequently, Alibaruho (1974) described declining cotton production in Uganda as a:

"phenomenon which reflects changing economic interrelationship between various outputs on the multiproduct peasant farms and these interrelationships show responses by cotton farmers to the relative price they have faced ... in the light of the different production and marketing opportunities available."

Alibaruho (1976) in his econometric approach explained that the pattern of cotton distribution is changing according to the ecological feasibility of growing alternative food crops and according to the accessibility of the main urban markets for these crops. From the foregoing discussion it is crystal clear that we are dealing with human materials and in selecting a crop the farmer is faced with a wide array of variables some of which are not easy to express quantitatively. But human preferences, ecological factors, economic factors, social considerations and human abilities cannot be ignored in cotton production in the Lake Cotton Area.

The downward trend in cotton production continued into 1973 and 1974 (table 3), although in South Nyanza there was a dramatic increase in hectareage from 5,653 ha. in 1973 to 12,456 ha. in 1974. In 1975, crops were again faced with the same socio-economic problems already mentioned. In addition, land preparation, thinning and planting were done late, spraying was hardly done hence the crops were seriously infested by aphids, stainers and American bollworm, particularly in Kakamega District. It is claimed that Cooperative Unions never provided insecticides in this district. Furthermore, farmers were unwilling to sell their late harvests because they had never been paid for their early harvested cotton sold to the Cooperative Unions. This is a common phenomenon in the entire Cotton Belt of the Lake Victoria Basin and unless the problem is rectified future cotton production in the area is likely to decline because some

farmers have definitely told agricultural extension officers that there is little to be gained in cotton production in the area, particularly when it takes a long time before the farmers get paid for their delivered Cotton (Republic of Kenya, 1975). In view of these problems most farmers are turning to growing Sugarcane (saccharum officinarum) which has a more lucrative market. With the invasion of the Cotton Belt by Sugarcane (Fig. 2), the downward trend in production of cotton is likely to increase in the future unless proper plans are devised by the government to arrest the situation.



COTTON PRODUCTION PATTERNS.

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The following three principal production patterns have been attempted in Kenya.

(a) Individual smallholder rain-fed agriculture.

The individual small-scale farmers have been and continue to be the most important producers of the bulk of cotton in Western Kenya and elsewhere in Kenya. However, cotton productivity from this sector is relatively low due to lack of full adoption of modern technology and agronomic recommendations.

(b) Cotton block farming system.

Cotton Block Project has been experimented in the Lake Cotton Area and in some other areas in Kenya unsuccessfully. Recently, the aims of the project have been to demonstrate the effect of early planting on cotton yields and to show how agronomic practices related to land preparation and pest control can be easily and more economically done in a block farming approach. But it has been impossible for these aims to be achieved because of the following reasons:

- (i) Some farmers decided to plant the project land to their own preferred crops,
- (ii) Land preparation is sometimes delayed due to heavy rains;
- (iii) Late release of seeds made farmers to plant other crops;
- (iv) Weeding is often not properly done in some plots;
- (v) Insecticides are available but they are not regularly applied.
- (vi) Hailstorm affect cotton in certain years. In view of these problems encountered in Cotton Block Projects, there has previously been a major change in Kenya to shift the emphasis away from large-scale cotton schemes to small-scale cotton farms (Republic of Kenya, 1974).

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(c) Irrigated Cotton.

Irrigated Cotton has been tried at Ahero Pilot Irrigation Scheme only, and this has not been extended to the farmers in the area. Initial yields at the Hola Pilot Irrigation Scheme averaged 1000Kg/ha seed cotton. But the 1974 productivity more than doubled, 2685 Kg/ha of seed due to better management practices. Data available reveal that individual yields range from 1500-4300Kg/ha with 85% of the farmers attaining yields between 2000 and 3,500Kg/ha. No doubt introduction of irrigation in the Lake Victoria Basin will boost cotton yields and production provided other factors affecting the production of this crop are maintained.

RECENT COTTON PRODUCTION PROBLEMS:

Cotton has been one of the major cash crops in the Lake Victoria Basin for a long time, however, there has been shortfalls in cotton production until recently for a number of reasons.

1. Competition in agricultural Land Use.

The existence of subsistence and cash crop dichotomy in the area influence cotton production. Firstly, there is the subsistence economy with first priority and superimposed on this, is cotton crop which is often considered secondary in small-scale farming. Table 2 confirms the significance of subsistence crops in the agricultural Land use in the area. There is greater emphasis on maize, sorghum, beans and Cassava in all districts. The hectarages under each crop portray that cotton ranks second to these subsistence crops. However, it is now about 10 years since these estimates were made, thus it is likely that there have been many changes since then, particularly as may be seen from the production figures (Table 3). Data available show that the extension of cotton has been stepped up while sugarcane has penetrated deeply into the Cotton Belt (Fig.2).

2. Ecological Stress.

Tables 3 and 4 show cotton production under rainfed agriculture and irrigation system respectively. Cotton production fluctuation under rainfed conditions is quite tangible. In 1971, Siaya, South Nyanza, Busia and Bungoma experienced drought which lowered cotton production. Similarly, cotton output fluctuated in the subsequent



TABLE:2 AGRICULTURAL PRODUCTION IN NYANZA AND WESTERN PROVINCES OF THE  
LAKE VICTORIA BASIN: 1969/70. (AREA PLANTED IN '000 HA.)

CROP ENTERPRISE:	SOUTH - NYANZA.	KISUMU	SIAYA	KAKAMEGA	BUNGOMA	BUSIA
Improved Maize	1.2	0.8	4.3	41.3	21.7	2.1
Unimproved Maize	62.5	32.9	40.0	34.9	17.1	17.4
Finger Millet	2.7	0.2	0.3	2.7	5.6	6.4
Sorghum	28.4	23.6	23.6	9.5	4.5	7.8
Beans	14.3	9.1	12.4	10.8	4.6	5.0
Cow Peas	2.2	0.8	1.4	0.8	-	0.1
Yellow, Green & black Grams	-	0.8	-	0.1	-	0.1
Cotton	12.3	0.8	3.9	0.4	3.3	10.
Sugar Cane	2.2	1.2	0.5	2.1	0.1	0.1
Groundnuts	4.0	1.2	1.1	0.9	0.5	0.3
Oil seeds	0.1	0.3	0.9	0.2	0.7	0.3
Cassava	8.3	3.2	5.5	6.3	3.3	3.3
English Potatoes	0.2	0.2	-	-	-	-
Sweet Potatoes	1.2	1.2	0.2	0.9	1.3	1.3
Cabbages	0.1	0.1	-	2.2	-	-
Bananas	0.6	0.8	0.1	7.2	2.1	2.1
Field Peas	0.4	2.3	0.8	-	-	-
Coffee	1.0	-	-	3.3	0.9	0.9
Bulrush Millet	-	-	-	0.9	-	-
Tea	-	-	-	4.2	-	-
Other Temporary Crops	-	0.1	3.4	0.3	0.2	0.2
Other Permanent Crops	0.2	0.2	0.1	-	-	-
Other fruits	0.1	-	-	0.1	0.1	0.1
Other Millet	2.8	-	-	1.8	-	0.8
Other Cereals	0.1	-	-	0.2	0.3	-
Other Vegetables	0.1	-	-	-	-	-

SOURCE STATISTICAL ABSTRACT, 1977

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years in several districts. Nevertheless, the fluctuations in cotton production cannot be explained by drought alone since it is clear that some districts had increased production despite this environmental hazard. This departure could perhaps be explained by increased cotton hectarages in some areas, thus it would be more meaningful to use yield data instead of production figures. This latter problem is well-illustrated by cotton under Irrigation (table 4). Within almost the same length of time, irrigated cotton shows no evidence of production fluctuations. While there is clear evidence of yield fluctuations in the same period. The continued rising output of irrigated cotton appears to correspond with the expanded hectareage. But the varied yields may be due to differences in the amount of irrigation provided other factors remain the same.

TABLE 3. Cotton Production Under Rain-fed Conditions in Lake Cotton Area in '000 kilogrammes.

YEAR	KISUMU	SIAYA	SOUTH NYANZA	BUNGOMA	BUSIA	KAKAMEGA
1970	477	264	-	269	1,375	48
1971	68	244	466	119	1,093	79
1972	2,553	302	508	287	637	85
1973	772	1,125	457	616	5,212	-
1974	417	534	1,043	2,373	-	-
1975	607	453	1,090	714	7,204	-
1976	1,730	392	1,721	433	7,528	82
1977	2,500	280	2,734	-	7,528	-



**TABLE 4** Progress in seed cotton production at the Hola Pilot Irrigation Scheme from 1964 to 1974.

YEAR	Ha. Under Cotton.	Total Production	Yield Seed Cotton
		(Bales*)	(Kg/ha)
1964	477	3,032	1,177
1965	499	4,437	1,646
1966	494	3,295	1,204
1967	500	2,025	926
1968	484	4,405	1,683
1969	535	6,065	2,098
1970	573	6,903	2,230
1971	571	9,918	3,181
1972	700	10,881	2,843
1973	855	12,200	2,690
1974	856	12,227	2,685

\* 1 Bale = 185 Kgs.

**3. Technological inputs:**

Lack of sufficient equipment for land preparation, for example, ox-plough and tractor has had particularly serious consequences for the cotton as it has resulted in competition for land between cotton and subsistence crops with the latter, being given the preference. Other technological constraints associated with cotton growing are: insecticides, fertilizers, irrigation and spraying pumps, which are either lacking or not readily available to the farmer and often untimely.

**4. Pricing Policy.**

The existence of poor pricing policy renders cotton uncompetitive to other crops, especially Maize and Sugarcane which have more lucrative markets.

**5. Other Inputs:**

Other inputs include credit and seeds which are often not readily available. Inadequate storage facilities (gunny bags) have also hampered cotton production, since with heavy rainfall at time of harvest, the lint deteriorates fast.

6. Cotton extension and Marketing:

This may be explained from three angles: the farmer and production, the extension worker and the innovation and the statutory board and its agri -support activities. So far the farmer has been reluctant to emphasize cotton as a cash crop partly because of the reasons already outlined and partly because of the absence of drive in planting campaigns to interest the smallholders in maintaining present hectareage and increasing hectareage under production. But even with the constraints eliminated, the farmer will still need to undergo some considerable educational process before applying effectively the research materials at his disposal. More Extension workers are required for this purpose since the extension coverage has been too sparse to permit effective work. This has made introduction of innovations almost practically impossible.

7. Labour Constraints.

In the Lake Cotton Area, Cotton is sown in the main rains. The early-sown crop has proved to be of a high yielding potential, although the achievement of this potential is determined by a reasonable standard of weeding and application of pest control measures. To date, yield potential rapidly declines with later planting. With proper agronomic practices, Cotton planted in May gives only half the yield from cotton planted in March or early April, at the commencement of the long rains. On small-scale farms cotton planting is often delayed until food crops are established, commonly taking place in June and July. This is associated with seasonal labour constraints and the desire of the farmer to establish an adequate area for food crops to meet the needs of his family. Small changes in supply and demand may result in soaring prices of food crops. Thus, priority is therefore given in attempting to achieve self-sufficiency in food supplies and if possible, a marketable surplus. Another observation is that the smallholder who prepares his cotton early finds himself at a disadvantage of having to store his produce for two months until the opening of the cotton markets in mid-December (Anthony and Brown, 1970).

8. Agronomic Practices:

Theoretically, the Lake Cotton Area small-scale farmer has been blamed for the following agronomic practices which have resulted to low cotton



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production and yields.

- (a) Poor land preparation and broadcasting the seeds. I feel that this sort of blame is acute since it is not all the time necessary to plant on ridges unless water-logging and soil moisture holding capacity are a problem.
- (b) Little attention is paid to weeding and thinning of the cotton plants.
- (c) Failure to plant and harvest at the appropriate time, however, this is partly determined by the environmental constraints, particularly unreliability of rainfall regimes which are beyond the control of the smallholders.
- (d) failure to apply fertilizers and insecticides. But these are often unavailable or untimely.
- (e) Crop rotation and inter-cropping may be undesirable under certain circumstances, but this is because of land shortage due to population pressure in the area.
- (f) Neglecting to destroy stalks.

9. Communications:

The roads in the Cotton Belt as well as transportation facilities are inadequate and impassable during the rainy periods. It is said that where an area's communications are regularly disrupted in the wet periods or where transportation costs are abnormally high because of impassable roads, trade will be discouraged and the area will tend to rely on subsistence farming and contribute little to the economic development of the nation, (Republic of Kenya, 1970). No doubt, this is perhaps one of the reasons for the smallholders emphasis on food crops and poor attitude to cotton production. Proper feeder and access roads are of paramount importance in cotton production. It is surprising to see excellent sugar, tea, and paper roads in the Lake Victoria Basin, while there is none for cotton! We seem to have lost our logic if what occurred during colonial era still continues with no or little change. However the discussion on communications although interesting is beyond the scope of the present paper.

Evidence emanating from the present discussion clearly indicates that the impression that colonial government was engaged in fairly consistent game to introduce cotton and that the indigenous people were resistant to innovation is false and misleading. It is quite clear that cotton was introduced under compulsion and never enjoyed a lucrative market that is enjoyed by other crops like Sugarcane and Maize until now. Moreover, it was not a simple matter to incorporate cotton into the traditional agricultural system because of its nature of competition for land and labour with subsistence crops. To date failure of the colonial administrators to impose agricultural innovation was perhaps associated with scarce extension workers, limited labour and financial resources as well as limited knowledge of the environmental requirements for the establishment of cotton cultivation in the Lake Victoria Basin. Even more annoying is the fact that the type of sophisticated research programmes and experiments carried out to benefit European plantation agriculture in Kenya was never extended to indigenous small-scale farmers until recently. But as can be seen from the present discussion, future efforts in cotton production should not be frustrating since there is much scope for success, particularly as the crop has multiple uses, its market demand greatly exceeds its production.

The Ministry of Agriculture should intensify its Services both in research and extension, especially the redeployment of technical assistance. Cotton production will principally be stepped up through the efforts of increased application of the results of experimentation and by securing better cultural practices in order to double or treble the yields. In addition, it is recommended that the Cotton Lint and Seed Marketing Board should appropriate its channels to make credit and farm inputs available on time to the farmers as well as reviewing its current price to encourage the growers. Consequently, the board should increase its tractor hire to alleviate the land preparation problems. As a measure of inducing cotton production, the growers should be paid Guaranteed Minimum Return (GMR) by the government.

It seems to me that the cotton farmers might have been deliberately denied high prices for cotton because this might induce growers to increase the cotton production thus leading to serious food shortages or possibly famine, a situation which is apparently emerging from the Sugar Belts in the Lake Victoria Basin. Such problems must be corrected by proper planning of agricultural land use. Nevertheless, whatever the advantages or disadvantages of the present system of farming, the result appears to be that



cotton growers have not been so well-rewarded for their labours as a result of the low prices.

Land consolidation should be completed and title deeds issued in order to enable farmers to get loans. However, land tenure reform per se without other forms of improvements such as access to market outlet, capital facilities, good roads, high value cotton may not necessarily result in economic improvements of cotton and standard of living of the people. Despite land tenure problems, the high population growth rate of over 3.5% associated with most people aged under 15 years constitutes one of the most challenging problems on cotton production in the Lake Victoria Basin. Such a strong demographic <sup>virility</sup> will inevitably lead to increased "farm fragmentation". I strongly recommended that the "concept of farm fragmentation" should be <sup>thoroughly</sup> evaluated during the initial stages of Lake Victoria Basin Development Authority. The success of the Lake Victoria Basin Development Authority is likely to boost cotton production by providing irrigation although this may be rendered difficult by farm fragmentation. But problems of, say, salinity and diseases associated with irrigation projects must also be examined and eliminated in the initial stages. If the black cotton soils in flat areas are cultivated for paddy rice, problem of poor drainage is not a significant constraint, but the cultivation of cotton clearly risks uneconomic yields, particularly with application of irrigation unless adequate drainage is ensured. In conclusion, an examination of environmental, agronomic and socio-economic constraints is prerequisite so that a scale of priority in agricultural land use in the area becomes apparent. Theoretically the small-scale farmer has been blamed for his attitude to cotton production without offering solutions to these constraints. Agricultural conditions have been seen to be aggravated by a host of interacting ecological, historical, political, economic, social and demographic factors in the area (Blundell, 1962, Marco Survey 1965 and Rukandema, 1977). The area is subjected to frequent hailstorms, seasonal and annual floods <sup>(Obara, 1976)</sup>, which may sometimes be severe enough to upset cotton production. More serious is the spatial variation in timing and quantity of the rainfall which may mean that the farmer has less probability of obtaining a reasonable cotton yield in the area. This latter ecological problem may be alleviated by irrigation. Despite the problem of rainfall unreliability, there are large areas of the Lake Victoria Basin with high potential soils which are only partly utilized at the moment mainly because of <sup>(Obara, 1973)</sup> tsetsefly infestation, <sup>swamps,</sup> lack of proper

roads and traditional customs. There is need for intensified research to eliminate diseases, drain swamps, control floods and to build proper roads in the initial stages of the Lake Victoria Basin Development Authority. Consequently, research is required to establish the possible environmental risks due to applications of various insecticides (DDT, BHC, Carbaryl, Sevin, etc.), irrigation and fertilizers in cotton production. Nevertheless, today's research cannot feed today's hunger, but unless today's research is carried out today tomorrow's needs will not be met (Gebrewold, 1956). In the longer term it is likely that it is through application of modern technology and scientific research that cotton production will be increased. The quality of land potentiality and productivity could be tremendously increased by harnessing the abundant fresh waters of the Lake Victoria Basin for irrigation and other purposes. However, this will not materialise unless we work in concert with the riparian countries (Uganda, Tanzania, Kenya, etc.), politicians, administrators, experts and the residents of the area. For the purposes of integrated river basin planning, it would be myopic to exclude mount Elgon, Mau Escarpment, Cherangani and Elgeyo Marakwet Escarpments as well as large chunks of Narok in the Lake Victoria Basin Development Authority.



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