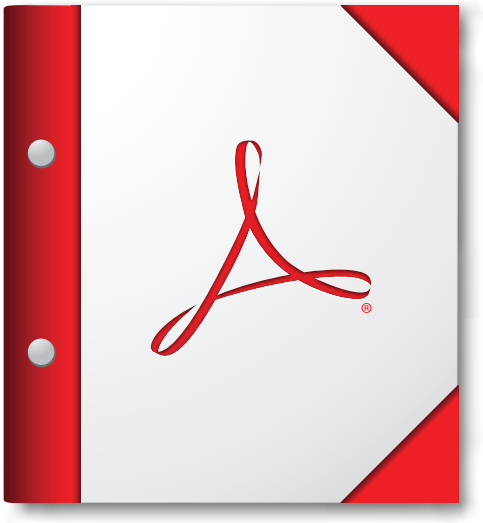

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managerial skills of farmers becomes critical when farmers adopt new factors of production and improved production practices. When making these changes (innovations) farmers do not have a number of years of experience, nor do they have the experience derived from trial and error over the time to drawn upon to identify the most appropriate system of production for the new technology. In such cases the extension officer must devote considerable time explaining proven production practices and the new managerial considerations involved in the use of the new technology to obtain increased output and reduced costs of production.

Improving the management of new farm technology will reduce the likelihood of poor performance and augment the possibility of increased net farm income and farmers satisfaction.

The Production Guide indicates that improving the standard of agriculture and welfare of individual farmers depends of several inter-related factors at the farm level; namely, good planting materials, good cultural practices, and good management, They all contribute to high performance and are inportant to achieve increased farm production and net income.

MAIN CROPS IN NORTHERN AND UPPER REGIONS

I. RICE:

Grown as a cash crop. The crop is rapidly being developed particularly in the Northern and Upper Regions.

II. MAIZE:

Commonly grown crop in Ghana. It is grown extensively as both subsistence and cash crop. The crop is used in making Kenke and for feeding poultry.

III. SORGHUM:

Grown on large scale in Northern Region. It is grown both as subsistence as well as for brewering pito. It can be used in feeding poultry and animals but the only hitch is that it is expensive.

IV. MILLET:

The crop is grown mostly in Northern and Upper Regions. It is used mainly as subsistence crop.

V. COTTON:

The crop is gradually developing as an industrial crop in the country. The crop can be used in several ways.

VI. KENAF:

The crop is being developed gradually as an industrial crop.

VII. GROUNDNUTS:

It is one of the commonly grown crops in the country. It is grown as a cash especially in the North. The growth of this crop should be encouraged in order to keep the vegetable oil mills going.

VIII. YAM:

It is grown as a major root crop. The crop is grown both as subsistence and cash crop. The development of the crop should be en couraged.

IX. TOMATOES:

The crop is vigorously being developed as a dry season crop in the Northern an Upper Regions. It is grown mainly as a cash crop.

RICE

History:

Rice is probably man's oldest cereal crop and exceeds in acreage all other cereals. It feeds about the half the wold's population.

In Ghana, rice was known as far back as the 17th and 18th century, when it was one of the leading commercial crops.

Cultivation on a larger scale started about 47 years ago in the Western Region when the first rice mill was set up at Esiama.

Due to lack of irrigation facilities, proper agronomic practices, credit facilities to growers and ready market, this first attempt failed.

The second attempt to increase rice production was made during the World War II (1939—45) when there was world-wide shortage of food. That time, Southern Ghana, Volta- and Northern Regions were encouraged to grow more rice. Nevertheless, after the War, the encouragement to farmers was not sustained until 1963 when total production in the country was in the range of 21,000 tons (milled). Even since that time production has been subjected to considerable fluctuations as shown by the following production respectively importation figures for the years 1963—1792.

Year	Quantity Produced (Milled Rice)	Quantity Imported to supplement local consumption
1963	21,333 tons	26,357 tons
1964	28,000 „	38,269 „
1965	21,333 „	29,598 „
1966	19,333 „	48,176 „
1967	28,000 „	39,448 „
1968	25,000 „	30,000 „
1969		
1970		
1971		
1972		

Table below compares production and importation figures from some neighbouring West African Countries and Ghana for 1968.

1968	Country	Production (Milled)	Imported
	Ghana	25,000 tons	30,000
	Sierra Leone	400,000 „	22,000
	Ivory Coast	300,000 „	28,000
	Liberia	152,000 „	33,000

The figures reveal clearly that our local production falls short at a reasonable percentage of what we actually consume.

As rice is now firmly established as one of the staple foods in the Country and about 6—7 Million Dollars are spent annually on the Importation of Rice, the increase of local production is of national importance.

There are two main species: **Oryza sativa,** originating, from Asia, to which all modern high-yielding rice varieties belong, and **Oryza glaberrima,** an originality of West Africa. Oryza glaberrima varieties are stil grown by peasant farmers.

There is a considerable confusion as to what exactly is meant by the term „Upland Rice". Many people describe it as rice grown without any form of irrigation works or structures, but include as „upland rice", rice grown on low-lying areas which become water-logged during the growing season.

The term upland rice denotes rice which is grown entirely as a rainfed crop, on well-drained upland soils. This definition clearly excludes the grop grown on soils which become water-logged.

Varieties:

International Research Institutions like IRRI in the Philippines have developed new improved rice varieties which have the following characteristics:—high yielding potential, good response to fertilizers, resistance to certain pests and diseases, and lodging, short growth period and intensity to photoperiodism.

After the introduction of these varieties to upland rice growers and rice cultivation under semi-dry conditions, yields have increased considerably.

Improved varieties in use in Northern Ghana are C 4—63, IR.5, IR.20. These three varieties, that mature in about 115—135 days,

are high-yielding and have shown good response to fertilizers. However, the C 4—63 variety will be phased out in the near future as it has the disadvantage of easy lodging and sensitivity to blast and neck-rot attack.

The varieties 617 A, C.21 and Alupe have shown encouraging trial results and may be soon passed on for multiplication. 617 A and C.21 with a maturity period of about 100—115 days have shown a fast development after sowing and seem to be suitable for the higher upland soils. Alupe with a maturity period of 145—160 days may be used for deeper flooded valleys.

Cultivation Systems:

Many systems of producing rice have been developed to suit the variety of conditions. It is relatively simple to produce if practices of cultivation are adopted to meet varying agricultural conditions related to soil, climate, size of holdings and availability of water and labour. Unlike other cereals, rice can tolerate and actually grow in standing water and swampy conditions.

The two main systems are: **the wet paddy system** and **the dry system or Upland rice cultivation.**

In wet paddy cultivation, the land is wet and actually often flooded from time of weeding or transplanting until time for harvesting approaches. This method is peculiar to rice as a crop because the physical, chemical and biological conditions of flooded rice fields differ greatly from conditions of dry fields.

The cultivation system of upland rice is very similar to that employed for other cereals. Seedbed preparation, planting, weeding and harvesting are done on relatively dry soil. The minimum rainfall required for upland rice is not precisely known, and the lower limits are differently quoted to be in the vicinity of 40—50 inches. As with all rainfall crops, however, the distribution of the rainfall is of much greater importance than the actual total rainfall. Early and mid season rains are more important then late rains. The highest yields are obtained when the monthly rainfall figures do not fall below 9 inches.

Soil: Rice can be grown on almost any type of soil, both light and heavy; exceptions are infertile sandy and stony soils. The soil should have good physical and chemical properties. It should

be noted that both extreme acidity (pH below 4.5) and high alkalinity (pH above 8) are harmful to most rice varieties and cause lower yields, a mild acidity (pH 5.5—7.0) being most beneficial.

Rice Cultivation in Northern Ghana

Land-preparation:

Land-clearing is done by hand or by machine, depending on factors like availability of labour, machines, funds, farm size, density of the bush, etc. Technics employed with the mechanical clearing differ. Most common in the North is block-clearing, threes are pushed down and uprooted by the bulldozer-blade and are later heaped or windrowed with the same machine when windrowing. It has to be taken care that the topsoil remains untouched.

Whether the clearing is done by hand or by machine, stumps and trees have to be removed properly, in order to avoid damage on tractors, ploughs and harrows.

The fields should be ploughed as early as the rains permit. Weeds and other organic matter have to be incorporated so that they get rotten before planting. A proper adjustment of the plough eases the operations of harrowing, sowing and harvesting. The recommended depth is between 6" to 9" depending on depth of the topsoil. The first harrowing has to be done when the weeds have emerged on the ploughed land. The second harrowing will follow shortly before sowing. The best results in preparing a good seedbed and to destroy weeds can be achieved when there is at least 14 days time between the two harrowing and if harrowing is done crosswise.

The fertilizer types presently used on rice in the North are the compound fertilizers 15-15-15, 20-20-0 and a straight nitrogenous fertilizer (Sulphate of Ammonium).

2 bags 15-15-15 are broadcast before planting and harrowed into the soil before sowing. One bag Sulphate of Ammonia is applied as a top-dressing 4—5 weeks after sowing when the first weeding is completed. If the land is newly cleared and there is no indication for the need of potassium, 20-20-0 may be used instead of 15-15-15. Farmers who own a combined fertilizer-seed-drill apply the compound fertilizer at once together with the paddy.

Observations and experiments have shown so far that the present fertilizer recommendations on improved rice varieties under favourable weather conditions and strict application of all recommended agronomic practices permit yields up to 25 bags/acre.

Fertilization:

With the introduction of the improved high-yielding varieties and in spite of the low nutrient status of our soils, it is generally agreed upon that fertilizers should be applied to obtain maximum yields.

The most usual deficiencies encountered in paddy growing are nitrogen and phosphorus, with potassium and sulphur in limited areas.

The main plant food elements Nitrogen, Phosphorus and Potassium will be briefly discussed in the following paragraphs.

Nitrogen:

Nitrogen is the dominant factor in the food requirements of paddy and it is, together with moisture and light, the main supporting agent of vegetative growth.

If other nutrients are also plentiful, a liberal supply of this element promotes tillering, increases the rate of leaf formation and the size of the leaves and thus boosts indirectly the yield of grains per acre.

In most rice growing countries in the humid tropics, the application of nitrogenous fertilizers is one of the most effective means of increasing the rice production. Nitrogen is never entirely lacking in paddy soils, as it is already present in rain and irrigation water, and it is also fixed from the atmosphere by certain algae and nitrogen-fixing bacteria which live in the water and in the upper layer of the soil by the million. Nitrogen is also released when organic matter, present in the soil, is broken down by bacterial activities.

In most instances, however, these natural sources of nitrogen are inadequate to support a good rice crop.

A common cause of nitrogen shortage is the condition of the soil itself which may be too compact, too acid or lacking in certain major and minor nutritive elements. Under these conditions, bacterial life cannot develop and this most important process of nitrogen fixation from the air is slowed down.

Liming the soil in order to neutralize excessive acidity or adding phosphate to the soil are treatments which often act as a nitrogen dressing because the growth of algae and bacteria in the soil is boosted again and the process of nitrogen fixation is re-established.

A deficiency of nitrogen becomes apparent in the field by a general yellowing of the growing paddy and finally by withering of the older leaves.

An excess of nitrogen, relatively to the other nutrients such as phosphorus and potassium, is also very harmful. Such an excess is easily produced by too liberal dressings of nitrogenous fertilizers. Although the plant looks healthy and dark-green at first, its internal nutrient balance is upset, the abundance of nitrogen causing a relative shortage of the other nutrients in the tissues of the plant.

Consequently, an excess of nitrogen may result in phosphorus starvation or potassium shortage and in a considerable yield depression. Lodging of the paddy is a very common result of excessive nitrogen dressings and varieties which already tend to lodging by nature should be kept short of nitrogen during growth.

The observant farmer will also notice that too liberal nitrogen dressings are soon followed by outbreaks of diseases or pests as the unbalanced conditions of the rice plant invite this mishap.

Therefore, nitrogen dressings should be properly balanced by phosphate and potassium dressings according to the demands of the soil.

Phosphorus:

During the growth and ripening of paddy, phosphorus plays an important part in several vital functions. Considerable concentrations of this element are present in those parts of the plant where the greatest growth activity takes place.

This explains why phosphorus has a striking effect one the formation of new roots, on the rate of tillering and on the filling of the ear-heads.

An early phosphate dressing helps greatly to establish newly germinated seedlings or transplanted young plants because it helps in a rapid development of a healthy root system. It is through this effect that phosphorus also assists the crop in overcoming droughts when the paddy is exposed to dry weather conditions in rainfed areas.

Since phosphorus stimulates tillering, it is a general experience that this element also helps the crop to recover more rapidly from the damage caused by the attacks of caterpillars or stemborers.

Finally it should be stated that lack of phosphorus in the soil delays the time of flowering and ripening of many varieties, whereas a high phosphorus status of the soil shortens the maturity period.

Since phosphorus shortage actually means a relative excess of nitrogen, it also can be said that it is the phosphorus-nitrogen ratio, really, which influences the length of the maturity period.

In most tropical soils, phosphorus tends to accumulate in the topsoil where it is often fixed in the organic matter of the soil. When such soils are converted into paddy lands, the organic matter is broken down and phosphorus is released for the feeding of the crop.

However, these phosphorus reserves are rapidly exhausted in the course of a couple of years as large amounts of phosphorus are removed each year.

Unlike nitrogen, no new phosphorus is formed in the soil and the paddy roots cannot explore the scanty phosphorus reserves of the deeper soil layers as some deep rooted crops do.

When the phosphorus content of the soil falls to that extent, growth and yield of the paddy drops accordingly and the activities of the nitrogen-fixing organisms in the soil slow down as well. Extreme phosphorus deficiency is shown in the crop by an early withering of the older leaves, these showing a peculiar reddish-brown discolouration, whereas the younger leaves assume a dark, bluish-green hue. Other symptoms are reduced tillering, stunted growth and bunching of leaves.

Fortunately, this unfavourable situation can easily be remedied by modest but regular annual dressings of phosphatic fertilizers.

Potassium:

Potassium is the third important plant food element. In combination with nitrogen and phosphorus, potash fertilizers increase yields and, what is equally important, greatly improve the health of the crop and its resistance against disease.

This is especially true in the case of light sandy or loamy soils in which this element is very often lacking. The heavier soil types are, on the whole, better provided with potassium and do hold this element more firmly when exposed to leaching by rain or irrigation water.

During the period of vegetative growth, paddy is very sensitive to a shortage of potassium. Especially when nitrogen is in excess, the plant is forced into luxurious development and, thus, runs out of potassium easily.

Shortage of potassium at this stage of growth particularly affects the strength and firmness of the lower parts of the shoots, thus endangering the necessary support of the growing stalks.

During the stage of ripening, when the filling ear-heads grow heavier and heavier, this lack of support will prove to be fatal as the crop will lodge under the first impact of heavy wind or rain.

Since potassium also plays an important role in the regulation of the plant's transpiration, a shortage of potassium may result in a slight wilting of the green parts because more moisture is lost through transpiration than can be supplied by the roots.

To protect itself, the plant will try, under this condition, to reduce transpiration by an erect stand of its foilage and, in very severe cases, by a rolling-up of the leaves along the midnerves.

Potassium hunger is also apparent by other visual symptoms on the leaves, depending on variety. The tips and margins of the leaves may turn yellow and die off, whereas the general colour of the leaves may turn from dark-green to a typical olive-green hue.

In the event of even a mild potassium shortage, the crop is very sensitive to disease because its health is impaired already.

Any additional supply of nitrogen will accentuate the degree of potassium hunger and may bring about an acute outbreak of bacterial or fungus attack.

For this reason, the application of potassium fertilizers is often looked upon as an insurance against these hazards.

On soils poor in potassium, a substantial increase in yield is obtained from the use of potassium fertilizers. This increase is mainly found in a larger number of filled grains per ear-head, but not so much in a greater number of ear-heads per acre.

On soils where potassium fertilizers do not pay so much trough bigger yields, a modest potash application may still be a sound practice and a wise measure against the chance of unsuspected crop failure through lodging, pest or insect attack.

Sowing:

Rice seed intended for sowing should be properly stored with a moisture content not above 10 %.

Before sowing, the seeds have to be cleaned to remove all foreign matter such as weed-seeds, emptly glumes, straw, etc. Germination tests have to be carried out to determine the proper seed-rate. Treatment with Aldrex T, Dieldrex A or Ceresan will protect the seeds against fungal diseases and pests.

The rice is sown into the dry field. This can be done:

1. by seed-drill, which has the advantage of a later easier weeding between the lines, better adjustable seed-rate and depth of sowing.
2. broadcasting by machine; this method can cover large acreage, and is preferred when the land is not properly stumped and cleared.
3. broadcasting by hand; this method is still the most common one in the North, mainly practised by smaller farmers.

It can also give good results if the seeds are distributed evenly at the right seed-rate.

After sowing the seeds have to be harrowed into the soil in order to protect them against bird damage.

The recommended seed-rate for the rice varieties in use in Northern Ghana is 65—80 lbs/acre, depending on the characteristics of the variety and the germination capacity.

The best planting time for rice in the North is end of May to early July, whereby the length of the growing period of a variety and the availability of the rains have to be considered.

Weed Control:

Yield losses and quality decreases are tremendous, due to weeds.

Weeds rob the farmer of his profits by:

a) reducing yields;
b) lowering the quality of the crop;
c) harbouring insects that damage the farmers crop;
d) reducing the land value.

The farmer must therefore fight to control weeds with every possible means.

There are two major weed control measures: mechanical and chemical.

Mechanical control involves:

1. destruction of weeds and weed-seeds through plough and disc-harrow before sowing;
2. uprooting of weeds by hand;
3. the use of hoes and cutlasses;
4. use of special equipment like cultivators and this harrows.

A good seedbed preparation will minimize the emergence of weeds after sowing and thereby lower the costs of weed control significantly.

Weeding after sowing must be done as early as possible in order to avoid competition of weeds and rice plants for nutrients, water and light.

Hand-weeding is the most common method practised on our farms. The disadvantage of this method is that it is tedious and time-consuming. However, presently, it is less expensive than chemical weed control and is therefore recommended.

Chemical control may be recommended for large mechanized rice farms with high yield expectations and where hand-labour is not available.

Herbicides can be applied pre- emergent and post-emergent. As many fields are flooded after sowing, the application of a post-emergent herbicide with a tractor-mounted sprayer becomes problematic.

Hand- sprayers on the other hand can not cover large acreages. A good selective pre-emergent herbicide should be more suitable

for our conditions on large mechanized rice farms. At present the cost of herbicides for one acre of rice is around C 20 as compared with C 10 hand-weeding. Their application therefore is only justified if high yields can be expected.

The most common weed species collected from the main rice-growing areas during the 1972 cropping season are shown in the table below:

SPECIES	Nyankpala rice fields	Farms on yendi road	Kokobilla rice fields	Walugu rice fields	Salaga rice fields	Bawku rice fields	Damongo rice fields
Rottboellia Exaltata (Monocot.)	×	×	—	—	—	×	—
Digitaria Acuminatissimum (Monocot.)	×	×	×	—	—	×	—
Setaria Anceps (Monocot.)	×	—	—	×	×	—	—
Panicium Subalbidum (Monocot.)	×	×	×	—	—	—	×
Cyperaceae (Monocot.)	×	×	×	×	×	×	—
Paspalum Commersoni (Monocot.)	×	×	×	—	×	×	×
Paspalum Orbiculare (Monocot.)	—	—	—	×	×	—	×
Fimbristylis Dichotoma (Monocot.)	—	—	×	×	×	—	×
Physalis Angulata (Dicot.)	—	×	×	—	—	—	×

SPECIES	Nyankpala rice fields	Farms on yendi road	Kokobilla rice fields	Walugu rice fields	Salaga rice fields	Bawku rice fields	Damongo rice fields
Cleome Viscosa (Dicot.)	–	×	×	–	–	×	–
Borreria Filiformis (Dicot.)	–	–	×	–	–	×	×
Eragrostis Squamata (Monocot.)	–	×	–	–	–	–	–
Pandiaka Hendelstii (Dicot.)	–	–	×	–	×	×	–
Sporobolus Pyramidalis (Monocot.)	×	–	×	×	×	×	×
Hyparrhenia Rufa (Monocot.)	×	×	–	–	×	–	–
Mollugo Nudicaulis (Dicot.)	–	–	–	–	–	–	×
Dactyloctenium Aegyptium (Monocot.)	×	×	–	–	–	×	×

Pests and their control:

In rice the group of stem borers (dark-headed, asiatic. pink, yellow and white stem borer) and the army-worms, different plant-suckers and hoppers cause most of the damage. All these insects feed and live on, the cultivated plants. Utmost attention must be paid in order to prevent the destruction of farmer's efforts by insects. Old plants, stubbles and bushes have to be burned, removed or ploughed down. Rotation of crops helps against staying of the insects on the field from year to year. Application of fertilizer and of good seed too helps that strong plants develop with a quick growth.

Control of insects by chemicals is possible and is only applied when all other measures fail. Skilled personnel and heavy capital investment are necessary, and not be needed if the above-mentioned measures of prevention are applied.

Control of diseases:

Pyricularia oryzae-blast is one of the most feared fungus disease in rice. Brown, spindle-shaped spots appear on tissues, spread and emerge into each other until the plant is destroyed. The disease attacks the plant in the early seedling-stage and later just before flowers appear, known, then, as neck-blast or neck-rot. The infestation may come from soil, seeds, old plants and host-plants. Conditions which favour the spread of the fungus are high humidity (conidia need free water to thrive), high night temperatures and cloudy days. Too high nitrogen supply coutributes to the danger of infestation. Faulty fieldpractices, late weeding, water logging through too much irrigation, sandy, light and shallow soil with a deficiency of nutrients may contribute to a quick multiplication of the disesase.

To reduce the danger of an attack, burning and removal of old plants and stubble are advisable with the use of clean and dressed seed at a proper seed-rate. The field must be well maintained and resistant varieties should be used.

Chemically, the rice can be dressed with organo-mercuric-powders and later the fields may be sprayed with fungicides or antibiotics. Care must be taken as some of the chemicals are toxic to humans as well as to plants.

The second known fungus disease (mycosis), **helminthosporiosis or brown spot,** develops reddish spots on leaves, ovalshaped with a light centre. This fungus is seed-born and conditions like those with blast favour its multiplication, especially low availability of nutrients and lack of potassium, manganese and magnesium.

To control the disease, poor soil conditions have to be improved, the fields well prepared and only very healthy and dressed seed should be used.

By severe attack, chemical control may be necessary but more investigation work has to be done in Ghana, in order to know the extent of the damage of this two fungus diseases (mycoses) in the country.

HARVESTING:

Harvest the crop when more than 85 % of the grains on the panicle are firm and clear in appearance, regardless of how green the leaves or straw are. Many nitrogen-responsive varieties have dark green leaves and stems even after the grains are fully ripe.

Delayed harvesting reduces yields because grains will fall from the panicle before harvest. Also, when harvested late, the panicle may shatter during cutting, carrying, stacking and threshing.

Delayed harvesting also increases the amount of sun-cracked grains. Furthermore, delayed harvesting may cause a total loss through bush fire, etc.

On most farms harvesting is done with the sickle or hand-operated knives. The plants are cut at about 1½—2 feet of the straw and are dried in the field. If the threshing is to be done later, they are piled into stacks with the panicles towards the centre in order to permit further drying of the grain.

Threshing and Winnowing:

The most common method of threshing is by hitting a certain quantity of the harvested crop with sticks on the hard floor or sandy clay. This is usually done by men and women with the women more engaged in the winnowing process. The most common method is hand winnowing — using large calabashes when the wind is blowing.

Maize (Zea Mays L.)

History:

Maize has been grown for thousands of years in the Americas, but it was not until Columbus returned to Spain from the New World that maize started to move into the rest of the world. The **Portuguese** brought it to West Africa in the early 1500's. Because it was easy to grow and had many uses, it spread quickly and became a very important part of the diet of many West Africans.

Varieties:

Maize is adapted to nearly all of Ghana, and in many areas, two crops a year are grown. The total acreage of maize in Ghana (major and minor seasons) is over 1 million acres.

The choice of variety is very important. When available, improved varieties should be grown as these have been shown to stand better and yield more than the local varieties. Varieties presently recommended include Diacol 153, Composite 2 and Mexican 17. Diacol 153 has a more yellow, softer kernal than the other varieties and, while it is not quite as well liked for human consumption, it is slightly better as a livestock feed.

Land Preparation:

With the first slight rains from April to mid May, ploughing and disking should be done in the North, to allow for optimum planting. Harrowing twice may help to control weeds, although care must be taken to avoid extreme pulverization of the soil which may expose it to the danger of sheet erosion. After ploughing, disking and harrowing, the soil is ridged. Ridges must be made across the slopes to check erosion and run-off. Where erosion is not a problem, planting can be done on flat ground after ploughing and harrowing, and ridging can be carried out at the time of the first weeding.

Fertilizer Recommendation and Application:

The present fertilizer recommendation for maize is two bages of compound fertilizer (15-15-15) per acre, spread on the land before planting. 1 bag of sulphate of ammonia per acre should be used in addition for top-dressing, 5-6 weeks after sowing.

Planting:

The best time to plant varies from region to region. In general, planting should start after the first rains of the season. In the northern savannah zone, mid-May to mid-June plantings are recommended. In the forest zone, mid-March to early April, and in the coastal savannah zone, mid-April planting dates are recommended. Rate and spacing: As a general recommendation, a plant spacing of 3' x 1', which gives a plant population of about 14,500 plants per acre, should be adequate for most conditions when fertilizer and improved seed are used.

Weed Control:

Weed control begins before the maize is planted. A well-performed first tillage, whether with plough and disk or cutlass and hoe, is the first step in successful weed control. Early weed competition is very damaging to maize; this is why weeding at this stage is very necessary for good yields. Weeds are also smaller and easier to kill at this stage. Hand weeding is more practical for small farmers, but on larger acreages, particularly with mechanized systems, chemical weed control may be best or even necessary. Chemical weed control using recommended herbicides offers the maize farmer the best way of preventing weeds.

Insect Control:

Maize is attacked by many insects, but only a few can be considered as major pests. In the seedling stage, cutworms and wire worms can do considerable damage, and there attacks are very heavy, replanting may be necessary.

The major insect problem in mature maize is stem borer. Many different chemicals have been found effective.

Harvest:

Most maize in Ghana is harvested, husked and shelled by hand. However, machinery for husking and shelling is becomming available. Large mechanical harvesting machines (maize combines) are doing an excellent job, but are very expensive and are therefore practical only on very large farming operations.

Hand harvesting can be done at any stage of maturity. Maize matures from 60 to 112 days after planting, depending on the

variety planted and weather conditions. When fully mature, the plants turn from green to yellow and then to brown, and the husks dry and loosen.

Storage:

Proper storage of maize grain is very necessary to avoid loss of quality and weight. Maize stores best with 11 to 13 percent moisture content, but most maize is harvested with between 20 and 25 percent moisture. It is therefore necessary that some means of drying be used to provide proper storage conditions. Moist maize is more apt to rot, lose viability and be attacked by insects.

Sorghum — Sorghum vulgare

1. History

About 75 per cent of the world crop of grain sorghum is used for human consumption from prehistoric times, mainly in parts of Africa and Asia.

Sorghum is the principal food crop of Northern Nigeria, where it accounts for about one third of the arable acreage and it should be the same in the Northern part of Ghana.

2. Varieties

Data on promising varieties:

Variety	Height	Maturity	Planting time	Yield/ acre (lbs)
SK-MDW (dwarf late)	6,5—8 ft	110 days	May—June	1500
CK-FF (dwarf late)	5,5—6 ft	110 days	May—June	1000/1200
Yadole (dwarf early)	6,5—7 ft	75—80 days	May—June	3000
Naga white (dwarf early)	6,5—7 ft	75—80 days	May—June	2800
AA 226/3 N (tall late)	10—13 ft	107 days	May—June	1250
Mankaraga (tall late)	12—15 ft	124—125 days	May—June	1200/1500
A 313 (tall late)	12—15 ft	110 days	May—June	800/1000
Bawku white (tall late)	12—15 ft	107—115 days	May—June	1100
WX 60 (dwarf late)	5,5—6,5 ft	100 days	May—June	2000

3. Soil and climate

Under dry conditions sorghum can produce a bigger crop than maize because of its ability to interrupt growth and to remain dormant during drought, resuming growth after rain. It has a high resistance to desiccation, a low transpiration ratio, a large number of fibrous roots, and the ability to produce a crop from the

tillers and branches developing after rain. It tolerates wet conditions better than maize and millet.

The soil type for best production is sandy to sandy loam soil pH 5.5 to 5.8.

4. Land Preparation

Thorough hoeing or ploughing and disc harrowing is necessary. Ploughing should start in March-April, 6" deep, harrowing in May and ridging in June.

5. Fertilization

Two bags of compound fertilizer (15 x 15 x 15), applied before planting. On light soil it is better to apply half of the total amount as a basal dressing, with the remainder applied in one ort two top dressings.

6. Crop Rotation

Northern Region: first year sorghum; second maize; third groundnuts 2—5 tons farmyard manure on maize plus fertilizer.

Upper Region: first year early millet; secound groundnuts; third sorghum and manure 4—6 tons plus fertilizer.

7. Planting Methods and time — Seed rate

Planting should be done on ridges 15" high 12" wide on top 36" wide at base in mid-June.

Three seeds per hole will give 21 000 to 22 000 plants per acre. Seedrate: 5 lbs per acre.

8. Weed and Pest Control

The seed should be weed-free at the start and should be weeded when the plants are 3 weeks old and later until the crop is high enough to overcome the weed.

Insect control: The Midge (Cantarinia) the larva of which may cause damage which reduces the yield by 50 % can be controlled by early planting and spraying the crop at flowering and again 10 days later with Sevin mixed at the rate of 43 g in 1 gallon of water. Spray 12 gallons per acre. Other insects are of little importance under present systems of agriculture.

Disease control: Grain smut — All grains of infected ears are converted into cylindric sacks containing masses of black spores. For control, treat seeds with Aldrex T, Ceresan or other seedressing chemicals on the base of mercury compounds. Head smut (Covered smut) may cause up to 10 % and is the worst disease of sorghum.

The floral structures are partly or entirely replaced by smutted galls, in the beginning covered by a pseudo-membrane. After rupture of this membrane the spore mass is scattering.
Control measures are the same as for grain smut.

9. Harvesting and storage

Procedures are similar to those of millet. Harevsting is generally done by hand. Plants are cut with cutlasses, the heads cut off tied together and dried on the floor or roof of buildings to a moisture content of 12 per cent. The dried heads may be stored in any dry building or baskets built for such storage purposes.

Spraying with 4 oz. of Gammalin „A" dust on 1 cwt. of heads will prevent loss if the storage is to be more than 6 months.

Millet — Penisetum cinereum

1. History

The term „millets" comprises a number of fine-grained cereal crops that have been cultivated and used as bread grains from prehistoric times. In all parts of Africa with a Sudanian climate, millet is one of the most widespread food crops. It is the principal crop in the compound areas of the Upper Region.

2. Varieties

Date on promising Varieties:

a) Early Millet

	Maturity	height
Manganara No. I	2—3 months	5—7 ft.
b) Late Millet		
Myanza II	4½—5 monts	12
Local		12—17 ft.

3. Climate and Soils

Millet is a traditional grain crop in the drier parts of tropical Africa. It can be grown successfully on granite sands which are too lighttextured for sorghum. On heavier textured soils it does better but cannot compete economically with sorghum. Because millet will give a yield on soils too poor to support any other grain crop, provided that they are well-drained, its use tends to be restricted to the lighter soils in low rainfall areas.

Millet needs less total rainfall than sorghum, although it can withstand drought. It can markedly reduce the transpiration rate, especially from the upper leaves, by closing the stomata during the heat of the day. Water stress in the first three weeks of growth has little adverse effect, whereas stress in the four to six week period delays maturity and reduces height, ear length, leaf number, yield per ear and 1000 grain weight.

Yields tend to be correlated with rainfall after planting.

4. Land Preparation

On small scale, field preparation is done by hand. On large farms ploughing and double harrowing is advisable. The fields should be ploughed 6 inches deep during March. Harrowing in April and ridging in May should follow before planting early millet.

5. Fertilization
When using compounds, apply either 2 bags of 20-20-0 or 15-15-15 as a pre-planting brodacast, but split dressing is preferable on light soils.

6. Planting Methods and time — Seed Rate
Sow on ridges „36 apart and 12" between plants. Sow 5 seeds per hole and thin later to one plant 15—20 days after germination. The planting time for early millet is in May, for late millet in June-July.
Millet is often interplanted with Guinea corn.

7. Weed and Pest Control
Weeding is necessary in the first growing period until the crop is high enough to overcome the weeds.
Field pests are mainly stem borers, they may be controlled with insecticides, applied 2 weeks and 4 weeks after sowing.
Always follow the recommendations provided by the manufactuerers and use extreme care in handling and applying these chemicals. Some of them are very poisonous to human being.
Head smut: Inflorescenses of the plant are converted into smutted gales, first covered by a false grey membrane. Later after rupture of this membrane dark brown spore masses become free.
For control, seed dressing with Aldrex T or Ceresan will help.

8. Harvesting
Harvesting is done by first bending the plants to the ground and then cutting off the heads which are carried home in baskets.
Where mechanical equipment is used, the crop is cut with corn binder, cured in shocks and threshed with a flail, small combine or thresher.

9. Storage
Millet may be sun-dried on the floor of the compound or the flat roof of the houses. If thoroughly dried no seed treatment is necessary for short storage periods.
When millet is stored more than 3 months in local silos, storage pests attack it often. Gammalin A dust will help to control storage pest. About 4 oz/cwt. is sufficient. Gammalin A does not affect gemination of the grain nor does it produce taint when the millet is used for food or pito.

Cotton Gossypium sp.

1. History

Cotton, also called „White gold" or queen of fibrous plant, has been grown in India for making clothing dating from about 3000 B.C., and in certain other countries:

2570 B.C. Textiles and cotton yarn discovered in preceramic finds at Huerta Prieta.

1500 B.C. Hymns of Reiveda provide first literary proof of cotton.

indefinite Pre-Inca tombs found in Peru with looms similar to those used in India.

555 B.C. Cotton grown in kingdown of Weroe, Sudan and so on.

Cotton growing has gradually increased in the countries of the old and New World climatically best adapted to its culture. As regards to climatic requirements, the cotton plant flourishes in the semi-arid and irrigated arid regions of the tropics and sub-tropics especially, between 41° Lat.N. and 36° Lat.S. Approximately 70 countries produce cotton, the main are in oder of area under cultivation: India, U.S.A., U.S.S.R., China, Brasil, Pakistan, Uganda, Mexiko, Egypt, Turkey, Sudan etc.

Cotton cultivation is also being promoted in many other countries in Africa, with further potential growing areas yet to be developed.

	Area in 1.000 acres.
Uganda	2.160
Egypt	2.000
Sudan	1.250
Nigeria	905
Chad	670
Mozambique	645
Tanzania	560
U.A.R.	375
Ghana	5

II. Soil and Climate

1. Cotton thrives on any type of soil as long as the other growth factors are given, and practically all soil types are found in the World's Cotton growing regions, except extremely sandy and very heavy clay soils. The soil must, however, be sufficiently deep, porous or well aerated, free from stagnant water and should have adequate nutrient elements. These are more often abundant in soils in the arid zones than in those of humid regions.

   Lime content of soils should be at least 0.5 %. Soil reaction should be somewhere between 6.0 and 7.5. Cotton is sensitive to high acidity of the soil — it does best on neutral or slightly alkaline soil reaction.

2. Temperature is the most important limiting factor in cotton cultivation — sufficient warmth with strong sunshine. During the whole cotton growing season the temperature should not fall below 77° F (25° C). Temperatures below 64° F (18° C) retard the germination and even later growth.

   Strong winds are unfavourable especially during flowering and ripening periods.

   Evenly distributed and sufficient rainfall is necessary from germination to flowering season, if irrigation is not possible. After flowering, dry weather conditions are necessary for ripening and for the formation of good qualitiy fibre and seed.

III. Varieties

Recomended and cultivated in Gahna at this moment:
Allen 333, BJA 592, HAR 444-2

The varieties Allen 333 and BJA were imported by Cotton Development Board from the neighbouring countries.
BJA 592 and HAR 444-2 show more or higher productivity than Allen 333.

HAR 444-2 as the newest variety will later replace the Allen 333, as is done in the neighbouring cotton regions.

IV. Land Preparation

Preparation of the field prior to sowing ensures a porous soil, friable and sufficiently aerated. This is done by
a) Tractors — Ploughing, and ridging
b) Bullock — Ploughing, harrowing and ridging
c) Hoe — superficial hoeing and ridgnig.

The raised ridges benefit the soil by rapid warming in the sun, enabling the young plants to utilize a deep upper mould, and also the farmer can easily control the weeds.

V. Fertilization

Fertilizer recommendations in the various cotton growing areas vary considerably with the type of soil, climate, irrigation conditions and rotation of crops. The fertilization in the Northern part of Ghana is done in two spreadings.

— First, the compound fertilizer 20-20-0 at the rate of two bags per acre is spread just after thinning out the plants or first weeding.

— Second, a complement of Ammonium Sulphate should be applied at the flowering period, at the rate of ½ bag per acre.

VI. Sowing

1. In the Northern and Upper Regions, the Farmers should start planting at the beginning of June (Beginning of rainy season).

2. According to varieties, germination potential, method of sowing and distance between the rows, about 13 to 26 lbs of seed per acre is sufficient.

3. Hand sowing by dibbling consists in making holes in advance and placing 4 to 6 seeds in each. The appropriate depth of sowing is about 1 inch in heavier soil and up to 2 inches in lighter soil. The planting distance should be 30 inches between the rows and 8 inches within the rows.

   Under the present planting method, too many plants will initially shoot at irregular intervals. By removing and thinning out seedlings, the most sturdy plants are

able to develop properly. The best time for thinning out (two plants per hole), is probably when the plants are 6—7 inches high, which is reached 30 to 40 days after coming up. By a distance 30 x 8 inches and two plants per stand, it will give 53,000 plants per acre.

VII. Weeding

Cotton is very susceptible to competition from weeds, and a plantation infested with an abundance of weeds is therefore liable to considerable yield loss. Many of these weeds are also known to be host of cotton pests.

Careful preparation and an intensive cultivation of the soil will reduce the weed growth, and spread of weeds may be stopped by systematic crop rotation. Weed control by hoeing is widely practised.

VIII. Disease and Pest Control

The insect problems facing today's cotton farmers have increased as the amount of the land devoted to cotton has increased. Cotton insects now can live their entire lives without having to travel more than few feet to find their favorite food. Farmers have found that intensive cultivation has made it virtually impossible to control the insects. Allow crop rotation by leaving the land fallow. Their experience has shown that chemical control of insects is necessary if the pests are to be prevented from devouring the crop.

From germination to harvest, the cotton plant is exposed to attacks from numerous bacteria and fungus disease as well as from a number of animal pests.

1. Disease of roots, seedlings, leaves und stalks.

   On the roots, seedlings, leaves and stalks of the cotton plants, there are a lot proved species of mould fungi and bacteria. Some of the main cotton diseases described:

   a) Black arm disease: — Xanthomonas malvacearum — Attacks begin on leaves, causing between veins on the under side water spots, which later discolour and dry out. The infection then spreads to stalks,

buds and fruit capsules, and also effects the seed (boll rot). Shedding of leaves and bolls can cause heavy damage. Favoured by rainy, moist weather, and communicated by seed, the infection is carried from plant to plant.

Seed dressing with mercury compounds (15 to 20oz/bag) can control this disease.

The Upland varieties have proved to be resistant to the disease in America and Africa.

b) Pink boll rot — Glomselloc gossypii Edy. —
Seedling show large red spots girdling the stem and killing it. Dark red sunken spots on the bolls, later turning brown or black. Generally a slimy pink is exceeded in the centre of the spots. Leaves usually are not so seriously attacked as seedling and bolls. Spots on leaves cause scold effect. Seed treatment with mercury compounds 15 to 20oz per bag can control the disease.

Further destroy infected plants and avoid excessive manuring with nitrogen.

c) Damping — off — Rhizoctonia spec. —
The seed fails to germinate, or if so then only partially. Older plants wilt or stunt, usually in patches, their roots rot and show shredding of bark.

Seed treatment with seed disinfectant or base of mercury 15—20oz/bag or with a fungicide on base of other active ingredients. Further it is important to select suitable dates for sowing to ensure as quick a germination as possible.

2. According to WIESMANN (Untersuchungen an den Prädatoren der Baumwollschädlinge in Ägypten im Jahre 1951/52 Acta Tropica, Vol. 12 No. 3 1955) normal cotton farmer includes 23 species of insects, 3 types of spiders and 1 acaride species.

   Some main cotton pests are here described:

   a) Cotton leafroller — Sylepla derogota —
   The small butterfly of this parasite, lays its eggs on

the under side on the leaf, whence the caterpillar perforrates the leaf to the centre rib. The leaf rolls up, is held together by thin threads, and serves as protection for the chrysolis.

Treatment with systemic insecticides e. g. Bidrin or Dimecron will control the leaf roller.

b) Red spider — Titranychus telarius —
Often very numerous, this tiny mite (0.5 mm long) sucks leaves and twigs, which becomes stunted. In the initial stage of infection the leaves shrivel and assume a reddish tint (red rust). Spread by many cultivated and wild plants.

Spraying repeatedly with systemic preparations such as Bidrin or Dimearon or apply acaricides on base of tetradifon, binapaerye or kelthane.

c) Cotton boll worm — Heliothis armigera —
Also feeds on tomatoes, tobacco and maize. The boll worm destroys beds and capsules, with greater damage in hot countries, and prefers maize flower tufts to cotton flowers; heads of maize therefore serve as traps. The cycle of development lasts 40 days, thus 5 generations may be raised during the vegetative period. The carterpillar migrates from capsule to capsule.

Spray or dust with insecticides on base of endosulfon, methylparathion, demeton, endrin etc. may control the cotton boll worm.

d) Sudan boll worm or red boll worm — Diparopsis costanea —

The little moth lays its eggs on all parts of the plant, and the caterpillars, which emerge after 3 days, bore into buds and bolls and completely destroy the contents. The pupa state occurs, after 3 weeks, in the soil, and the moth emerges after a further 10 days.

Spray or dust with insecticides on base of endosulfon, methylparathion, demeton, endrin etc. may control the Sudon bollworm.

e) Red bug or cotton stainer — Dysderauspecies — (or other bugs (Oxycarenus species, Nesara species etc.).
The tips of the shoots and the young capsules bitten by this parasite ripen permaturely and shed, and contamination makes useless the fibre of the attacked bolls.
Dust with insecticides on base of parathion, endosulfan, demeton, endrin etc. will help to control these parasites.

f) Cotton Aphid — Aphis gossypii Glov. —
The parasite sucks parts of the plant, causing stunted sprout and leaf growth especially in dry years. On the sugar containing secretions of the aphids, fungi grow and cover the plant. In profusion the insect cause heavy yield losses through shedding of capsules.
Dust or spray such as based on endosulfan, parathion, demeton, endrin etc. may control the cotton aphids.

g) Jassids — Empoasca devostans Dist. —
Small greenish leaf hoppers as well as their nymphs suck on the leaves causing them to turn yellow and to bend their edges downwards. Heavily infested plants stunt, flower buds and bolls may drop or open prematurely.
Dust or spray with insecticides on base of methylparathion, endosulfan, demeton, endrin will control the Jassides.

h) Sping bollworm — Earias Specias —
A small greenish or brown caterpillar bores into the buds and shoots of the plants and later in the bolls. Infested top shoots become black and drop, bolls fall on the ground, and affected parts of the plant show holes.
Recommended insecticides, based on endosulfan, asinphos, trichlorphon, endrin etc. may be control for the bole worm.

3. Application equipment and instructions.
Sprayer, rather than duster, are more suitable for cotton insecticide application at present.

Knapsack hand pump or compressed — air sprayers with 2 to 3 gallon capacity can be used for insect control on 2 to 5 acres field of cotton. One compressed — air sprayer would be sufficient to spray 2—2½ acre of full grown cotton in a day. The are also adaptable for home vegetable gardens and control of household insects including mosquitoes.

Motorized knapsack sprayers are more suitable for larger cotton fields. This sprayer would be capable of treating 10 acres of mature cotton in a day.

Tractor — drawn field sprayer, perhaps even aerial application, are items for future considerations.

Application: The farmer should always read carefully the tables on the containers of insecticides and follow strictly the given instructions provided by the manufecturers or the recommendation given by the Cotton Development Board, in applying and handling these chemicals. Some are very poisonous to human being. Plant control is necessary every two or three days for adult insects, larvae and eggs.

The spraying should start just before or when hatching is taking place.

In general, spraying will be necessary every 7 to 10 days, starting 30—40 days after planting.

Spraying should be done early in the morning and should be stopped at least 10.00 o'clock. At this time the updraft will reach a strength that will carry away the sprayed insecticides.

3—4 weeks before harvesting, spraying should be stopped but Insecticides should be available, when the farmers start planting their cotton crop.

IX. Harvesting

First picking should not be started until ⅔ of the bolls are widley open.

Following this system one labourer can pick 50—100 lbs per day, and it is more efficient than looking every morning for a few newly opended bolls.

Two to three pickings in total will be enough.

For quality reasons the third picking should be separated and not mixed with the first two pickings.

Further, picking should not start in the morning before 9.00 o'clock, until the seed cotton is absolutely free from dew. Clean picking causes more work and better organisation during the harvest, but is the guarantee for good quality cotton and high price.

1. Uprooting:
   Immediately after harvesting, the cotton plants should be cut, or if possible, uprooted; put these plants in heaps and burn them — Otherwise it provides excellent surviving conditions for the cotton insects during the next dry season and it will give more insect problem for the next growing season.
2. Rotation system:
   Cotton should not be planted on newly cleared busland
   1st season: Maize
   2nd season: Cotton
   3rd season: Groundnuts/Beans
   4th season: Cotton
   5th season: fallow or maize

X. Ginning

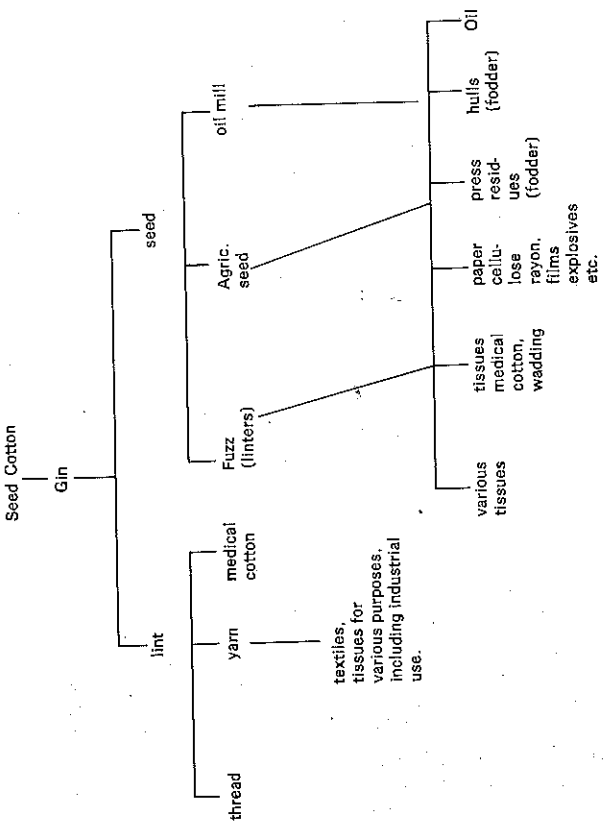
After harvesting the cotton must be separated from the seed. Only pure fibre provides a high grade marketable product. In most producing countries the crop is ginnend immediately after harvesting, in some other countries the seed cotton is stored for about a month before ginning.

Now-a-days, ginning is done by cotton ginning machines (roller-type gins or saw-type gins) in ginning centres. The average ratio between unravelled seed kernels and lint is 3 to 1. Important factors after ginning are length of staple, colour, fineness and tensible strenght of fibre.

XI. Use of Cotton Products

In countless centuries cotton threads and yarns have been processed into woven goods and textiles.

The main purpose of seed processing in the oil milles is the production of oil. Oil content of the seed is 18—22 %. The use of harvested cotton are illustrated in following diagramm:



KENAF (Hibiscus — Cannabinus)

Kenaf is considered a good substitute for jute and urena. It is grown and processed in many countries all over the world. In India for instance the annual kenaf production represents over 30 per cent of the total soft fibre production in the country. Kenaf is also grown in Middle- and South-America, USA, Southern Europe, USSR and many countries in Africa. Kenaf is known by many names such as bimilipatan jute, siam jute, meshta, stockroos, chanvre de guinee, to mention only a few.

Varieties and Photoperiodicity:

Photoperiodism greatly effects the growth, yield and quality of kenaf. Most varieties grown on commercial scale require 12½—13 hours of daylight and more for vegetative growth. If the daylight drops under this limit, the plants will stop growing, flowering occurs and the plant will set seed. Much emphasis has been placed on the development of varieties which are less sensitive to the photoperiod. In northern Ghana the following varieties are recommended: „2032"; „G 45"; „Cuba 108"; and the local variety „Roselle". Good quality and high yields under local conditions are typical attributes of these varieties.

Soil and Climate:

Kenaf is adapted to a wide range of soils. If adequate fertilizer is provided it tolerates even poor, sandy soils. In Ghana kenaf of excellent quality is grown especially in Upper Region around Wa and Navrongo, but also in other districts. Optimum soil conditions are well drained sandy clay loams with adequate humus and a pH of 6—6.8. The ideal climatic conditions for kenaf are in subtropical or tropical areas. Abundant rainfall is necessary for high yields. For good growth the monthly rainfall should not drop under six inches even though some drought can be tolerated.

Land Preparation and Sowing:

Kenaf does best on a well prepared seed bed. The planting distance for fibre production is 6—8" between rows and 2—3" apart in the drills. Approx. seedrate per acre is 25—30 lbs/acre. The planting distance for seed production is 12—16" between

rows and 6—8" apart in the drills. Approx. seedrate is 10—15 lbs/acre. Planting in moist soil ½" deep and even coverage of seed ensures uniform germination and even stand. Broadcasting is not advisable. Planting time is generally at the beginning of the rainy season.

Fertilization:

Before planting, the soil should be analyzed. There is no other way to determine the amount of available nutrients. Depending on the analysis the amount and kind of fertilizer has to be choosen. General fertilizer recommendations are:

N 40 lbs/acre = 2bags sulphate of ammonia
P_2O_5 40 lbs/acre = 2 bags single super
K_2O 60 lbs/acre = 1 bag muriate of potash

Before planting all the phosphate and potash plus ½ bag of sulphate of ammonia must be applied, followed by harrowing. When plants are 4—6" high, the balance of the sulphate of ammonia is applied as top dressing between the rows.

Weed Control:

Sowing immendiately after the last operation of seed bed preparation favors kenaf plants and reduces the possibility of weed development. Under optimum conditions kenaf will outgrow most broad leafed weeds. Kenaf should not be planted on land that is infested with vining type weeds such as „morning glory". During the first few weeks of plant development weeding is strongly advisable.

Pest Control:

Kenaf is attacked by several serious insect pests. Some of them are: Lygus,, Corn earworm, Spiny bollworm, and Cotton stainers. Control measures are necessary especially in cotton growing areas. Kenaf is also susceptible to several diseases, but anthracnose is the most severe. There are now high yielding varieties which are resistant to anthracnose. Another but more serious pest is „root knot nematode". The best and cheapest method of control against this nematode is crop rotation.

Harvesting and Processing:

When the first flowers appear on the kenaf stalk, the crop must be harvested. Late harvest reduces the quality of the fibre.

There are several methods of harvesting and processing kenaf, depending upon economics and upon the use of the product. The most widespread and simplest method of harvesting is hand cutting with a sickle or a knife. Mechanized harvest is also possible. The plants must be cut, the woody pith and also some of the pectinous substances removed before the fibre can be spun. The best quality of fibre is produced by ribboning, followed by retting. Ribboning means removal of the inner woody portion of the stem. Retting is the bacteriological decomposition of the pectinous substances which bind the fibres together.

To reduce transportation costs ribboning in the field is recommended, it also allows the organic matter in the pith to remain in the field.

Decortication:

Decortication involves the mechanical removal of the woody portion and some of the gummy substances. Decorticated fibre cannot be spun into as fine a yarn as retted fibre and therefore its use is limited to coarser materials. It has, for instance, often been converted into bags usable for various agricultural products.

Groundnuts (Arachis hypogaea L.)

History:

The origin of groundnuts is believed to be Brazil from where they spread to the other continents. About 1880, Groundnuts started to play a certain role in the world trade for food and oil crops and they now range sevond in importance as crop used for vegetable oil production.

Varieties:

Manipinta — This variety has been tested by the Crop Reseach Institute in various locations. It is high yielding and has a high oil content and is therefore subitable for oil extraction. Other varieties are still being tested.

Biology:

Groundnuts belong to the family of leguminous crops. Hundreds of varieties are known all over the world, however they can generally be grouped into three types.

1. The erect bunch type whose nuts cluster around the base of the main stem and matures in 90 to 110 days.
2. The semi erect bunch with the nuts clustered around the main stem which matures in 130 to 140 days.
3. The true spreading type which produces flowers along the stems and thus has nuts scattered away from the base of the stem. This type matures very late and is more difficult harvest.

Land Preparation:

Groundnuts require thorough seedbed preparation which can be done by ploughing and harrowing or hoeing. All weeds should be completely buried or removed.

Fertilizer Recommendation and Application:

The present recommendation is two bags of single superphosphate, applied before planting. This type of fertilizer gives better results than other forms of phosphate because of its content of calcium and sulphur which has shown to be important in groundnut nutrition.

Planting:

Both planting on ridges and the flat are practised in Northern Ghana. There is no evidence yet to show one method of planting superior to the other. However ridge planting makes harvesting easier, but in dry areas ridges loose the soil moisture quickly. A planting distance of about 24 inches between rows and 6 inches in the rows are recommended. A high plant population (40,000—50,000 per acre) is essential for a good crop and also helps to control weeds in the latter stage of the growing period. All seeds sohuld be dressed with organo-mercury powder like Dieldrex A before planting. The time of planting in Northern Ghana is generally in May/June.

Weed Control:

Presence of weeds is a great source of yield reduction. Hoeing should be done at least two times during the early growing stage. A good groundnut crop is closed by the time of flowering and does not need any more growth care.

Diseases:

Rosette: — a virus disease carried by aphids causes either extreme stunting with small markedly mosaiced leaves or slight stunting in which the leaves become chlorotic with dark green veins. Selection of resistant varieties, early planting, close spacing and seeddressing with Dieldrex A help to minimize the infection.

Cercospora leaf spots: — are caused by fungi which produces spots on the leaves. In humid weather the disease spreads fairly rapid. The leaves turn yellow and fall off. Spots may appear on the stem, weakening them. Finally, the plants die prematurely. Spraying with 6 grams Duter per gallon of water at the first appearance of the disease result in some control. If necessary, spraying should be repeated after 2 weeks.

Pests:

Termites: — attack the roots, tunnel into them and the plants finally die. Some control may be obtained by Aldrex 40 mixed with fertilizer and applied shortly before planting.

Harvest:

When the leaves begin to yellow and the kernels are fully developed and coloured, harvesting may begin. The nuts should be dug out and left to the sun for drying for about 10 days. The nuts may then be stripped from the haulms and again sunried before they are shelled or taken to the decoriator mill. Much of this work is normally done by hand, but there are some small machines like groundnut stripper and sheller which are quite useful.

Storage:

Storage of groundnuts is no problem. They can be stored shelled as well as unshelled. If pests attack the unshelled groundnuts, they can be controlled with Gammalin A dust.

Yam

History:

Yam is one of the most important food crops in West Africa because of its high concents of carbohydrates. About 650 species are known all over the world but only ten are important as food crops.

Vartieties:

The following four varieties are the most common ones in West Africa and therefore mostly planted in Ghana:

- White yam (Discorea rotundata POIR.) — is especially suited to the climatic conditions of Northern Ghana, grows very well in the light sandy soils of the savanna zone with long dry season.
- Yellow yam (Discorea cayensis LAM) — its inside is coloured yellow due to the high carotin content. Prefers areas with shorter dry season.
- Water yam (Discorea alata L.) — can produce very big tubers but is not so common as it cannot be used very well in preparation of „fufu".
- Bitter yam (Discorea dumetorum KUNTH) — can produce high yields per acre but is not so widerspread because of its bitter taste.

Landpreparation:

The land should be either ploughed or hoed at a depth of approximately four to five inches. In most cases mounding is practised in Northern Ghana. Yam can also be planted in ridges, in order to mechanize the various operations bu it is not common in North Ghana. The mounds may vary in size but normally they are about 2 to 3 feet high and 3 to 4 feet wide at the base.

Fertilizer recommendations and application

The present fertilizer recommendation for yam is two bags of compound fertilizer (15—15—15). One bag should be broadcasted before mounding, the second one should be sprinkled around the mounds when the vines are 1 to ½ feet high.

Planting:

Planting of yam in Northern Ghana starts towards the end of the dry season in order to take advantage of the early rains. Usually large tubers are cut into pieces, each with 3 to 4 „eyes" and used for seeds. The order of preference for the different part of yam planting are: head — tail — middle. The method of using whole small yam tubers for planting has shown that better yields can be achieved as compared with other planting practises. These seedlings are obtained by leaving a small piece of the yam tubers on the roots when harvesting. The pieces will then develop into small tubers and can be used for planting Treatment of the setts with a fungizide powder is advisable. To avoid drying out of the young shoots, seeds should be planted deep in the mound with the „eyes" facing upwards. For prodection of the seeds, mounds should be mulched at the time of planting. This is usually done by placing a „cap" of dry leaves or grass on top of the mound. The cap is being prevented from being blown away by weighing it with a small stone or loose soil. Mulching is particularly necessary in the hot dry conditions of the North, for it keeps down the temperature within the mound and so reduces deteriotation during the period of dormancy before the rains. Staking is necessary to enable the vines to climb. Tall poles have shown to produce higher yielding plants presumably by encouraging more luxuriant foliage.

Weedcontrol:

Weeds should be cut down regularly. Use of chemicals is not necessary.

Diseases:

Many types of leaf spot affect yam. These diseases are not particularly destructive and control measures have not been developed.

Insect pests:

Yam beetles and termites damage the tubers while they are growing. Some control can be obtained by treating the setts used for planting with fungicide powder.

Harvest:

When the leaves have died at the end of the rainy season, harevesting can start. Wooden tools should be used so as not to injure the tubers.

Storage:

Commonly in Northern Ghana, the yam tubers remain in the soil and are removed according to demand. By this method the tubers may start germinating again and thereby loose quality and taste. They can also be attacked by pests. Storage in an airy dry shed is advisable.

Tomatoes: Lycospersium esculentum

In old books on gardening, tomato appears under the name „LOVE APPLE" but since the earliest days it has been known by the latin name **Lycospersium esculentum.** It is a vegetable, one of the basic and, therefore, irreplaceable ingredient of human diet. It is reasonably rich in vitamin and minerals. It has a great commercial potential not only in Ghana, but other developing nations of tropical Africa.

Tomato as any other vegetable, can neither stand the heavy rains of the wet season nor the dry spell of the dry season, for that matter, its cultivation is still limited to traditional varieties and methods and only irrigation or adequate water supply can guarantee the cultivation of this vegetable.

History:

The origin of tomato is still not known. Some writers on gardening contrast the popularity of this fruit in France and Italy with its unpopularity in Great Britain. But some authorities say that tomatoes were introduced in Great Britain as far back as 1596 when the red-fruited, white-fruited and yellow-fuited types seemed to have appeared about the same time. In the eighteenth century, other types were seen in the same country such as the cherry-shaped, the pear-shaped and so on, and today it is still possible to get varieties that bear fruits of the same various shapes, sizes and colours.

Today, African developing countries have realiyed that tomatoes is one the best vegetables to be grown in the tropics and that no soup is complete without it, thus the out-cry for its production to elevate shortages in the green or fresh form and also to feed it's factories.

PRODUCTION TECHNIQUES

1. **Site Selection:** — Tomato plants in the open-air when properly grown and carefully fed, bear heavier fruits throughout the period they occupy the ground than they do in green houses and there is seldom any difficulty in fertilization. Every flower seems to set and produce fruit. It prefers a dryish atmosphere and moderately high temperature coupled, of course with plenty of sunlight and air. In Ghana, tomato-

cultivation in the open air is practiced under temperature of about 60° F to 85° F. Temperatures higher than above tend to inhibit fruit setting, medium rainfall with irrigation is recommended.

2. **Soil:** — The soil must be well drained sandy loam to clay loam rich in organic matter and nutrients. Soil pH being 5.0 to 7.5. Unused soil is more prefered.

   Tomatoes do not do well in rainforest areas. Steep stapes are not preferable since control of erosion may present a big problem. Very flat soils may also favour the incidence of fungus diseases unless they are well drained or rainfall is mild. Gentle slopes are the best.

3. **Varieties:** — Is is very difficult to make a decision with regard to varieties, for the old adage „One mans meat is another mans poison" is almost as true to tomato varieties for growing in the open air as of any garden subject which is affected by soil, climate, treatment of the gardener and so on. The following have however proven successful under Ghanaian experiments even though there may be others equally good.

   Roma, Marglobe, Zuarungu, Fireball, OK 1, OK 5, C.P.C.2, MH 6/1, Malanucie, Puck Mani local, Ponderosa, Red Plum, Ruby, Turrialba, Zuarungu Improved, Amateur, Anahu, Dwarf gem., Early dwarf, leader and Pearl harbor.

   Even though all varities grow well especially in the dry season, its advisable to contact your nearest extension agent when choosing a variety for your garden.

4. **Site Preparation:** — Tomatoes if not intended to be interplanted as companion crop with any cash crop in which case the major crop takes the upper hand in cultural practices, the site should be devoured of stumps, roots stones etc.

   They should be dug out to a depth of 18 inches, Ploughing and harrowing should be done to a depth of about 10 inches depending on depth of the top soil.

5. **Fertilizer or Manure:** — During ploughing and harrowing, apply farm-yard-manure. If no organic manure is used, on sandy loam soil, apply on prepared land before transplanting.

600 lbs 5—20—20 per acre or 150 lbs/acre sulphate of ammonie, 270 lbs/acre double superphosphate, 200 lbs/acre muriate of potash. On clay loam 5—20—20, 800 lbs/acre or 200 lbs/acre Sulphate of ammonia, 360 lbs/acre double superphosphate and 265 lbs/acre muriate of potash. Where mixtures are difficult to obtain, apply 3 cwts compound fertilizer (15—15—15) to an acre before transplanting and top dress with sulphate of ammonia before first fruits are set.

6. **Planting Time:** — Tomato is a vegetable that can be obtained three times a year especially in the Northern and Upper Regions of Ghana. For these two regions ,ist crop should be sown in January and transplanted to the field from February 21st to March 31st.

   2nd Crop — Sow seed from May 15th—31st. Transplant to field about June 21st to 30th.

   3rd crop — Sow seed from August 15th—21st. Transplant to field from September 21st—30th.

   Tomatoes find it difficult to set any fruit successfully during the period February 15th to March 31st due to very high night temperatures. Planting programmes should therefore be planned to avoid this.

7. **Rotation:** — Tomatoes like any other vegetable should not be grown on the same field every year. Rotate it with cabbage or other vegetables. However, never plant tomatoes following egg plant or peppers or egg plant following tomatoes and peppers. The following is suggested when tomatoes are involved.

   1st Crop — Leafy vegetables such as cabbage, cauliflower, lettuce, spinach, kale or collard greans.

   2nd Crop — Follow first crop by root crop such as carrots, onions, beetroot, radish or turnip.

   3rd Crop — Follow second crop by fruit farming vegetables such as eggplants, beans, peppers, tomatoes, okro, cucumbers etc.

8. **Nursing of Tomatoe-Seeds:**

   a) Seed Boxes and trays: — Tomatoes like other vegetable seeds require sowing in nursery before transplanting to the field. They are normally planted in seed boxes, pri-

cked out to field when the plants are about 6 inches high. Sizes of boxes are not important but must be 4—6 inches deep with drainage holes about 1/4 inch in diameter at the bottom and about 6 inches apart to allow excess water to drain out.

   b) Seed box Preparation: — The bottom of the box must be covered with a thin layer of small stones or gravel to prevent particles blocking drainage holes. Fill the box 1/2 inch to top with soil or mixture of good fine loam and vegetable compost in approximately equal proportions. Do not forget to use sterilized soil! Sterilization can be done in two ways, either by chemicals or by steam. (Ask your Technical Officer for advice). Surface soil should be reduced to a good tilth, levelled and firmed. Before firmnig, mix into the top two teasponnful of single superphosphate and one teaspoonful Sulphate of Ammonia per square foot or box 18 — 8 inches (better ground to powder). This gives the seedlings a good start after transplanting. Avoid seeds washing to one side during watering. This can be checked by placing the box in a container with one inch water. Leave the box in the water for the soil to get socked from bottom to surface. Shade the seed box.

   c) **Sowing In the Seed Box:** — Make groves not more than 1/2 inch deep and three or more inches apart with a blunt stick about the size of a lead pencil. Plant in rows or lines not too close together. Three ounces seed will be enough for planting an acre.

      Scatter the soil over the seeds and lighty firm. Water ligthly by sprinkling. Keep it constantly moist but not wet. When the seeds have germinated, it may be necessary to thin out. This ensures healthy sturdy growth.

   d) **Before Transplanting:** — It is better to prick out 2" apart into manured nursery beds when the first true leaves appear. These should be grown in the shade. A few days before transplanting, the seedlings should be hardened (acclimatized) by gradually introducing them to sunlight. Smokers should remember that virus disease can be transmitted to tomato plants on the fingers if the hands are not washed after touching tobacco.

9. **Transplanting:** — Where rainfall is heavy, raised beds are preferred but in areas where rainfall is light, flat or sinking beds should be prepared. Transplant to field beds when seedlings are about 4—6 inches high. Transplanting is best done in the late afternoon or during cloudy weather. Set plants not more than ½ inch deeper than they stood in the nursery bed. Firm soil around the roots making sure there are no air pockets.

   After setting, use one cup starter solution around each plant, Make this solution by dissolving four teaspoons of 10—10—10, 15—15—15 or any complex fertilizer in a gallon of water. Mix well. This will help to get the plants a quick start. Mulching keeps the soil damp, cool and soft around the roots of the plants and should not be overlooked during dry weather. Avoid using disease or insect infested material.

10. **Growth Care:** — Tender care is needed in dealing with tomato seedlings. Watering should be adequate and carefully done. Over watering causes „damping off".

    As plants grow upwards, they require staking with sticks 5 feet long, pushed 1 foot deep. Plants should be tied to the stakes at 12" intervals. If good sized fruits are required, the plants must be debudded as soon as side shoots develop in the axils of leaves. Care must be exercised to avoid confusing these flower-shoots, which grow on the stem, not in leaf axils. The later can be recognised quite readily by producing flower buds and little or no leaves. This pruning can be one once every week or ten days. It helps ease disease control practices and harvesting.

11. **Pests and Diseases of Tomatoes:** — Planting on virgin fields and rotation help elimate pest and disease incidence on tomato fields. Where nematodes are suspected, fumigate the soil with D.D.T. or Nemagen 2 weeks before transplanting.

    Pest: — Major pest are grass hoppers and moths. Control by applying Sevin at a concentration of 1 oz. in 2 gallons/water or D.D.T. as 5 % dust at 30 lbs/acre applied immediately after transplanting. Below are few disesases and their control measures: —

Common Name of Disease	Scentific Name of Disease	Nature of Damage or Disease symtoms	Treatment or control
Early Blight	Alternaria solani (E 11. et. Marl.)	Dark brown or black spots with concentric zones on the leaflets; on fruits black or brown sunken lesions, tissue leathery.	1. Crop rotation. 2. Seed treatment with mercuric or organic fungicides. 3. Repeated spraying with Zineb, Ziram, Maneb or other organic fungicidas.
Septoria leaf spot	Septoria lycopersici speg.	Small water-soaked, circular spots on the under surface at first of lower leaves. Spots enlarge, margins become black brown with sunken white or gray centre; defoliation.	1. Eradication of solanaceous weeds, long rotation (at list 4 years) 3. Repeated spraying with copper compounds (at 7to10 days) or organic fungicides like Zineb (at 6 to 7 days).
Leaf Model	Cladosporium fulvan, cook.	Irregular cholorotic spots at first on the lower leaves, which turn greyish-black On green fruits, infected areas appear black, leathery while on ripening fruits they are yellow and sunken.	1. Use resistant varities. 2. Control of humidity. 3. Repeated spraying with Zinam, Ferbam Menab, Captan or other organic fungicides.
Leaf mottling	Virus	Leaves mottled, distorted, reduced in size, Flowers fail to set fruits.	1. Eradication of affected plants. 2. Eradication solanaceous weeds.
Bronze leaf spot	Virus	First, brown spots on the leaves which enlarge, distortion of leaves and stem, dropping of fruits.	
Blossomend rot	Nutritional disorders	Sunken dars brown lesions at the blossom end, internal discoloration of the core —	1. Bring soil to good fertility 2. Regular watering. 3. Application of calcium. 4. Mulch in dry season.
Root-Knot	Meloidogyne spp.	Galls are produced on roots, leaves become pale in colour the stem becomes spindy and dwarfted. Swellings on the root vary from spheroid galls to elongated spindles. Affected plants form only a few fruits, sometimes the whole plant dies.	1. Long term rotation with non-susceptable crops. e.g. corn and cassava 2. Use non affected seedlings. 3. Use resistant varieties. 4. Seed bed and field fumigation with methyl bromide and nematicides such DDT and nemagon respectively

12. **Harvesting:** — Tomatoes ripen in about 11 to 18 weeks after planting Harvesting may last over a period of six weeks. If fruits are to be transported for a long distance it is much better to harvest when still yellow.

Bush Fire — The Farmers' Enemy

For many centuries, fire was the most effective means in man's fight against trees and grass. Shifting cultivators destroy trees in order to establish their farms. The herdsmen destroy trees in order to create more grassland. Grass was burnt off during the dry season in order to destroy old, unpalatable grasses and get a second growth of green grass.

Our hunters have set fire to the bush in order to drive animals in a desired direction and thus make hunting easier.

In the past, there were so many trees that man had to destroy them in order to survive. Unfortunately, this destructive influence of man on nature went so far that today, he must protect trees and grass in order to survive.

Main Causes of Bush Fires in Ghana

Our hunters, herdsmen and shifting cultivators are the main causes of bush fires in Ghana.

Solution

Firstly, the use of fire in hunting must be prohibited for ever.

Secondly, because there is a general shortage of animal protein, we have to increase the production of meat. This is the best way to eliminate bush meat bunting.

Thirdly, our herdsmen must realise that in many parts of Northern Ghana, burning of pasture does not promote the new green growth of grass at all: mowing instead of burning the pastures should be practiced.

On the „Abel Modern Ranch" at Doyum mowing instead of burning is practiced on the pastures, with excellent results. It would be better to make hay than to burn the grass into black ashes and thus lose this valuable material.

The tree and shrub vegetation on the pastures should not be eliminated by fire. Cutlasses, axes, bulldozers, herbicides, rotary mowers and other means should replace fire.

Fourthly, our hifting cultivators must be more vigilant while burning the bush for farming. We have to look for a substitute for the shifting cultivation in order to help our farmers abandon