

## **Preface**

Kenya has a great potential for cotton production for both rain fed and irrigated production spread out in Rift valley, Nyanza, Central, Coast, Eastern and Western Kenya regions. Under the Government's Big 4 agenda, cotton and textiles have been identified among the key drivers towards expansion of the manufacturing sector. The government plans to support the textiles industry through increased cotton production, improving policy in the import rules for textile products to cushion local producers and providing incentives to investors to build modern ginneries and textile manufacturing plants. One of the flagship projects envisaged in the Vision 2030 is the development of the arid and semi-arid regions that will include cotton as one of the priority enterprises as it is one of the few cash crops that thrive in such fragile environments where few economic activities exist. African Growth Opportunity Act (AGOA) also offers a ready duty free market in the United States which needs to be exploited through increased production.

Cotton is a cash crop suitable for marginal areas which comprise large parts of Kenya and it is grown in 24 Counties of Kenya. It is grown for its fibre and its byproducts are used for making oil, animal feeds, among others. Cotton farming also promotes environmental conservation. Cotton has the potential to benefit 8 million people in the drier areas of the country.

Cotton production in the country has declined from a peak of 70,000 bales per year in 1986 to about 5,500 bales per year in 2019 while the domestic market demand currently stands at 140,000 bales. The country has a potential to produce up to 368,000 bales of lint annually. While the potential land is 400,000ha, only about 10,000 ha is being utilized.

There are currently about 40,000 cotton farmers while the industry can be able to support over 200,000 farmers. The national target is to increase production to 200,000 bales from 185,600 acres by year 2022. However, cotton production faces key constraints including high cost of production occasioned by high input cost (fertilizer and pesticides), poor producer prices and poor quality seed. To mitigate the high cost of production, the

Government has introduced seed and pesticide subsidy to bring the cost of production low. The Government has also introduced high yielding cotton hybrids including Bt cotton so as to increase cotton production and productivity. Cotton research is also on going in a bid to clean and multiply the cotton conventional varieties as well as conducting adaptability/performance trials of superior cotton varieties.

This handbook illustrates sustainable practices in cotton production and farm management that address the economic, institutional, technological and environmental aspects of sustainability in the cotton sector. Through using it, farmers shall now be able to improve their cotton businesses by making informed decisions. It is simple and user-friendly for both producers and Extension Service providers.

It contains 10 chapters covering the following topics: Cotton Farming is a Business; Suitable Conditions for Cotton Production, Commonly Used Cropping systems; Cotton Varieties and Emerging Technologies; Soil Fertility Management; Land Preparation, Planting and Spacing; Thinning, Gapping and Weeding; Ratooning and Cap-ping, Disease and Pest Management/Safe Use of Pesticide; Harvesting and Quality Control, Farmer Empowerment; Contract Farming; Marketing of Seed Cotton; Value Addition and Technology, and Crosscutting Issues.

Future research results may modify the recommendations contained in this handbook and it will be revised accordingly and availed to cotton stakeholders. Any information on cotton growing that is beyond the scope of this booklet can be obtained from Fibre Crops Directorate, County Agriculture Offices or Kenya Agricultural and Livestock Research Organization. We also invite farmers, extension officers and other cotton stakeholders to send any feedback they may have on how to improve this handbook to the Fibre Crops Directorate office nearest them.

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**DIRECTOR**

## **FIBRE CROPS DIRECTORATE**

### **Foreword**

This handbook contains cotton-growing information that is meant to assist cotton farmers to produce better and more profitable cotton and it is a revised version of cotton hand book developed in year 2013.

One of the major drawbacks facing cotton revitalization in Kenya is the limited knowledge capacity especially among the farming community in the rural areas. As one of the key interventions in the revival of this subsector, Fibre Crops Directorate is committed to capacity build Counties in various aspects intended to assist farmers to improve crop productivity and quality along the value supply chain.

The Constitution of Kenya (2010) devolved agriculture extension functions to County Governments. Fibre Crops Directorate which is under National Government is supposed to capacity build the Counties in all aspects of cotton production and therefore extension officers, and other stakeholders will find this handbook an important tool in their extension work in the respective counties.

The information in the handbook is suitable for growing cotton both under rain fed and irrigated conditions. The information has been derived from the following sources:

- Research work carried out and Annual Reports from Kenya Agricultural and Livestock Research Organization (KALRO).
- Cotton Technical Handbook (2013)
- Cotton industry code of practice KS 2857:2019
- Fibre Crops Self-Regulation Guidelines, June 2019
- The Crops (Fibre Crops) Regulations, 2020
- The Crops Act, 2013
- Pest Control Products Board (PCPB) registered pest control products registered for use in Kenya. (2018)

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## **1.0 INTRODUCTION**

Nationally, cotton is considered under the Vision 2030 and Medium Term Plan as one of the most important industries to implement for the long term Arid and Semi-Arid Lands (ASAL) development initiatives and industrialization strategy. Under the Government's Big 4 agenda, cotton and textiles have been identified among the key drivers towards expansion of the manufacturing sector since it provides raw materials to our industries. It is among the few cash crops that thrive well in the fragile ASAL regions where few other economic opportunities exist hence providing source of livelihood to rural communities in ASAL areas where poverty levels are high.

Cotton growing was introduced in Kenya in 1902 with the assistance of a private company known as the British Cotton Growing Association. In the early 1980s, the textile industry was the leading manufacturing activity in Kenya as it employed over 200,000 farming households and about 30 per cent of the labour force. The industry also contributed significantly to income generation in rural areas by providing a market for cotton.

The cotton industry was greatly affected by the 1991 Government policy on liberalization and privatization. This policy encouraged importation of cheap cotton products including lint and second hand clothing from Asia and Europe, leading to the collapse of the cotton-garment subsector. Consequently, cotton production declined due to decrease in the price of lint cotton produced locally.

Currently, the area under cotton cultivation is estimated at 10,000 ha against a potential of 400,000 ha of both rain-fed and irrigated. National production stands at 6,200 bales annually against the national requirement of 140,000 bales with a potential to grow to 260,000 bales. The cotton industry supports approximately 25,000 households against a potential of over 200,000 households directly and indirectly along the value chain.

Challenges in cotton sub sector include low production and productivity at farm level, inappropriate value addition technologies, insufficient integration of marketing systems and high cost of manufacturing.

In Kenya, cotton growing areas are grouped into Eastern and Western regions as indicated below:

**Eastern Region:**

Counties: Kitui, Makueni, Embu, Meru, Isiolo, Kirinyaga, Tharaka Nithi Murang'a, Kwale, Kilifi, Tana River, Taita Taveta and Lamu.

**Western Region:**

Counties: Turkana, Elgeyo Marakwet, Baringo, Kajiado, Busia, Bungoma, Siaya, Migori, Kisumu and Homa Bay.

Other emerging cotton growing counties includes Laikipia and Kakamega

Cotton Value Chain is comprised of cotton growing, ginning, spinning, weaving, garment and non-apparels and peripheral industries (oil, animal manufacture, sanitary wares).

## **2.0 SUITABLE ECOLOGICAL CONDITIONS AND AREAS FOR COTTON PRODUCTION**

### **2.1 Ecological Requirement for Cotton Growing**

Cotton - crop thrives well in the following conditions:

**Altitude:** 0 – 1,372 metres above sea level.

**Temperatures:** 21-30 degree centigrade.

**Rainfall:** 500-750mm of well distributed rainfall during the first four and half months, for the single rainy season. The two rainy seasons will require an additional rainfall of 380-500mm (10-11 months).

**Soils:** Cotton grows in a wide range of soils types including black cotton, the red clay and the sandy loams. The soils should be deep with free drainage and of <sup>1</sup>pH range 5.0-8.00 (optimum 6.2).

## 2.2 Kenya map showing Cotton Growing Regions



Figure 1: Kenya Map Showing Cotton Growing Regions

<sup>1</sup> pH is a measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.

### **3.0 CROPPING SYSTEMS, LAND PREPARATION, VARIETIES AND PLANTING**

#### **3.1 Cropping Systems**

Cotton can be grown mainly using the following four systems:

- i. Pure Stand Crop
- ii. Crop Rotation
- iii. Intercropping
- iv. Relay Cropping

##### **3.1.1 Pure Stand Crop**

This is a system where one particular crop is grown on the same piece of land every season continuously. Pure stand crop can lead to pest buildup and degradation of your soil over time.

##### **3.1.2 Crop Rotation**

This is a system where different crops are grown on the same piece of land in a sequence e.g.

Year 1. Cotton	Year 2. Beans / Green Grams
Year 4. Maize (Katumani, DH-01) / Sorghum	Year 3. Cassava / Sweet Potato

In this system, in the second year cotton shifts to the plot where beans or green grams were planted; beans or green grams shift to the plot where cassava or sweet potato were planted; cassava or sweet potato shifts to the plot where maize or sorghum was planted; while maize or sorghum shift to the plot where cotton was planted, and so on.

Benefits of crop rotation:

- Sustains fertility.
- Reduces pests and disease incidences by breaking their life cycles.
- Higher yields.
- Improved soil structure and texture.

- Reduced input costs.

### **3.1.3 Intercropping**

Intercropping involves growing of two or more crops in a piece of land at the same time. For example, cotton can be intercropped with ground nuts, peanuts, green grams, non-climbing cowpeas and beans.

Intercropping can increase a farmer's income significantly. This system may manage pests better depending on the choice of the intercrop. It also enhances soil fertility

Remember! Interplant cotton with one row of legumes of choice.

Caution! Intercropping cotton with maize, sorghum and millet leads to competition for sunlight, nutrients, lime (mulching technologies) and moisture (heavy feeders) and this may result in lower yields.

### **3.1.4 Relay Cropping**

Relay cropping involves planting a new crop when an earlier crop is still in the field for example, planting cotton during the first or second weeding of a maize crop that is already on the farm. This practice is common where there is scarcity of land. It requires fertile soils.

Caution: With relay cropping, there is a risk of pest buildup especially if planted with cereals. If you relay crop with maize or sorghum, apply the cotton after the maize or sorghum has flowered.

## **3.2 Land Preparation**

Good agricultural practices will help the cotton crop grow well and increase yields. Early land preparation, dry planting and correct spacing is recommended.

Land should be prepared using machinery or manual implements to attain medium tilth. Some of the machinery and equipment recommended for land preparation include tractor mounted ploughs, rippers, sub-soilers, ox-plough and hoes (jembes).

- Land should be ready for sowing a month before the expected time of rains begin or planting.
- Deep tillage is encouraged to a depth of 1 - 1½ feet, that is 30cm – 40cm, at least once in every four years to reduce soil compaction and formation of hardpan. Where possible, use conservation farming.
- In conservation farming herbicides recommended by Pest Control Products Board (PCPB) should be used.
- The seedbed should be of medium soil texture (tilth). This is a moderately compact and firm seedbed which is not cloddy or loose.
- Ploughing followed by harrowing will give adequate tilth.
- Furrows should be cut to drain excess water especially in black cotton soils.
- In areas with scarce rainfall, tied ridging is recommended for soil moisture conservation.
- Soil amendment should be implemented where necessary to bring the site to its optimum production levels.

### **3.3 Varieties**

#### **3.3.1 Conventional varieties (open pollinated)**

Variety	Region	Yield potential rainfed(kg/hectare)	Yield potential irrigated(kg/hectare)
HART 89M	East of Rift & Coast	2,500	3,000
KSA 81M	West of Rift	2,000	2,500

### 3.3.2 Hybrids

Variety	Yield potential irrigated(kg/hectare)
HA 211	5,700
HA701	5,700
C567	6,000
C569	6,000
C570	6,000
C571	6,000
C567 BG II	6,000
C569 BG II	6,000
C570 BG II	6,000
C571 BG II	6,000

### 3.3.3 Varieties release dates and Owner

Variety	Year of release	Owner
KSA 81M	1998	KALRO
HART 89M	1989	KALRO
IRMA L457 IRMA L484	2012	CIRAD/IRAD/SO DECOTON
HA211	2017	Hazera Seeds
HA701	2017	Hazera Seeds
C567	2020	Mahyco Kenya Private Limited
C569	2020	Mahyco Kenya Private Limited
C570	2020	Mahyco Kenya Private Limited
C571	2020	Mahyco Kenya Private Limited
C567 BG II	2020	Mahyco Kenya Private Limited

C569 BG II	2020	Mahyco Limited	Kenya	Private
C570 BG II	2020	Mahyco Limited	Kenya	Private
C571 BG II	2020	Mahyco Limited	Kenya	Private

### **3.3.4 Bt cotton(BGII)**

Bollgard II Cotton(BGII) are cotton hybrids incorporated with the BGII technology and are a revolutionary solution to the low productivity and Lepidopteran pests of cotton crop.

#### **3.3.4.1 Mode of Action**

Bollgard 2 cotton hybrids produce two Bt (*Bacillus thuringiensis*) proteins Cry1 Ac & Cry2 Ab which together manage the key Lepidopteran pests of cotton viz. African Bollworm, Spiny Bollworm, Pink Bollworm and Tobacco Caterpillar.

#### **3.3.4.2 Benefits of BGII to cotton farmers**

- Provide built in protection to cotton crop against bollworm
  - Control a wider range of Lepidopteran insect pests
  - Extremely effective in places where pests have developed resistance to conventional chemicals.
- Acts specifically against targeted range of pests only
  - No more adverse effects on beneficial insects and non-target organisms including humans.
- Leads to savings on crop protection.
  - Farmers significantly reduce the number of sprays of chemical insecticides applied to the crop while maintaining higher yields
  - Less labour requirement for spraying of insecticides
- Ensures good lint quality.

- By reducing damage to the cotton bolls by Bollworms, the quality of the lint is better (white and clean cotton lint) in Bollgard2 cotton as compared to conventional varieties.
- Safer to environment and humans
  - Reduced worker exposure to pesticides
  - Provides an ideal fit with integrated pest management (IPM) and sustainable agriculture programs.

This technology does not provide control of Sucking Insect Pests of Cotton

### **3.3.4.3 Agronomic Practices**

#### **➤ Land Preparation:**

A fine seed bed is essential for securing a good plant stand. Do Cross-Ploughing twice to ensure soil is brought to fine tilth.

#### **➤ Sowing and Spacing:**

- Seed rate: 4 kg/ha or 1.6 kg/acre
- Spacing: 100cm x 60 cm (No thinning, 2 plants/stand). Target 16,660 plants/acre.
- Planting on the shoulders of the Ridges should be preferred to keep the field well drained.
- Sowing at first planting rains when 50 mm rains is recorded over a period of 5 days.
- Plant ONLY 2 seeds per hill
- Plant the seeds 4 to 5 cm deep; cover with soil and press

#### **➤ Fertilizer application:**

- Proper & timely application of fertilizers is necessary. The fertilizer schedule should be based on the soil test and local recommended practices by AFA, KALRO and local agricultural universities for respective zones.
- Application of basal dose is a must for early growth and development of plants.

➤ **Basal Application & Top Dressing**

- As recommended by AFA, KALRO, and other Agricultural Research Institutes in Kenya.
- Please ensure adequate soil moisture at the time top dressing fertilizer application.

➤ **Foliar fertilizer:**

- Foliar sprays help to provide nutrients during peak boll formation and boll load periods thereby reducing nutrient induced premature defoliation and boll shedding.
- **Note:** Dilution rate for foliar fertilizer needs to be strictly followed to avoid leaf burning. Please read the label before use and follow recommendation accordingly.

#### **3.3.4.4 Irrigation and Drainage:**

The cotton hybrids must not be allowed to suffer for lack of water during the flowering and fruiting stages, otherwise a lot of shedding of flowers and bolls will take place resulting in low yield. Cotton during its early growth is very sensitive to water stagnation. Therefore, drain out the stagnant water, if such a situation arises.

#### **3.3.4.5 Gap filling:**

To achieve optimum plant stand, if necessary go for gap filling in the respective Bollgard2 Cotton Hybrid within a week of germination. Non-Bollgard seed should not be used for gap filling in Bollgard2 area.

#### **3.3.4.6 Characteristics of Hybrids:**

##### **MAHYCO C 567 BG II**

Medium duration Hybrid with Big Boll Size

- Resistance to Bollworm complex
- Medium maturity: 160 to 170 days
- Tolerant to sucking pests
- Boll size: 5 to 5.5 gm
- Staple Length: 30.0 to 30.5 mm
- Fibre Strength: 27.0 to 28.0 g / tex
- Medium hairy leaf surface

### **MAHYCO C 569 BG II**

Medium duration Hybrid with large boll Size

- Resistance to Bollworm complex
- Medium maturity: 160 to 170 days
- Tolerant to sucking insects pests
- Boll size: ~ 5.0 gm
- Staple Length: 30.0 to 31.0 mm
- Fibre Strength: 26.5 to 27.0 g / tex
- Sparse hairy leaves

### **MAHYCO C 570 BG II**

Early duration very large boll size Hybrid

- Resistance to Bollworm complex
- Early maturity: 150 to 160 days
- Tolerant to sucking insects pests
- Boll size: ~ 5.5 gm
- Staple Length : 30.0 to 31.0 mm
- Fibre Strength : 27 to 28 g / tex
- Sparse hairy leaves

### **MAHYCO C 571 BG II**

Early duration Hybrid with Good Tolerance to Sucking Pests

- Resistance to Bollworm complex
- Early maturity : 150 to 160 days • Boll size: 4.5 gm

- Staple Length : 30.0 to 30.5 mm
- Fibre Strength : 26.5 to 27.0 g / tex
- Sparse hairy leaf surface
- Tolerant to sucking pests

### 3.4 Planting

The time of planting for cotton depends on the region. Below are the recommended times of planting.

Cotton crop takes 5-9 months to grow and be ready for harvesting depending on seeds type and the production location as follows;

*Table 1: Recommended time for Planting for Various Regions*

<b>Region</b>	<b>Planting Season</b>	<b>Harvesting Season</b>	<b>No. of Months</b>
Nyanza	April	15 <sup>th</sup> Oct-15 <sup>th</sup> Feb	6
Western	June	15 <sup>th</sup> Dec – 15 <sup>th</sup> Feb	6
Rift Valley	April	1 <sup>st</sup> Nov-15 <sup>th</sup> Jan	7
Coast	April	1 <sup>st</sup> Sept-30 <sup>th</sup> Dec	5
North Eastern, Central and Eastern	October	1 <sup>st</sup> July – 30 <sup>th</sup> Oct	9

- All crop residues should be destroyed at least one month before planting season without harming the environment.
- Planting should be completed at least one week before onset of rains using machinery or manual implements.
- The recommended seed rate and spacing for specific varieties shall be observed during planting. Seed should be placed at a depth of 3-5 cm.
- Seed dressing with chemicals which have anti-fungal and insecticidal properties shall be ensured to prevent early pest and disease infestation.

- Growers shall check that seed for planting are packaged, labeled and treated in accordance with provisions of Seeds and Plant Varieties Act CAP 326 of the Laws of Kenya.



*Figure 2: Planting using Manual Implements*

### 3.4.1 Spacing

Seed rate varies depending on the type of seed (fuzzy or delinted) and spacing. Plant spacing depends on varietal traits (compact or bushy).

*Table 2: Seed Varieties and Spacing*

<b>Variety</b>	<b>Seed Rate</b>	<b>Spacing</b>	<b>Plant Population</b>
Conventional (HART 89M, KSA 81M)	• 6Kgs/acre fuzzy	• 90x30 cm (1 seed per hole)	15,706 plants/acre
Hybrid (HA 701, HA 211, C567, C569, C570 and C571, C567 BG IIC569 BG II C570 BG II C571 BG II)	1.6kg/acre	100x60 cm (2 seeds per hole)	13,495 plants/acre
Compact (high	4.5-5kgs/ acre	75-100x10 cm	40,00065,000

density)			plants/acre
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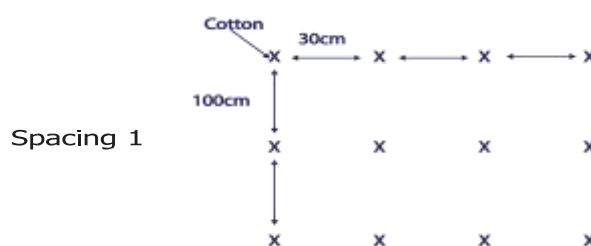


Figure 3: Illustration on Spacing 1

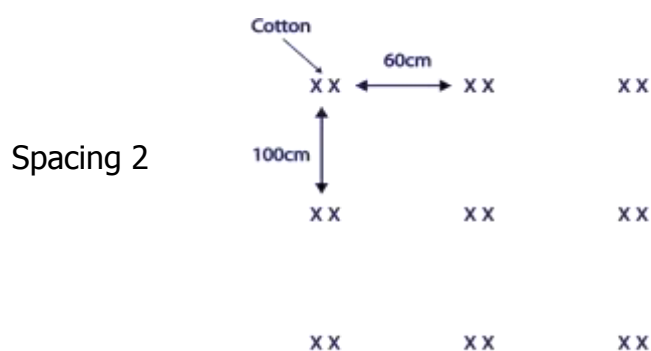


Figure 4: Illustration on Spacing 2

## Irrigation

Where irrigation is essential, it is recommended to apply at intervals of once every three weeks (21 days). This is ideal because too much moisture results in heavy vegetation growth (for a period of four months).

The critical stages of irrigation are flowering and bolling during which you should avoid water stress at all costs. Water stress leads to flower and boll abortion/dropping, which in turn reduces your yields.



*Figure 5: Bura Irrigation Scheme, Tana River County*

### 3.5 Flowering

- On the day the flower opens, it's white. Pollination occurs within a few hours later
- On the 3<sup>rd</sup> day, the flower will have a pink like colour and a red colour on the third day
- On 5-7 days after bloom, flower dries and falls off, exposing the boll



*Figure 6: Flowering of Cotton Plant*

## 3.6 Boll Development

### 3.6.1 Enlargement

- The boll enlargement phase lasts for about 3 weeks.
- **Each fibre** develops from a single epidermal cell on the seed coat.
- **Low** water availability, extremes in temperature and nutrient deficiencies (especially potassium) can reduce the final fibre length.

After pollination, it takes 50 days for the boll to fully open. Three phases of boll development

### 3.6.2 Filling



*Figure 7: Filling of Cotton Boll*

### 3.6.3 Maturation

- Boll maturation phase begins when the boll reaches its full size and Fully filled cotton bolls  
Maximum weight: Fibre and seed maturation take place and boll dehiscence (spontaneous opening) occurs. The capsule walls of the boll dry and shrink.
- This shrinking causes the suture between the walls to split, and the boll opens.



*Figure 8: An Opened Cotton Boll*



*Figure 9: Cotton Ready for Harvesting*

#### **4.0 SOIL FERTILITY MANAGEMENT**

Most of nutrients other than macronutrients are usually available in most soils fit for cotton production. The quantity of fertilizer to be added depends upon soil structure and nutrients status, previous crop grown and target yield.

## **4.1 Macronutrients**

### **Nitrogen:**

Shortage and over supply of nitrogen have a significant effect on fibre quality. Shortage results in short and weak fibre while excess supply can produce a longer fibre but weak and immature. Nitrogen losses occur in soil due to volatilization and denitrification as well as leaching. Nitrogen can move in the soil quickly and nitrogenous fertilizers have to be added more than once during the growing period. Soils low in organic matter are more susceptible to nitrogen deficiencies.

The first nitrogen deficiency symptoms are reduced growth, shorter height and fewer branches. It also results in high fruit shedding and premature termination of fruit formation. A pale yellow color of leaves indicates nitrogen deficiency. Excess nitrogen results in vigorous growth, delay in maturity and high pest attack.

### **Phosphorus**

Phosphorus is used in growth regulation and has minimal effect on fibre quality.

Alluvial soils are usually rich in phosphorous. In cotton the availability of phosphorus is low when the soils are over 7.5 pH (alkaline soils). Phosphorous moves very little in the soil and it is recommended to apply it before planting or at the time of planting and work it well into the soil. Phosphorous deficiency could have adverse effect resulting in dark green leaves and stunted growth. Severe shortage may result in reddish purple leaves, reduced flowering and delayed maturity of set bolls. Older leaves quickly translocate phosphorous to newly formed leaves therefore deficiency symptoms are more pronounced on older leaves.

### **Potassium:**

Potassium is required throughout plant growth but is most needed at the time of boll formation. Potassium is mostly needed for seed maturity but helps to maintain sufficient turgor pressure for fibre elongation, enzyme activation and Ph balance and disease suppression. Deficiency symptoms typically begin as yellowing white molting in the area between leaf veins and leaf margins. Bolls could remain unopened in case of severe potassium deficiency.

Foliar application of potassium can have an effect on yield in high yielding areas if enough supply is not available from the leaves.

## **4.2 Soil Analysis**

- Farmers are advised to carry out soil analysis before planting. This helps you determine the types and amounts of fertilizer – both organic and inorganic that you will need to apply on your farm.
- To carry out a soil analysis, contact your nearest Extension Officer or private service provider to guide you accordingly on the proper procedure for soil sampling, among others.
- Soil analysis helps you to buy the right type of fertilizer in the right amount. This saves you money that would have otherwise been spent on wrong fertilizers, and/or led to lower yields due to wrong application.
- Using the right type and quantity of fertilizer will enable you to increase yields and this will improve the quality of your seed cotton.
- Apply manure and fertilizers as per the recommendations given to you based on the results of your farm's soil analysis. (The amount and types of fertilizers to use will be site specific).
- Remember, improper use of inorganic fertilizers can be harmful to your soil.

## **4.3 Five Top General Guidelines for Soil Analysis and Fertilizers**

1. Apply the basal inorganic fertilizer during planting if required.
2. Top dress with Calcium Ammonium Nitrate (CAN) or Sulphate of Ammonia (SA) when the flower buds appear.
3. If a farmer has got manure, this can be used instead of the fertilizer at the rate of 2-4 tons per acre depending on the soil analysis results and the recommendations thereof.
4. Apply well decomposed manure during land preparation.
5. Discoloration (yellowing, browning, pink - see photos below) on leaves is an indication of mineral deficiency. Apply foliar fertilizers when you observe

symptoms of mineral deficiency. Remember to also contact your nearest agricultural officer for assistance.

#### **4.4 Examples of Discoloration due to Mineral Deficiencies**



**4.4.1 Magnesium deficiency**



**4.4.2 Manganese deficiency**



**4.4.3 Nitrogen deficiency**



**4.4.4 Phosphorus deficiency**



**4.4.5 Potassium deficiency**



**4.4.6 Sulphur deficiency**



**4.4.7 Zinc Deficiency**

Remember: Excessive manures and nitrogen fertilizers leads to more vegetative growth at the expense of fruit formation, resulting in lower yields.

## **4.5 Recommendations for Soil Improvement**

If you do not have access to soil analysis facilities, find below some general guidelines on what fertilizers to apply and at what rate for some common soils (see page 20 for list of common soils found in Kenya):

#### **4.5.1 Reddish-brown Clay**

Apply 55kg/acre Triple Super Phosphate (TSP) or 55kg/acre of Diamonium Phosphate (DAP) at planting.

#### **4.4.2 Black Cotton Soils**

Top-dress with 41kg/acre of Calcium Ammonium Nitrate (CAN).

#### **4.4.3 Sandy Soils**

Top-dress with 61kg/acre of Sulphate of Ammonia (SA).

Caution: Sulphate of Ammonia and Urea has some acidifying effect. Use of SAL Urea as top dressing is appropriate when practicing irrigated cotton. For acidic soils, use lime to neutralize effects.

Remember: Seek the assistance of your nearest extension officer when carrying out soil analysis to be guided on the proper procedure to use when sampling your soils in order to have an accurate soil analysis.

### **4.6 Fertilizer Application**

Blanket recommendation for fertilizers application is not advisable. Farmers are encouraged to use a combination of inorganic and organic fertilizers to improve the soil physical and biological properties. The choice of fertilizer and the application rates should be guided by soil test results. Ensure adequate soil moisture at the time of basal fertilizer application.

#### **Foliar Fertilizers:**

Foliar sprays help to provide nutrients during peak boll formation period thereby reducing nutrient deficiency induced premature defoliation and boll shedding. For improved yield the following foliar sprays are recommended: -

Onset of squaring (about 7 to 8 weeks after planting)

N:P:K (19:19:19 OR 20:20:20) water soluble fertilizer application – 1kg/acre

Boll formation stage (about 10 to 11 weeks after planting)

N:P:K (19:19:19 OR 20:20:20) water soluble fertilizer application – 1kg/acre

**Note:** Dilution rate for foliar fertilizer needs to be strictly followed to avoid leaf scorching. Read label before use and follow recommendation accordingly.

Use recommended fertilizer application methods. If in doubt, consult the nearest extension officer for the recommended application method to optimize the benefits of the fertilizer.

### **Irrigation and Drainage:**

The cotton hybrids must not be allowed to suffer moisture stress during the flowering and fruiting stages. Otherwise a lot of shedding of flowers and bolls will take place resulting in low yield. During the early growth stages, cotton is very sensitive to water logging, therefore in such situations drainage is necessary

Remember:

Scout for:

- Leaves showing mineral deficiency. If leaves are green they are ok.

Stunted growth.

- Many farmers do not apply fertilizer because they believe their soil to be naturally fertile. But if for example you see this pinkish looking grass, sometimes called “Poverty grass”, anywhere near your farm know that your soil is poor and it needs fertiliser
- If for example your farm has managu (black nightshade) or terere (amaranthus), then your soil is fertile

Caution: Do not replace fertilizers application recommendations with application of foliar feeds.

Remember:

- a. The best time to apply manure is during land preparation because at this stage it mixes with the soil properly.
- b. Do not assume your soils are so fertile, contact your nearest extension officer to do proper soil analysis and give you recommendations that will improve the fertility of your soil, save you money misspent on wrong fertilizers, and increase your yields.
- c. Do a soil analysis once every 3-5 years.

## **5.0 THINNING, GAPPING AND WEEDING**

To achieve competitive production levels, it is recommended to follow good agricultural practices in thinning, gapping and weeding.

### **5.1 Thinning**

Thinning is the removal of extra plants to achieve the recommended plant population.

- This practise is recommended to avoid overcrowding of cotton seedlings in one hole. Therefore, thinning results in healthier plants.
- Leave one plant per hole where the spacing is 100cm between rows and 30cm between plants (100cm x 30cm), and two plants per hole where spacing is 100cm between rows and 60cm between plants (100cm x 60cm).
- Thin immediately after the first weeding or during weeding when seedlings are about 15cm or three weeks old.
- Thinning should not be delayed beyond four weeks (one month).

- Hold the healthiest and most vigorous seedlings firmly in its place with one hand while you uproot each of the others horizontally.
- Thin when the soils is moist to lessen the damage of the root sys- tem of the remaining seedling(s).

Remember: If you do not thin, your farm will give you low yields.

## **5.2 Gapping**

Gapping is the filling-in of empty spaces due to poor germination so as to attain the correct population.

- Gapping is recommended one week after germination in order to maintain correct plant population.
- Gapping is also recommended where the germination rate is too low so as to avoid empty spaces in the farm.
- Gap only when the germination rate is less than 80%. Cotton has the ability to compensate for up to 20% un-germinated seed.

## **5.3 Weed Management**

Weeds compete for water, light and nutrients with the crop. Broad and narrow leaved weeds are common in cotton fields. Take note of the following when weeding:

- Delay in weeding will cause stunted growth and yellowing of crop.
- At harvest, weeds can make picking difficult and contaminate the cotton.
- Weeding is easier and more effective in the dry season.
- Weed before the weeds flower.
- Start weeding two weeks after germination. Do a second weeding before the end of the 8th week depending on weed intensity.

Weed 2-5 times per season depending on the weed abundance and intensity using a hoe (jembe) or a panga.

- Weeding requires 4-6 Man days per acre depending on weed growth, rainfall and heaviness of the soil.
- Weed can also be controlled by use of herbicides. These include pre-emergence herbicides such as Round up (Glyphosate), Diuron (Diurex), Paraquat Dichloride (Gramoxone), among others.



*Figure 10: A Cotton Farm with Proper Weed Management*

## **6.0 PESTS AND DISEASES**

Cotton is attacked by a wide range of arthropods pests and diseases. Here are some of the strategies you can use to manage cotton pests and diseases on your farm.

During the growth period of the crop, pests and diseases scouting should be performed to assess the level of infestation and infection respectively before the control measure is instituted.

Pesticides should be handled in a manner that ensures safety of handlers and the environment as guided by Occupational Health and Safety Act and Environmental Management and Coordination Act.

## **6.1 Integrated Pest Management (IPM)**

Integrated pest management involves scouting and identifying pests, followed by the use of a combination of different strategies including chemical, biological and cultural control methods.

## **6.2 Chemical Control**

The most commonly used method in cotton pest control is by use of man-made (synthetic) pest control products. The choice of pest control product to use will depend on its price, availability, effectiveness and the type of targeted pest. You should only use pesticides as the last result, that is, when other pest control methods have failed. Please Note: Use of pesticides from the same chemical group may lead to pests developing resistance. This is a major problem facing cotton farming. So use mixtures and rotations of pesticides belonging to different chemical groups as this is the surest way of managing pesticide resistance. Appendix 1 has a table showing approved pesticides in cotton farming. This information can help you know how to develop mixtures and rotations that are most effective by the use of pesticides from different chemical groups.

Remember: Farmers are advised to scout and accurately identify diseases and arthropod pests before applying any of the recommended pest control methods. In addition, farmers are advised to read the manufacturer's label carefully, mix the pesticides at the recommended rates and ensure a full cover spray to the cotton crop.

## **6.3 Cultural Control Methods**

### **a) Destruction of crop residues**

Collect, heap, dry and burn cotton stalk and trash at the end of the season. This will reduce or prevent the carryover of insect, mite, nematode and disease pests from one season to the next.

**b) Crop rotation**

The practice involves growing different crops in succession on the same piece of land. This helps minimize the cotton diseases and arthropod pests by breaking their life cycle.

**c) Trap crops**

Trap crops help keep pests away from the cotton crop by offering a more attractive source of food. For example, Lucerne and Sunflower are good trap crops for moths that produce the African bollworm caterpillars.

## **6.4 Biological Control**

In biological control, living organisms are allowed to naturally regulate pest population. The most common natural enemies of cotton arthropod pests are predators and parasites. Predators prey on the pests while parasites lay their eggs on the host's body causing them to die. The other classes of natural enemies are the disease pathogens like fungi or bacteria which cause sickness to the arthropods causing them to die out of sickness.

### **6.4.1 Predators**

The ladybird beetle is one of the most common predators of a wide range of arthropod pests. Other predators are tachinid flies, garden spiders and dragon flies.

### **6.4.2 Parasites**

Wasps are the most common parasitic natural enemies of cotton pests. They lay their eggs on caterpillars like the African bollworm. The eggs hatch and the young wasps emerge from the dead caterpillar.

### **6.4.3 Pathogens**

The most important pathogens that affect the arthropod pests are the fungi, bacteria, virus and nematodes. The infected arthropod die of sickness and this is how they control the cotton pest population.

### **6.5 Botanical pesticides (Plant extracts)**


Plant extracts are pest control products obtained from naturally occurring plants. The products are removed from various plant parts like leaves, fruits, stems and roots. Some of these products for example Nimbecidine and Achook are commercially available. However, plant extracts can be made by using simple methods like plucking plant leaves (for example Neem) and putting them in water for one day (24hrs.) After one day, sieve the plant extract and water and put in a Knapsack sprayer. Spray the crop to control pests or diseases.




Please note: Different plants control different pests and diseases.


### **6.6 Resistant/Tolerant Cotton Varieties**


Plant varieties that resist or tolerate harsh environmental conditions, severe pest or disease attack, are referred to as resistant or tolerant plant varieties. These plants have characteristics which cause them to be avoided by pests or not preferred by certain pests or diseases.


Table 3: Pest, Damages, Symptoms and Control



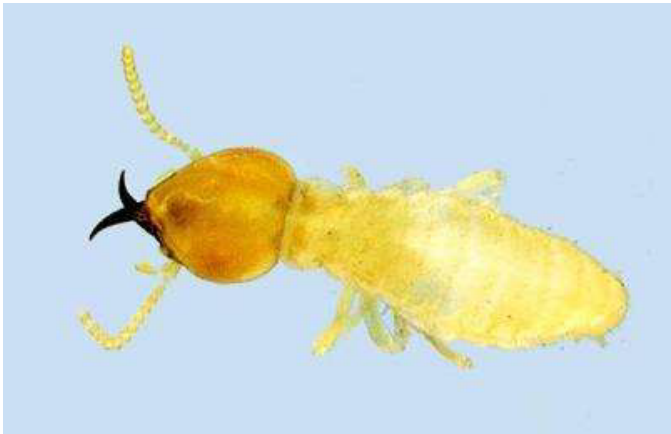
Pests	Damages Caused	Control
 <p data-bbox="293 1055 774 1086">African bollworm (<i>Helicoverpa armigera</i>)</p>	<p data-bbox="1034 277 1230 1048">Caterpillars of the African bollworm feed on leaves, buds, growing points, flowers and fruit. Leaf damage reduces leaf area, which can slow plant growth. Feeding on flowers and fruit causes the main damage. Flower feeding can prevent fruit formation. Caterpillars usually bore clean, circular holes through fruits/pods</p> <p data-bbox="1034 1050 1230 1240"><b>Economic Threshold Level (ETL)</b> – 5% of the plant infested by bollworms.</p>	<p data-bbox="1257 277 1414 371"><b>Chemical</b> See PCPB list below</p> <p data-bbox="1257 405 1414 1048"><b>Cultural</b> -Handpick and destroy eggs and small caterpillars. This is feasible in small plots or when infestations are low. - intercropping and trap crops - Crop rotation -Pheromone trap</p> <p data-bbox="1257 1081 1414 1240"><b>Biological</b> -Use of Bt cotton -Birds -Reptiles</p>

Pests	Damages Caused	Control
 <p>Cotton aphids, (<i>Aphis gossypii</i>) (<i>Homoptera</i>)</p>	<p>The damaging stages are nymphs and adults. Severe infestation at early stage of the cotton cycle destroys the plant by causing curling of leaves. Heavy infestation causes growth of sooty mold. <b>ETL</b> – 5 aphids</p>	<p><b>Chemical</b> See PCPB list below</p> <p><b>Cultural</b> -Yellow traps -Weed to remove alternative hosts -Use plant extracts e.g. Neem or Garlic</p> <p><b>Biological</b> -Parasitic wasps -Ladybird beetles</p>
 <p>Cotton stainer, bug, stink bug (<i>Heteroptera</i>)</p>	<p>Nymphs and adults attack immature bolls which fail to open or shed. Destroy the seeds and also cause poor quality of lint. <b>ETL</b> – 1 stainer per plant</p>	<p><b>Chemical</b> See PCPB list below</p> <p><b>Cultural</b> -Handpicking -Birds including chicken -Reptiles</p> <p><b>Biological</b> -Birds -Reptiles -Spiders</p>
 <p>Thrips – <i>Frankliniella</i> spp, (<i>Thysanoptera</i>)</p>	<p>The damaging stages are the nymphs and adults. Cause silverying of leaves which latter turn brownish or reddish in colour. Serious damage occurs at the seedling stage. <b>ETL</b> – 5 thrips per plant</p>	<p><b>Chemical</b> See PCPB list below</p> <p><b>Cultural</b> -Handpicking -Birds including chicken -Reptiles</p> <p><b>Biological</b> -Birds -Reptiles -Spiders</p>

Pests	Damages Caused	Control
 <p>Mealy bugs (<i>Phenacoccus solenopsis</i>).</p>	<p>The nymphs and adults do the damage by sucking sap from roots, leaves and stems. Heavy infestations cause stunting and distorted leaves, which turn yellow and fall. Flowers and fruits, too, are damaged and fall from infestations. Its waxy body protect it from natural enemies and pesticides, a small size allowing it to hide in plant crevices.</p>	<p><b>Cultural</b> Do not plant near old infested crops.</p> <ul style="list-style-type: none"> <li>• Do not plant downwind from infested crops</li> <li>• Handpick or prune infested leaves, branches or stems when mealybugs are first seen and infestations are low. Burn or bury infested plant parts.</li> <li>• Remove weeds which may harbour infestations of the mealybug.</li> <li>• Discourage farmers from planting okra around fields of cotton. Collect, burn or bury the remains of crops after harvest.</li> </ul> <p><b>Chemical</b> Use white oil or soap solution (see PCPB list attached)</p>

Pests	Damages Caused	Control
 <p><i>White flies (<u>Hemipterans</u>)</i></p>	<p>Whitefly is a serious pest of cotton that lowers yield by feeding on the underside of the leaf and spreading diseases like Cotton Leaf Curl Virus. Whiteflies feed on the sap of the leaves and release a fluid on to the leaves on which a black fungus grows. This affects photosynthesis, the food making process of the plant, and so lowers the strength of the plant.</p>	<p><b>Cultural</b> Remove crop residues, weeds and alternate host plants from sowing to harvest. Look for whiteflies on the underside of leaves, if 5 adult or young ones per leaf, are present then control measures are recommended</p> <p><b>Biological</b> Several natural enemies prey whiteflies including ladybird beetles, big-eyed bugs, and parasitic wasps. If you see these insects, do not kill them.</p> <p><b>Chemical</b> Use seed treatment (Imidacloprid 70ws @10gm/kg seed) at the time of sowing. (See PCPB list attached)</p>

Pests	Damages Caused	Control
 <p data-bbox="256 1126 798 1160">Pink bollworm(<i>Pectinophora gossypiella</i>)</p>	<p data-bbox="1114 286 1310 954">The caterpillars bore into the flower buds and young bolls causing shedding. Caterpillars feeding on flowers spin the petals together, causing the formation of what is called "rosette flowers" which do not open up. The bolls open prematurely and may also rot or drop to the ground.</p>	<p data-bbox="1335 286 1501 1469"><b>Cultural</b> Practise field hygiene. Remove and destroy old crops and plant debris after harvesting Crop rotation with plants not related to cotton (avoid kenaf, okra, abutilon and other malvaceas) Mixed cropping helps to reduce attack Encourage natural enemies like ladybird beetles, lacewings, spiders etc. Hand picking. This helps when their numbers are low and in small fields. <b>Chemical</b> See PCPB list attached</p>

Pests	Damages Caused	Control
 <p data-bbox="475 790 820 824">Systatee weevil (Coleoptera)</p>	<p data-bbox="1114 230 1305 745">The adult systates weevil are found feeding on the leaves. They cause serrations on the edge of the leaves and by so doing reduce the photosynthetic area which is necessary for a good healthy plant. <b>ETL</b> – 1 weevil per plant</p>	<p data-bbox="1337 230 1497 521"><b>Chemical</b> See PCPB list below <b>Cultural</b> -Handpicking <b>Biological</b> -Reptiles</p>
 <p data-bbox="512 1335 756 1368">Locusts (Orthoptera)</p>	<p data-bbox="1114 902 1305 1227">The damaging stages are nymph and adult. They cut the base of cotton seedlings and defoliate leaves. <b>ETL</b> – 2 locusts/ per</p>	<p data-bbox="1337 869 1497 1216"><b>Chemical</b> See PCPB list below <b>Cultural</b> -Handpicking -Plants <b>Biological</b> - Birds</p>
 <p data-bbox="517 1834 751 1868">Termites (Isoptera)</p>	<p data-bbox="1114 1406 1305 1865">They eat into taproots of young plants (e.g. cotton and groundnut) immediately below the soil surface, destroying the central root portions. <b>ETL</b> – 5 termites/ at the base of plant</p>	<p data-bbox="1337 1406 1497 1989"><b>Chemical</b> See PCPB list below <b>Cultural</b> -Dig to remove the termite queen <b>Biological</b> - Entomopathogenic fungi and nematodes Reptiles</p>



Diptera (Serpentine leafminers)-  
*Liriomyza spp*

The nymphs and adult are the damaging stages. They attack leaves which turn reddish to brownish with webbing on the underside of the leaf, premature leaf drying up and shedding.

**ETL** – 5 mite per plant

**Chemical**  
See PCPB list below

**Cultural**  
-Blue sticky traps



Red Spider Mites  
*Tetranychus spp* (Acarina)

The nymphs and adult are the damaging stages. They attack leaves which turn reddish to brownish with webbing on the underside of the leaf, premature leaf drying up and shedding.

ETL – 5 mite per plant

**Chemical**  
See PCPB list below

**Cultural**  
-Burn leaves at the end of season  
-Soap plus water

**Biological**  
-Predatory mites  
-Ladybird beetles








Pests	Damages Caused	Control
 <p data-bbox="560 920 823 987">Root Knot Nematodes (<i>Meloidogyne spp.</i>)</p>	<p data-bbox="1114 315 1305 920">The most common nematode attacking cotton is the root knot nematode, <i>Meloidogyne spp.</i> The symptoms are stunted growth, wilting and yellowing or browning of leaves. Galls on the roots are also evidence of nematode attack.</p> <p data-bbox="1114 925 1305 1099"><b>ETL</b> – 1 plant per 5 m<sup>2</sup> showing nematode damage signs.</p>	<p data-bbox="1337 315 1497 405"><b>Chemical</b> See PCPB list below</p> <p data-bbox="1337 443 1497 477"><b>Cultural</b></p> <ul data-bbox="1337 481 1497 1357" style="list-style-type: none"> <li>-Solarization using plastic mulch</li> <li>-Practice crop rotation</li> <li>- Resistant varieties</li> <li>-Marigold leaf extract</li> <li>-Neem extracts (seed cake or leaves)</li> <li>-Avoid planting cotton in infested soil</li> <li>-Soil amendments- (compost manure, cow or poultry manure)</li> <li>-Deep ploughing during long dry season</li> </ul>

Table 4: Disease, Attacks, Symptoms and Control

Disease	Part Attacked	Symptoms	What to do
 <p>Bacterial blight (<i>Xanthomonas axonopodis</i> pv. <i>malvacearum</i>)</p>	Seedling, leaves, stem and ball	Affected part is browned and blacked	<ul style="list-style-type: none"> <li>-Plant resistant variety</li> <li>-Use disease free seeds</li> <li>-Crop rotation</li> <li>-Good field sanitation</li> <li>-Use pesticides</li> </ul>
 <p>Fusarium Wilt (<i>Fusarium oxysporum</i> f.sp. <i>vasinfectum</i>)</p>	Leaves and stem	<ul style="list-style-type: none"> <li>- Yellowing and browning of cotyledons and leaves</li> <li>- Stunted growth</li> <li>- Blackening of the woody tissue</li> <li>- Discoloration beneath the bark</li> </ul>	<ul style="list-style-type: none"> <li>- Plant resistant variety</li> <li>- Crop rotation</li> <li>-Use disease free seeds</li> <li>-Liming of the soil</li> <li>-Good field sanitation</li> <li>-Use pesticides</li> </ul>

Disease	Part Attacked	Symptoms	What to do
 <p data-bbox="279 728 667 761"><i>Anthracnose (Glomerella gossypii)</i></p>	Seedling, stem and boll	<p data-bbox="1093 309 1267 880">Diseased seedlings show reddish-brown lesions below ground - Diseased boll has a small, round, water-soaked spots, which enlarge and become sunken and brownish in colour.</p>	<ul data-bbox="1294 309 1465 779" style="list-style-type: none"> <li>-Use disease-free seeds</li> <li>-Practice crop rotation</li> <li>-Practice good field hygiene</li> <li>-Use pesticides</li> </ul>
 <p data-bbox="188 1346 542 1379">African cotton mosaic disease</p>	Leaves	<p data-bbox="1093 981 1251 1126">Foliar discoloration stunted growth</p>	<ul data-bbox="1294 981 1465 1272" style="list-style-type: none"> <li>- Practice good field sanitation</li> <li>- Use disease-free seed</li> <li>-Use pesticides</li> </ul>
 <p data-bbox="188 1897 635 1930"><i>Ascochyta blight (Ascochyta gossypii)</i></p>	Upper small leaves, petioles, buds and stem	<ul data-bbox="1093 1532 1267 1778" style="list-style-type: none"> <li>- Small, round, white, purple-ringed spots on the cotyledons and lower leaves.</li> </ul>	<ul data-bbox="1294 1532 1465 2022" style="list-style-type: none"> <li>-Use disease-free seeds</li> <li>- Crop rotation with crops non-related to cotton (e.g. cereals)</li> <li>- Practice good field sanitation</li> <li>-Destroy cotton residues</li> </ul>

Disease	Part Attacked	Symptoms	What to do
			-Use pesticides
 <p>Damping-off diseases</p>	Seedlings	<p>-Attacked seedlings develop dark to Reddish brown cankers on the stems near the soil line.</p> <p>-The cankers encircle the stems or penetrate so deeply that the plants fall over and die.</p>	<p>-Use disease-free seeds</p> <p>-Avoid planting during cold, wet weather</p> <p>-Use pesticides</p>

The pesticides mentioned below have been registered for use against cotton pests and diseases: Source: PCPB- List of registered Pest Control Products 2007 and KENGAP-Agricultural Products Handbook-ISBN 9966 7035 27. For more information on how to scout effectively, consult your nearest extension officer.

## 6.7 Safe and Effective Use of Pesticides

### 6.7.1 Mixing pesticides

- Read the label carefully and follow the instructions.
- Make sure you use the correct dosage as indicated on the label and wear protective clothing before handling the pesticides.
- Mix and dilute pesticides as recommended by the manufacturer
- Mix and dilute pesticides in the open and away from water sources.
- Do not mix two pesticides in one pump unless so advised.
- Mix the chemical thoroughly with clean water.
- The mixture should be sprayed the same day it is mixed.

### **6.7.2 Spraying Equipment**

- Use a knapsack sprayer fitted with a hollow cone nozzle recommended for cotton spraying.
- Motorized knapsack-mist blowers may be used for larger areas and dense cotton crop, while ultralow volumes (ULV) applicators should be used with ULV formulations in areas with water problems.

### **6.7.3 Pesticide Application**

- Use efficient spray equipments and ensure that it doesn't leak.
- Pressure the pump to the full before mounting it on your back.
- Use a walking speed of 1metre/second (3ft/second) when spraying.
- Hold the nozzle of the pump about 30cm (1ft) above the crop and ensure a judicious, full cover, spray on both sides of the leaves.
- Avoid spraying when it is raining or when it is too hot. Spray the crop between 4.00 pm and 6.30 pm when the pests are less active.
- If it is windy, make sure your back is facing where the wind is coming from.

### **6.7.4 Precautions during and after Application**

- Always use protective clothing including hand gloves, gum-boots, overalls, nose masks and eye goggles to prevent contamination.
- Never spray, or dust against the wind to avoid spray drift falling on your body.
- When spraying all people not involved, especially children, should keep away.
- Take a bath with a lot of soap immediately after operations involving pesticide.
- Protective clothing should be washed separately from other clothes immediately after use.
- Never eat, drink or smoke when spraying.

- Store pesticides away from children and animals.
- Never store pesticides in food stores or in containers other than the original. For example, don't put pesticide in a soda bottle because children may confuse it for a drink and take it.
- Isolate empty pesticide containers and obsolete pesticides by putting them in a container and contacting the Pesticide Control Products Board (PCPB) through your extension officer for safe disposal. Never use empty pesticide containers for storing sugar, salt etc.
- Contaminated effluent from washing of the equipment and mixing vessels must be disposed off according to National Environment Management Authority (NEMA) recommendations.
- Never wash spray equipment in the river or canals.
- In case of poisoning, see a doctor immediately and carry the label of the used chemical.
- Open a "Spraying Book" to record chemicals applied, level of dilution, the section of farm sprayed and the date you sprayed your farm.
- Don't transport pesticide in the same containers with foodstuffs.

## **6.8 Environmental Consideration**

Cotton production involves the use of toxic pesticides which if not used properly can cause illness or disease. This comes about through contamination of water sources and air pollution, which can adversely affect human beings, domestic animals and wildlife. There is a need to be careful while using or disposing of farm chemicals.

Remember to:

- Use protective clothing during spraying.
- Observe instructions on the labels.
- Observe soil conservation practices such as minimum tillage and planting of trees. (Remember that to have up to 10 per cent of your farm under trees is required as per the law.)
- Apply environmentally friendly technologies throughout the cotton value chain.



*Figure 11: Use Full Protective Clothing during Spraying*

**Spray between 4:30pm and 6:30pm.**

## **7.0 HARVESTING AND QUALITY CONTROL**

### **7.1 Harvesting and Post Harvesting**

Cotton is mainly handpicked in Kenya. Weather conditions immediately prior to harvest have a direct effect on cotton quality especially color and trash content. Seed cotton should be harvested when it is dry immediately after the bolls open to preserve quality. During harvesting, it is recommended to use bags made of cotton material to reduce contamination of seed cotton with extraneous matter. To reduce loss of quantity and quality during harvesting of seed cotton, picking and sorting the cotton into respective grades A and B before bagging is recommended. To achieve this harvesting bags with separate compartments are used.



*Figure 12: LHS Separating grades at harvesting*



*Figure 13: Using Recommended Harvesting Bags*

When picking of open bolls is delayed, it results in the cotton changing colour, which lowers grade. It also increases contamination risks.

## **7.2 Drying**

After harvesting, seed cotton is dried to attain a moisture content of 11% or less before storage using recommended practices preferably on raised platforms.



*Figure 14: Seed Cotton Drying on a Platform*



*Figure 15: Traditional Drying Method (Not recommended)*

### **7.3 Mechanized Harvesting**

Manual hand picking of cotton is a slow and tedious process. Mechanized harvesting involves the use of calibrated mechanized seed cotton pickers. Pickers are of different sizes and sophistication. There are simple hand held, tractor mounted and self-propelled cotton pickers which can be based on the scale of production. Use of mechanized harvesting ensures harvesting is done as quickly as possible when cotton is ready for harvesting to prevent deterioration on fibre and seeds. The technology reduces loss of quality and quantity of cotton and increases labour productivity.



*Figure 16: Hand Held Pickers*



*Figure 17: Mechanized Picker*

## **7.4 Seed Cotton Sorting and Grading**

This is separating seed cotton of different qualities before marketing. After drying and before offering for sale, seed cotton is graded by the grower to clarify its actual value. Proper grading of seed cotton guides on the value of the seed cotton hence the price to the grower. The process starts during harvesting and involves sorting out seed cotton into different grades, currently into grades A and B based on colour and trash content. The sorting and grading process continues in the next stages of drying and storage to refine the grades before it is marketed or ginned. Pre-determined authorized grades from the regulating agency are used in the grading process using grading boxes as reference point.



*Figure 18: Seed Cotton Grading Boxes*

## **7.5 Storage of Seed Cotton, Lint and Seed**

Seed cotton and seed may be stored in the farm store, cotton collection centers, ginneries or in aggregation stores. Seed is stored in bags or in bulk at a moisture content of 7% for quality preservation. Lint is normally stored in warehouses, ginneries and in spinning factory stores. The store should be easy to clean, dry and well ventilated to improve air circulation therefore preserve quality of stored product. Adequate ventilation ensures avoidance of excess moisture build up and rotting of the stored product. It should be proofed against rodents, water leakage and direct sunlight. It is recommended that for ginneries, aggregation stores and lint stores, it is judicious to install fire detection and suppression systems. Establishment of a store monitoring schedule based on prevailing environmental conditions is recommended to reduce post-harvest losses.



*Figure 19: Seed Cotton Storage in Bags*



*Figure 20: Cotton in Cotton Fabric Bags*

## **7.6 Cotton Transportation**

To preserve quality, seed cotton is transported in respective grades A and B. The transportation should be in a clean, dry and well secured to prevent spillage, physical damage, water, direct sunlight, dust and any other contaminants.

## **7.7 Quality Control**

### **Some agronomic practices that preserve cotton quality**

Farmers and extension agents promote good agricultural practices (GAP) in order to preserve quality of cotton. Key practices include:

- i. **Timely planting:** Time of Planting period affects the maturity period by for example shortening the fruiting period. This affects lint quality and yield. It also affects the harvesting period and where it leads to late harvesting it results in losses in yield and quality.
- ii. **Timely weeding and application of herbicides:** Reduces the cotton plant's competition for nutrients with the weeds. This results in healthier cotton crop hence better yields, quality and avoids contamination of the produce.

- iii. **Timely pesticide application:** Insects such as aphids, white flies, cotton seed bugs, cotton stainers cause contamination of seedcotton by excreting honey dew deposits. These deposits require a special ginning process because they normally leave the cotton with a bad smell as well as staining the cotton lint. This affects how marketable your cotton will be.
- iv. **Recommended plant spacing:** This affects cotton quality and yield. When plants are too close, they are prone to diseases. There is also greater competition for nutrients, sunlight and aeration, all which affects quality. That is the reason why you see cotton plants on the edge of the farm doing better than the ones in the centre.
- v. **Applying recommended fertilizer types and rates:** Excess use of nitrogen fertilizers will lead to excessive foliage and fewer bolls, reducing the yield. Deficiency of nitrogen at flowering decreases yield, fibre length and strength. Likewise, deficiency of potassium K affects fibre quality in length, strength and lowers yields.
- vi. **Soil moisture:** Lack of enough soil water results in weak fibres, non-uniform lengths, and increased immature bolls.
- vii. **Harvesting Conditions:** Weather conditions immediately prior to harvest has an effect on the cotton color and trash content, for example, when there is high moisture content.
- viii. **Timing in picking /Delayed picking of open bolls effects:** This can result in the cotton changing colour, which lowers its grade, as well as increases the risk of contamination.

## 8.0 VALUE ADDITION

Value addition is the process of improving quality and returns from cotton by producing different cotton products at different stages along the value chain. Different levels of technology are usually applied in order to enhance quality of product.

Note that value addition is not something that just happens after harvesting of cotton. It is something that happens at all stages of the cotton production, from the farm all the way to processing.

## **8.1 Value Addition at Farm Level**

Farmers and extension officers should promote good agricultural practices (GAP) in order to produce quality products and add value through the practices recommended in this handbook. Key practices include:

- **Timely planting:** The planting period affects the maturity period by for example shortening the fruiting period which affects quality and yield. It also affects the harvesting period by leading to late harvesting, which results in losses in yield and quality.
- **Timely weeding and application of herbicides:** Reduces the cotton plant's competition for nutrients with the weeds. This results in healthier crops and avoids contamination of the produce
- **Timely pesticide application:** Insects such as aphids, white flies, cotton seed bugs, cotton stainers can cause contamination of seedcotton by excreting honey dew deposits. These deposits require a special ginning process because they normally leave the cotton with a bad smell as well as stain the cotton lint. This affects how marketable your cotton will be.
- **Recommended plant spacing:** This affects quality and yield. When plants are too close they have more diseases. There is also greater competition for nutrients, sunlight and aeration, all which affects quality. That is why when you plant cotton, you see the plants on the edge of the farm doing better than the ones in the centre.
- **Applying recommended fertilizer types and rates:** Excess use of nitrogen fertilizers will lead to excessive foliage and fewer bolls, reducing the yield. Deficiency of

nitrogen at flowering decreases yield, fibre length, strength. Likewise, deficiency of potassium K affects fibre quality in length, strength and causes lower yields.

## 8.2 Value Addition at Cottage Level

The processes here involve:

- Hand spinning.
- Weaving, with use of handlooms.
- Knitting.
- Stitching and sewing.
- Tie and dye.
- Training.

While using the above technologies, ensure that the equipment or formulation used is of good quality and finished products meet the required standards. For more information on how to carry out these value addition processes, contact the Kenya Textile Training Institute (KTTI), the Directorate of Industrial Training (DIT), CODA or your nearest extension officer.



Figure 21: Cotton Handloom and Final Products

### **8.3 Ginning**

This is primary processing of seed cotton after harvesting. It is the efficient process of separating lint from seeds by mechanical means in a manner to preserve quality of lint (fibre) and seed using ginning machine to allow for further processing and value addition. For best practice, priority is to start ginning seed cotton of grade A before grade B. To maintain integrity of lint quality, whenever grade B seed cotton is ginned, the ginning system is cleaned before ginning grade A seed cotton. Ginning takes place at optimum moisture content (MC) of seed cotton starting with and careful removal of trash to maintain fibre quality. Apart from storage and ancillary systems, ginning process equipment comprises of seed cotton, lint and seed conveying systems, trash removal machines, gins, lint sample cutter and lint pressing machine.

After ginning, lint produced is pressed into prescribed weights and volume and wrapped using high density polyethylene paper or cotton cloth to preserve lint quality. Cotton lint is pressed into bales weighing between 185 to 220 kilograms. Each grade bales are stored separately to avoid mix up. Bales are then staked on pallets avoiding direct contact with walls. Standard bale labeling requirements are ensured.

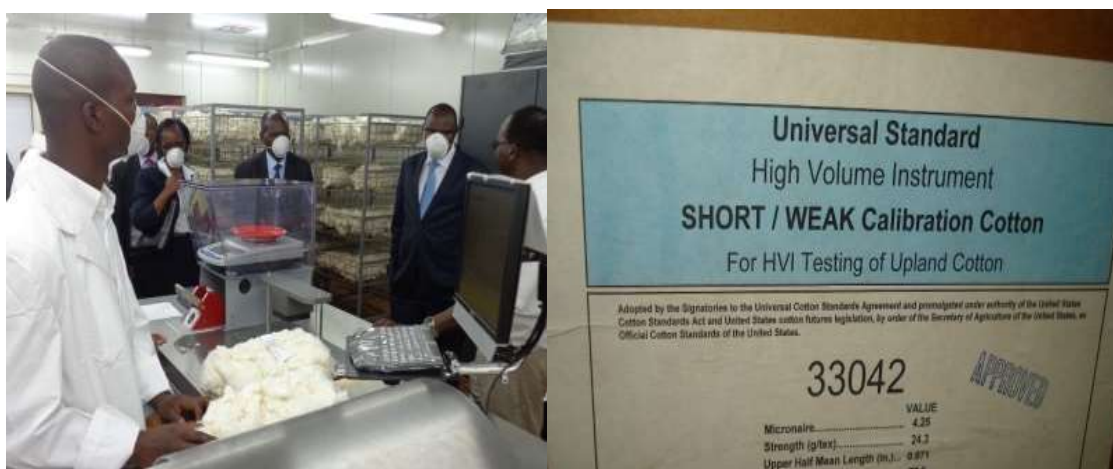
### **8.4 Lint Sampling**

Lint samples are collected from each bale by the ginner during the baling process for quality assessment. The samples are then labeled, packed, transported and delivered to the Authority in accordance to the lint Sample Collection Protocol provided by the regulating agency. Samples collected from other sources are taken in accordance to methods prescribed by Kenya Standard (KS) ISO 1130. Each sample delivered to the Authority for testing shall be preferably 400 grams but not less than 200 grams.

### **8.5 Lint Testing and Classing**

After receiving the lint samples, the Authority tests and classifies the lint by determining its physical attributes using cotton classification instruments. Testing and classing establishes the actual quality of the lint to promote trade, market access and to maintain consumer

confidence. The testing and classing is carried out in accordance to KS 2174 and reports issued to the client.



*Figure 22: Cotton Testing and Classing at the Cotton Fibre Laboratory*

The objective of testing and classing is to eventually integrate the data generated through a National Cotton Classing System with a view to trace cotton to the farmer. The testing and classing services avails actual lint quality data to buyers during trading to mitigate on loss of value of farmers / client produce from subjective quality assessments. This increases the market access for locally produced lint. The system has adopted standardized methods of lint sampling, testing and results reporting in a competent laboratory.

## **9.0 MARKETING**

In Kenya, the marketing of cotton is regulated by Fibre Crops Directorate.

Marketing of cotton in Kenya has the following key elements:

- A minimum guaranteed price is set by stakeholders by taking into account a pricing model pegged on international and local prices.
- Fibre Crops Directorate facilitates stakeholders to meet and designate appropriate locations/sites as buying centres which are then gazetted.

Buying centres are designated for purposes of:

- Quality control.

- Inspection of weighing scales.
- Ensuring storage for seed cotton.
- Observing other trade regulations e.g. cash on delivery of produce, encouragement of farmers to open accounts.

In order to eliminate brokers, ginneries and buying agents are licensed by Fibre Crops Directorate so as to purchase seed cotton. Fibre Crops Directorate also sets a buying window, that is, some specific months of the year during which the produce can be bought.

Market information (such as prices, buying centres, buying window, purchasing ginneries and agents) is also provided to cotton farmers through the mass media e.g. newspaper adverts, websites, coded SMS', radio programmes, and bulletins from Fibre Crops Directorate.

Training is available from Fibre Crops Directorate or other stakeholders on the following:

- a. Principles of cotton production (general husbandry).
- b. Strengthening of farmer groups.
- c. Group approach to marketing/contract farming.
- d. Cotton General Regulations: 2007.

## **Compliance with Trade Rules**

The marketing of seed cotton starts with:

- **Grading:** The farmer is expected to have sorted his cotton before delivery. Grading is a requirement on the farmer.
- **Purchasing:** The buyer buys seed cotton from the buying centre. Purchase is recommended on the payment-on-delivery basis and should be receipted. The buyer should pay the farmer the set price.
- **Pricing:** the price is set by Fibre Crops Directorate and Cotton Value Chain Stake- holders periodically.

- **Payment:** payment-on-delivery.
- **Inspection/Licensing:** the buyer has to have inspection boxes where he identifies his grade AR and BR for comparison by the farmer. The inspector from Fibre Crops Directorate comes in to ensure everybody is playing by the rules.
- **Penalties:** the farmer and buyer are guided by trade rules and any lack of compliance has penalties contained in the Cotton General Regulations, 2007, Legal Notice No.405. If a farmer has a problem, he should discuss it with extension staff or the nearest Fibre Crops Directorate office.



*Figure 23: Training on Cotton during an Open Day*

## **10.0 COTTON FARMING AS A BUSINESS**

### **10.1 Introduction**

The annual domestic demand for cotton lint is 140,000 bales, while currently the country can only produce approximately 6,000 bales (2020 season). This implies that any person with a passion for undertaking farming as a business, seed cotton farming could be a priority choice since there is a ready market for the produce since the amount of cotton lint marketed is often insufficient to fulfill national demand.

Cotton takes on average one year to reach maturity and is essentially a cash crop, mainly used to produce lint, the raw material for production of yarn which is woven to make textile and garments and non-garment products. The demand for cotton never wanes because the need for cotton products is always there.

#### **Factors to consider for increased profitability levels for seed cotton farming**

Cotton is grown mainly in low rainfall areas and usually under rainfed conditions. Currently, cotton is undertaken under irrigation in Bura – Hola Tana delta where approximately 500 acres are under the crop.

Low yields per acre, implying very low gross margins and hence profits is characteristic of majority of the smallholder farmers.

To ensure high profitability, the following factors are necessary to adhere to:

- Ensure early Planting, immediately the rains set
- Follow good agronomic and husbandry practices
- Make sure you enroll in an active cooperative – this will help you to sell your produce as a group and avoid being short changed by middlemen.
- During marketing window, ensure to rally other farmers to harvest the same time and aggregate your produce. This will give an extra coin and improve your returns and profits
- Enter into a Contract with the ginnery who will purchase your crop once

- Maintain highest quality and hygiene for your produce especially during harvest. This will ensure a greater percent of the produce will be the best grade (AR), which has a higher price.
- Use Superior seed provided by the government
- Growing at least 5 acres of cotton will reduce the cost of production

Table 5: Gross Margin Analysis for Cotton Production

**Gross Margins per Acre - under Irrigation (Bura Irrigation Scheme) - Level I Management**

Activity per Acre	unit	cost/unit (Ksh)	total units	Total Amount(Kshs)
<b>Gross Output</b>				
Average Yields kg	<b>Kgs/Acre</b>		<b>2000</b>	
Price	<b>Ksh</b>	<b>52</b>		
Gross Value /Revenue (Price * Yields)				<b>104,000</b>
<b>Variable Cost</b>				
Ploughing				2,500
Ridging				800
Planting	MD	300	5	1,500
Cost Seed	Kg	2200	1.5	3,300
Planting Fertilizer (DAP or NPK)	50kg Bag	3000	1	3,000
Top-dressing Fertilizer (Urea)	50kg Bag	2000	2	4,000
Fertilizer application	MD	300	5	1,500
Weeding 1	MD	300	7	2,100
Weeding 2	MD	300	7	2,100
Weeding 3	MD	300	7	2,100
Pesticides -8 sprays	No.	1000	8	8,000
Canal maintenance(O&M) NIB charges	No.	3400	1	3,400
Irrigating - labour	MD	300	10	3,000
Spraying labour	MD	300	8	2,400
Harvesting per Kg	Kg	10	2000	20,000
<b>Total Value Costs per Acre</b>	<b>Ksh</b>			<b>59,700</b>
<b>GROSS MARGIN PER ACRE</b>	<b>Ksh</b>			<b>44,300</b>
<b>Break Even Price (Ksh)</b>				29.85
<b>Break Even Yield (Kg)</b>				1,148.07

### Gross Margin Per Acre - Cotton Level ii, Rain Fed – Lamu

Activity per Acre	unit	cost/unit (Ksh)	total units	Total Amount (Kshs)
<b>Gross Output</b>				
Average Yields kg	<b>Kgs/Acre</b>		<b>1500</b>	
Price	<b>Ksh</b>	<b>52</b>		
Gross Value /Revenue (Price * Yields)				<b>78,000.00</b>
<b>Variable Cost</b>				
Ploughing		2000	1	2,000
Harrowing		2000	1	2,000
Planting	MD	300	4	1,200
Cost Seed	Kg	2100	1	2,100
Cost of Pesticides	Kg	1500	8	12,000
Planting Fertilizer (DAP or NPK)	50kg Bag	1	3000	3,000
Top-dressing Fertilizer (Urea or CAN)	50kg Bag	1	2000	2,000
Fertilizer application	MD	300	4	1,200
Weeding 1	MD	300	5	1,500
Weeding 2	MD	300	5	1,500
Pesticides - 6 sprays	No.	1000	6	6,000
Pesticides -spraying/application labour	No.	300	6	1,800
<b>Sub-total 1</b>				<b>36,300</b>
Harvesting (per Kg)	Kg	5	1500	7,500
<b>Sub-total 2</b>				<b>43,800</b>
<b>Total Value Costs per Acre</b>				<b>43,800</b>
<b>GROSS MARGIN PER ACRE</b>	<b>Ksh</b>			<b>34,200</b>
<b>Breakeven Price (Ksh)</b>				29.2
<b>Breakeven Yield (Kg/acre)</b>				842.31

## Appendix 1.

### List of Recommended Cotton Pesticides :(PCPB 2021)

<b>Trade Name</b>	<b>Active Ingredient</b>	<b>Local Agent</b>	<b>Uses</b>
ARTEA 330 EC Emulsifiable Concentrate	Cyproconazole 80g/L + Propiconazole 250g/L	Syngenta E.A. Ltd., P.O. Box 30393, Nairobi	Fungicide for the control of rusts and Septoria leaf spot in Wheat; Net blotch, Spot blotch and scald in Barley; Cotton aphids on Cotton. REI: 12 hours Wheat: Codex MRL: Cyproconazole- 0.08mg/kg; Propiconazole- 0.09mg/kg; PHI- 42days Barley: Codex MRL: Cyproconazole- 0.08mg/kg; Propiconazole- 2mg/kg; PHI- 42 days Cotton seed: EU MRL: Cyproconazole- 0.01mg/kg; Propiconazole- 0.05mg/kg; PHI- 35days WHO Class II, Moderately hazardous, Yellow Color Band
ASATAF SP Soluble Powder	Acephate 750g/Kg	Osho Chemical	Insecticide for the control of aphids and thrips on Roses; Aphids, whiteflies & bud worms on tobacco; aphids on cotton, and for the control of armyworms (NOT FOR USE ON VEGETABLES).
BETAFOS 263 EC, Emulsifiable Concentrate	Beta cyfluthrin 12.5g/L + Chlorpyrifos 250g/L	Osho Chemical Industries Ltd.	An agricultural insecticide for the control of thrips, aphids, whitefly nymph and caterpillars on Roses; and aphids in cotton. NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES Application rate: 450-500ml/, repeated after every 7 days. Chlorpyrifos: MRL = 1.0 mg/Kg, PHI = 14 days Beta cyfluthrin: MRL = 0.5 mg/Kg, PHI = 14 days WHO Class II Moderately hazardous Yellow Colour Band
BRIGADE 25EC Emulsifiable Concentrate	Bifenthrin 25g/L	Juanco SPS Ltd.	Insecticide / Miticide for the control of bollworms, aphids, caterpillars & whiteflies in cotton, French beans, barley and coffee; stem borer in barley, and mites in French beans, citrus, roses, cotton, coffee and barley. PHI: Cotton, French beans, Barley, Coffee, Citrus: 3days EU MRLs: Cotton: 0.5mg/kg French beans: 0.01mg/kg Barley: 0.05mg/kg Coffee: 0.05mg/kg Citrus: 0.05mg/kg WHO Class II Moderately hazardous Yellow Color Band.
BULLDOCK 025EC Emulsifiable concentrat	Beta-Cyfluthrin 25g/Kg	Bayer East Africa Ltd.	Insecticide for the control of biting and sucking insect pests in cotton and leaf miner on coffee.

<b>Trade Name</b>	<b>Active Ingredient</b>	<b>Local Agent</b>	<b>Uses</b>
BULLDOCK STAR 262.5 EC Emulsifiable Concentrate	Beta-Cyfluthrin 12.5g/L + Chlorpyrifos 250g/L	Bayer East Africa Ltd.	Broad spectrum insecticide for control of aphids in barley; bollworms, aphids & cotton stainers on cotton. NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES
CYCLONE 505 EC Emulsifiable Concentrate	Cypermethrin 10% w/v + Chlorpyrifos 35%w/v	Osho Chemical Industries Ltd.	Insecticide for control of aphids on cereal aphids and Russian wheat aphids on barley; African bollworm and aphids on cotton; Coffee Berry Borer (CBB) and armyworms. NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES
DANADIM BLUE 40 EC Emulsifiable Concentrate	Dimethoate 400g/L	Pytech Chemicals GMBH Distributor: Farmchem (K) Limited	Insecticide for control of chewing, sucking & biting insects on coffee, cotton, flowers & tobacco NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES
DECIS 0.5 ULV Ultra Low volume	Deltamethrin 5g/L	Bayer East Africa Ltd.	Insecticide for use in cotton, vegetables, cereals, ornamentals, field crops.
DECIS 2.5 EC (Emulsifiable Concentrate)	Deltamethrin 25g/L	Bayer East Africa Ltd.	Insecticide for control of Aphids, Bollworms, Cotton stainers in Cotton; Aphids, Thrips & Whiteflies in Carnations & Roses; Boll worms & Ear aphids on Barley & Wheat; Thrips & Coffee borer in Coffee; Maize stalkborer in Maize; Aphids in Citrus REI: 12hours PHI (Cotton, Barley, Wheat, Citrus, Coffee): 1day EU MRL: Cotton: 0.02mg/kg Barley: 2mg/kg, Wheat: 1mg/kg, Citrus: 0.4mg/kg, Coffee: 0.1mg/kg WHO Class II Moderately hazardous Yellow color band.
DIUREX 80 WP Wettable Powder	Diuron 80% w/w	Amiran (K) Ltd.	Pre-emergence herbicide for control of Broadleaf weeds & Grass weeds in Pineapples, Sugarcane, Coffee, Cotton & Citrus. REI: 12hours Citrus, Pineapples: EU MRLs- 0.01mg/kg; PHI- 60days Sugarcane: EU MRLs- 0.01mg/kg; PHI- 150days Cotton seeds: EU MRLs- 0.02mg/kg; PHI- 60days Coffee beans: EU MRLs: 0.05mg/kg; PHI- 60days WHO Class II, Moderately hazardous, Yellow Color Band
DOMINO 40 EC	Dimethoate 400g/L	Laibuta Chemicals Ltd.	Insecticide for control of chewing, sucking & biting insects on coffee, cotton & tobacco. NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES

<b>Trade Name</b>	<b>Active Ingredient</b>	<b>Local Agent</b>	<b>Uses</b>
DURSBAN 4 EC	Chlorpyrifos 480g/L or 40.8% m/m	Agent: DPP AgroScience (K) Ltd; Distributor	Insecticide for control of Armyworms & Maize stalk borer on Maize; Coffee leaf miner on Coffee; Bollworms, Aphids & Cotton stainers on Cotton; Locust control Public health Larvicide for Mosquito larvae (NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES). REI: 12hours Coffee beans: Codex MRLs: Chlorpyrifos- 0.05mg/kg; PHI- 21days Cotton: Codex MRLs- Cotton seed- 0.3mg/kg; Cotton seed oil- 0.05mg/kg; PHI- 28days WHO Class II, Moderately hazardous, Yellow Color Band
ETHOATE	Dimethoate 400g/L	Pytech Chemicals GMBH. Distributor: Elgon (K) Ltd.	Insecticide for control of chewing, sucking & biting insects on coffee, cotton, flowers & tobacco NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES
FURY 10 EC Emulsifiable Concentrate	Zeta-cypermethrin 100g/L	Juanco SPS Ltd.	Insecticide for RE-EXPORT to Tanzania for use in cotton. NOT FOR USE OR SALE IN KENYA
GRAMOXONE 20 Aqueous solution	Paraquat Dichloride, 200g/L as paraquat ion	Syngenta E.A. Ltd.	Herbicide for use on coffee, tea, bananas, citrus, mango plantations, cereals, sugarcane, cotton, row crops, and maize - minimum cultivation
GRIZLY 175/30 SC Suspension concentrate	Imidacloprid 175g/L + Novaluron 30g/L	Adama Agriculture East Africa Ltd	Insecticide for the control of aphids, whiteflies and thrips on roses and Tomatoes; Tuta absoluta on Tomatoes; as well as aphids on cotton; for the control of aphids, whiteflies, thrips and diamond back moth in Broccoli. Imidacloprid- 0.5 mg/kg Novaluron- 0.01 mg/kg PHI- 14 days WHO Class II Moderately hazardous Yellow color band REI: 6hours Tomatoes: MRLs (EU): Imidacloprid-0.5 mg/kg Novaluron- 1.0 mg/kg PHI: 7 days
HANGTHOATE 400 EC Emulsifiable Concentrate	Dimethoate 400 g/L	Hangzhou Agrochemical Industries (E.A) Ltd.	Insecticide for the control of aphids, whiteflies and African bollworms in cotton NOT FOR USE ON VEGETABLES AND FRUITS Retested on Cotton
HARNESS EC Emulsifiable Concentrate	Acetochlor 900g/L	Monsanto Kenya / Bayer East Africa Ltd.	Pre-emergence herbicide for the control of annual grasses and certain broadleaf weeds in maize, cotton & sugarcane
MARSHAL 250 EC Emulsifiable Concentrate	Carbosulfan 250g/L	Juanco SPS Ltd.	Insecticide/ Miticide for use on maize (pre-plant) for maize stalk borer control; coffee thrips, coffee berry borer, leaf miner, star scale, fried egg scale control, cotton aphid control; citrus - red scale control, flowers against mites

<b>Trade Name</b>	<b>Active Ingredient</b>	<b>Local Agent</b>	<b>Uses</b>
MITAC 20 EC Emulsifiable Concentrate	Amitraz 200g/L	Callikenya Ltd.	Acaricide / Insecticide for the control of mites and white flies in field crops (cotton), fruits, vegetables, ornamentals / Flowers.
MONCEREN GT 390 FS Flowable Concentrate	Imidacloprid 233g/L + Pencycuron 50g/L + Thiram 107g/L	Elgon Kenya Limited	An insecticide / fungicide combination product for seed dressing against early sucking insects and seedling diseases on French beans and cotton.
NURELLE D50/500EC Emulsifiable Concentrate	Cypermethrin 50g/L+ Chlorpyrifos 500g/L	Agent: DPP Agro Science (K) Ltd; Distributor: Lachlan (K) Ltd.	Insecticide for the control of cotton bollworm, aphids and whiteflies in Cotton
OMITE 57 EC Emulsifiable Concentrate	Propargite 57% w/w	Arysta Life science (Kenya). Ltd, P.O. Box 30335-00100, Nairobi.	An acaricide for use on cotton, ornamentals/flowers
POLYTRIN P 440 EC Emulsifiable Concentrate	Profenofos 400g/L + Cypermethrin 40g/L	Syngenta E.A. Ltd.	Foliar, broad-spectrum insecticide for use against insect pests in cotton.
PROSPER 44EC Emulsifiable Concentrate	Profenofos 40% + Cypermethrin 4%	Agrichem & Tools Limited	Miticide/insecticide for the control of Spider mites on Roses; Aphids, African boll worm & Cotton stainer on Cotton. REI: 12hours Cotton seed: EU MRL- Profenofos- 3.0mg/kg Cypermethrin- 0.2mg/kg; PHI- 21 days WHO Class II, Moderately hazardous, Yellow Color Band
PYRINEX 48 EC Emulsifiable concentrate	Chlorpyrifos 480g/L	Amiran (K) Ltd.	Insecticide for use on cotton & armyworm control. NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES
PYRINEX QUICK 256 ZC Capsule suspension & Suspension concentrate	Chlorpyrifos 250g/L + Deltamethrin 6 g/L	Amiran (K) Ltd	Insecticide for the control of Russian wheat aphid and other cereal aphids on Wheat. WHO Class II Moderately hazardous, Yellow color band; for control of aphids and boll worm in cotton EU MRL: Chlorpyrifos - 0.05mg/kg Deltamethrin -0.05 mg/kg PHI: 21 days
RIPCORDER 5% EC	Cypermethrin 50g/L	Topserve E.A Ltd.	Insecticide for use on cotton, coffee, maize, horticultural crops; also for armyworm and locust control.
SHIELD 600 FS Flowable concentrate for seed treatment	Imidacloprid 600g/L	Greenlife Crop Protection Africa Ltd	Insecticide Seed dresser for the control of Russian wheat aphid and Green bug in Wheat; and early pests of Cotton (aphids, whiteflies, mealybugs and jassids); Stalk borer, cutworms, thrips, beetles & aphids in seed maize, aphids in French beans and snow peas EU MRL:0.1 mg/kg PHI- 45 days WHO Class III Slightly Hazardous Yellow color band Wheat MRL: 1mg/Kg PHI:

Trade Name	Active Ingredient	Local Agent	Uses
			120days French beans EU MRL-2.0mg/kg Snow peas EU MRL- 4.0mg/kg
TALSTAR 10 WP	Bifenthrin 100g/L	Juanco SPS,	Insecticide / Miticide for the control of various insect pests and mites in cotton, for control of cereal aphids in barley.
TATA ALPHA 10 EC	Alpha-cypermethrin 10g/L	Osho Chemical Industries Ltd.	Insecticide for the control of Whiteflies on Hypericum; Aphids on Roses; Antestia bug on Coffee; Thrips & Cutworms on Onions; Aphids, Whiteflies, Thrips, Caterpillars, Leafminers on Tomatoes; Thrips, Aphids, Whiteflies & Squash vine borer on Squash; Aphids & African bollworm on Cotton; Whiteflies & Aphids on French beans. REI: 12hours PHI: Coffee, Onions, Tomatoes, Squash, French beans-3days EU MRLs: Coffee, Onions: 0.1mg/kg Tomatoes: 0.5mg/kg Squash: 0.2mg/kg French beans: 0.7mg/kg WHO Class II Moderately hazardous Yellow color band
TERRAMITE 7.52 EC	Tetradifon 75.2g/L	Chemwold Enterprises Ltd.	Acaricide for the control of spider mites on cotton, coffee, citrus, fruit crops, vegetables ornamentals both in the open and in greenhouses.
THUNDER OD 145	Imidacloprid 100g/L + Beta-cyfluthrin 45g/L	Bayer East Africa Ltd.	Insecticide for the control of Thrips, Aphids & Whiteflies on Tomatoes & French beans; Aphids & Whiteflies on Roses & Carnations; Leaf miner & Antestia bugs in Coffee; Aphids, African bollworm, Loopers & Stainers in Cotton; Stink bugs, Tropical nut borer & Red banded thrips on Macadamia; Aphids in Barley; Russian wheat aphids on Wheat; Thrips in Maize REI: 12hours Tomato: EU MRLs- Imidacloprid- 0.5mg/kg ; Beta cyfluthrin- 0.5mg/kg; PHI- 7days French bean: EU MRLs- Imidacloprid- 2mg/kg; Beta cyfluthrin- 0.1mg/kg; PHI- 7days Coffee beans: EU MRLs- Imidacloprid- 1mg/kg; Beta cyfluthrin- 0.1mg/kg; PHI- 7days Cotton seed: Beta cyfluthrin: Codex MRL- Cotton seed 0.7mg/kg; Cotton seed oil- 1mg/kg; EU MRL Imidacloprid- 1mg/kg; PHI- 28days Macadamia nuts: EU MRLs: Beta cyfluthrin- 0.02mg/kg; Imidacloprid- 0.05mg/kg; PHI- 21days Barley: EU MRLs: Beta cyfluthrin- 0.3mg/kg; Imidacloprid-

Trade Name	Active Ingredient	Local Agent	Uses
			0.1mg/kg; PHI- 21days Wheat: Maize: EU MRLs- Beta cyfluthrin- 0.05mg/kg; Imidacloprid- 0.1mg/kg; PHI: 42 days WHO Class II, Moderately hazardous; Yellow Color Band
TIHAN OD 175	Spirotetramat 75g/L + Flubendiamide 100 g/L	Bayer East Africa Ltd	Insecticide for control of thrips, aphids and Tuta absoluta in tomatoes; thrips and aphids on French beans and mealybugs on cotton, aphids in broccoli; for the control of thrips and aphids on snow peas and watermelon; for the control of aphids, whiteflies and thrips in potatoes; aphids and caterpillars in Runner beans REI: 12hours Snow peas EU MRL: Spirotetramat- 1.5 mg/kg Flubendiamide- 1.5 mg/kg PHI- 3days. French beans: EU MRL: Spirotetramat- 1.5 mg/kg Flubendiamide- 0.5 mg/kg PHI- 3 days. Tomatoes: EU MRLs: Flubendiamide: 0.2mg/kg Spirotetramat: 2mg/kg PHI: 7days. Broccoli EU MRL: Spirotetramat -1.0 mg/kg Flubendiamide- 0.01 mg/kg PHI: 14days Runner beans EU MRL: Spirotetramat - 1.5mg/kg Flubendiamide- 0.5mg/kg PHI: 3days WHO Class II; Moderately hazardous; Yellow Color Band
VAPCOTHION EC Emulsifiable Concentrate	Tetradifon 8% w/v + Dicofol 25% w/v (Containing less than 0.1% DDT - related compounds)	Osho Chemical Industries Ltd.	Non-systemic acaricide for the control of red spidermites on Cotton and Roses
ANACONDA 55 EC	Chlorpyrifos 50g/L + Cypermethrin 5g/L	Highchem Marketing Ltd	Insecticide for control of aphids and African Bollworm on Cotton. WHO Class II Moderately hazardous, Yellow band. NOT FOR FOLIAR USE ON FRUITS AND VEGETABLES
FORESTER 150 EC	Fluazifop-p-butyl 150g/L	Greenlife crop Protection ltd	Post-emergence herbicide for control of annual and perennial grasses in cotton, onions, French beans, snow peas and carrots EU MRL: French beans-1.5mg/kg PHI: 31 days Snow peas-1.5mg/kg PHI: 35 days Onions-0.3mg/kg PHI: 44 days Carrots EU MRL-0.4mg/kg PHI-30days Cotton- REI: 12hours WHO Class II, Moderately hazardous, Yellow color band.

<b>Trade Name</b>	<b>Active Ingredient</b>	<b>Local Agent</b>	<b>Uses</b>
BESTOX 100 EC	Alpha-Cyberpermethrin 100g/L	Juanco SPS Ltd.	Insecticide (1) For Public Health use against mosquitoes either as a larvicide or adulticide. (2) For agricultural use - in cotton, for armyworm control.