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FOREWORD

Sisal is mainly grown for fibre production but the by product (boles and bogas) can be converted to animal feeds, bio energy and organic manure, thereby improving the profitability of the crop. The poles produced at the end of the production cycle are used in the construction industry. The crop is also suitable for environmental conservation.

Currently the demand for sisal fibre is on the increase due to emerging uses and increased environmental awareness. Sisal production is mainly undertaken by large scale estates who have vast knowledge on the industry. Smallholder sisal production on the other hand is more informal and majority of the crop is grown along the boundaries and hedgerows. There is huge potential to increase production by the smallholder farmers most of whom have limited knowledge of the industry. There is therefore need to build capacity of sector players along the value chain.

This revised hand book is update of an earlier edition published in 2006 and is intended for use by sisal stakeholders especially farmers and the extension service providers. The content has been enriched through inclusion of new and emerging technical information including emerging uses of sisal fibre and economic analysis of sisal production.

ABBREVIATIONS

ASAL – Arid and Semi-Arid Lands

Ha – Hectares

KALRO – Kenya Agricultural & Livestock Research Organization

KEPHIS – Kenya Plant Health Inspectorate Service

Kg – Kilogram

KSB – Kenya Sisal Board

KWS –Kenya Wildlife Service

MOA – Ministry of Agriculture

PCPB – Pesticide Control Products Board

SGEA – Sisal Growers and Employers' Association

MT – Metric Tonnes

UHDS – Unwashed Hand Decorticated Sisal

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1.0 INTRODUCTION

1.1 Background

Sisal is a perennial crop of the Agave genus, whose botanical name is *Agave sisalana.* The crop is grown for its fibre which is used for making agricultural baler twines, mats and carpets, bags, geotextiles, specialty paper, while bogas (flesh matter) can be used as a supplementary animal feed or as organic fertilizer. Other uses include alcohol and bio-energy generation.

The crop was introduced into Tanganyika from Mexico by Richard Hindorf in 1893 and later into Kenya by the Department of Agriculture in 1903. By 1963 there were 64 sisal estates, covering 102,000 Ha and producing 70,154MT of fibre of which 63,821MT was exported. With the advent of man-made fibres in the 1940s, interest began to shift from natural fibres to the cheaper synthetics, and by the mid-1960s, demand for sisal fibre in the world market started falling steadily. Currently sisal is grown in arid and semi-arid regions of Coast, Eastern and Nyanza covering estimated area of 35,000 Ha with annual production of 26,000MT.

Due to concern for environmental conservation and emerging end uses of sisal fibre such as in paper industry, geo textiles and building industry, the demand for sisal fibre has increased and this trend is envisaged to continue. Current global annual demand for fibre is estimated at 400,000 MT while production is approximately 250,000MT, of which Kenya produces about 25,000MT.

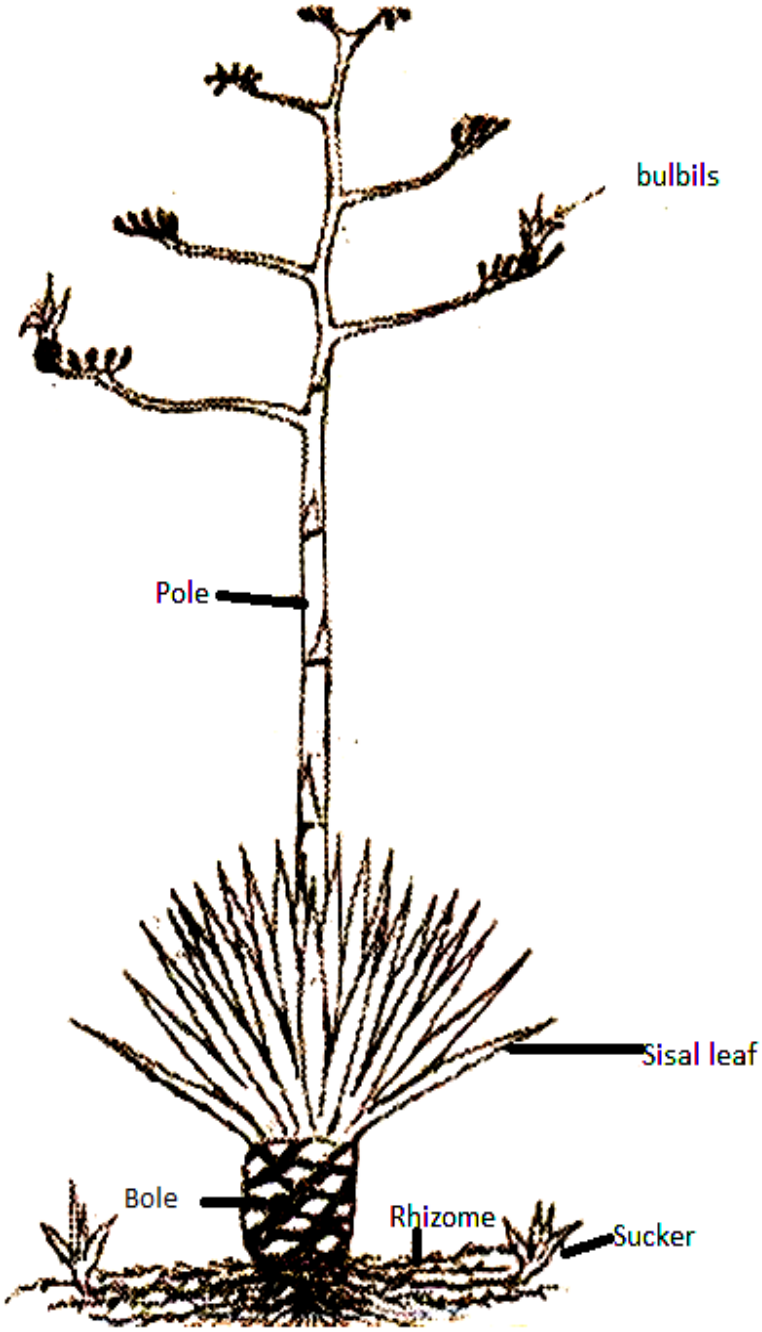
1.2 Comparative Advantages of Sisal Farming

In comparison to other crop enterprises, Sisal farming has the following advantages:

- Sisal is drought tolerant crop well-adapted to hot, dry environments,
- It can grow on land that otherwise may be useless for agriculture.

- There are less pest and diseases which attack this crop and still they would not completely destroy it.
- Sisal can be intercropped with other crops at early stages of establishment.
- Sisal fibre can be stored for long without losing its quality
- Provides employment in rural areas where cottage industries can be established for the production of various products such as ropes, cyondos, mats, and other crafts.

1.3 The Sisal Plant



1.4 Uses of Sisal Fibre

For many years, sisal crop has been grown for its fibre which forms 3-4 % of the plant. The fibre was used for manufacturing twine and ropes, and other hand woven crafts. The uses of sisal plant however, have since expanded. This is as shown in Figure 1 below:-

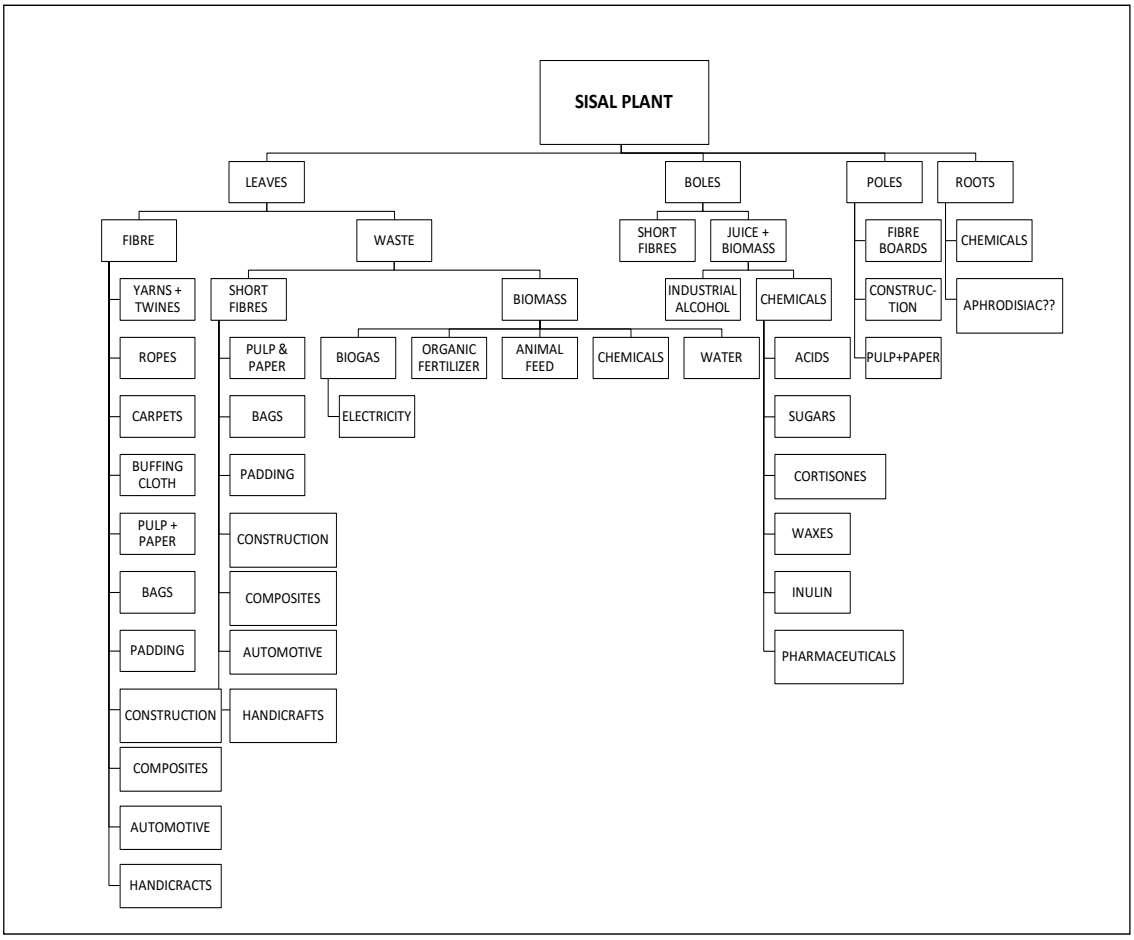


Figure 1: Utilization Sisal Plant

2.0 SISAL PRODUCTION

2.1 Agro-ecological Requirements for Sisal Growing

2.1.1 *Rainfall*

Sisal is a drought tolerant plant and requires 500 – 1200 mm of rainfall, well distributed throughout the year and preferably in a bimodal pattern. Sisal can survive in areas receiving less than 500 mm of rainfall annually. However, the required rainfall is 500 – 1200 mm annually.

2.1.2 *Altitude*

Sisal grows best in areas ranging from sea level to 1800m above sea level but is mainly grown in lower altitude areas 0 – 600m.

2.1.3 *Soils*

Sisal does well in a wide range of soils; from red clay soils, to sandy loams. The soils should be deep, well drained, and of PH range 5.0 - 8.0 with the optimum PH being 6.2.

2.1.4 *Temperature*

Although sisal is a drought tolerant plant and can withstand dry climates, it grows under diverse temperatures ranging from the hot humid coastal regions to the cooler and drier areas in the hinterland i.e. between 16^{o}C and 27^{o}C.

2.2 Other Requirements

It is important the field be accessible by tracks or vehicles for various activities of the farm including ploughing, harvesting and transporting the leaves.

2.3 Land Preparations

Land that has been left fallow for a period should be cleared and the vegetation collected and stacked along the hedges so as to rot. The land is then ploughed and harrowed before planting using machinery or manual implements until medium tilth is attained. This is a moderately compact and firm seedbed which is not cloddy or loose. These operations should be done early enough so that planting is completed just before onset of rains. Ridging is recommended in heavy clay soils because they are prone to water-logging.

The fields should be free of troublesome weeds like couch grass which are hard to control.

It is recommended that for old crop fields when changing cycle, burning of bores and other sisal remains. This helps eradicate pest build up.

2.4 Sisal Varieties

The current commercial varieties are:

- Agave sisalana, which was the original sisal variety introduced into East Africa.
- Hildana, a selected mutant from Agave sisalana.
- Hybrids, which include H11648 and H1300.

Their characteristics are as tabulated below:

Table 1: Varieties & their Characteristics

Varieties	Potential leaf yield (T/Ha/yr)	% Fibre content	Production cycle (Years)	Remarks
Agave sisalana	30	4.5	8-10	Hardy, well adapted and resistant to diseases and water logging.
Hildana	30	3.7 – 3.8	10 - 12	Resistant to diseases though not drought tolerant.

Hybrid 11648	50	4.8 – 5	10 - 15	Susceptible to pests and diseases and water logging, though drought tolerant.
Hybrid 1300	40	4.5 – 4.8	10 – 12	Corrugated leaves hence difficult to decorticate Prone to pests and diseases.

Figure 2: H11648

Figure 3: Agave Sisalana

2.4.1 Advantages of Sisal Hybrids

i) Have a bigger bole with various sugars that can be used to manufacture various chemicals and products.

ii) Produce a thicker pole that is suitable for construction of houses among other uses.

iii) Do not have spines along the leaf edges like Agave Sisalana and their sap does not cause much irritation during decortication.

2.4.2 Disadvantage of Sisal Hybrids

i) Hybrids are heavy feeders requiring adequate nutrient replenishment or relatively fertile soils.

2.5 Planting

2.5.1 Planting Materials

Commercial sisal is propagated vegetatively by means of either suckers or bulbils and materials developed from meristematic tissue culture.

- **Bulbils**

These are miniature plants borne on the inflorescence, or pole, that develops at the centre of a senescing plant (at the end of the production cycle). One pole may produce as many as 3,000 bulbils. When mature they are 6-12 cm long and easily fall to the ground when the pole is shaken. With their rudimentary roots they are excellent planting materials.

Figure 4: Sisal Pole Bearing Bulbils

- **Suckers**

Suckers grow from rhizomes which emerge near the parent (although they may emerge as far as 1.8m away) to form a miniature plant. Sucker production begins about a year after planting and is most prolific during the first half of the production cycle. As many as 20 suckers may grow from one plant during this period.

Figure 5: Sisal Plant with Suckers around its Base

- Meristematic Tissue Culture

In vitro, MTC plantlets constitute an alternative route for micro propagation. They are developed from culturing of apical meristems located at the tip of the plant or auxillary meristems located at the axil of leaves. MTC involves promoting the development of already existing organized regions whose function is precisely to form new shoots. Rooted plantlets are transferred into the greenhouse for acclimatization before being transferred into an open nursery for hardening.

Figure 6: MTC sisal shoots in the laboratory

2.6 Comparison of Bulbils and Suckers as planting materials

Table 2: Advantages and Disadvantages of Bulbils vs Suckers

Planting material	Advantages	Disadvantages
Bulbils	1. Easily sorted and graded, therefore used to establish fields with uniform size and maturity period. 2. Easier to collect and transport.	1. Takes longer before transplanting (at least 12-18 months). 2. They are produced only at the end of the production cycle. 3. Expensive to establish.
Suckers	1. Always available in sisal farms. 2. Takes a shorter time for the first harvest. (No nursery operations).	1. Commonly attacked by pests and diseases. 2. Fields lack uniformity in age and size since they are hard to grade. 3. Collection, transport and establishment costly. 4. Crop established have a shorter production cycle.

2.7 Nursery Establishment and Management

Nursery bed should be prepared to a fine tilth on free draining soil.

- Select bulbils from oldest healthy sisal fields.
- These bulbils (usually 6-12 cm in size) are sorted into equal sizes to ensure uniformity in growth, eliminating diseased ones. They are then dipped in recommended fungicides to prevent attack from fungal diseases.
- The various sizes are planted in different blocks.
- 20-50 MT/Ha of organic manure or decomposed sisal waste, incorporated in the nursery before planting. At planting apply recommended fertilizers depending on the soil analysis results from the fields.
- The bulbils are planted at a spacing of 50 cm between rows and 25 cm between plants (population density of 60,000 - 80,000 plants/ha) which is enough to establish 22-25 ha of field sisal.
- In case of signs of sisal weevil attack, spray the seedlings with recommended insecticide.

- In the nursery, the plants stay for 12-18 months when they attain a height of 40-46 cm (weighing 1-2 kg) and are ready for transplanting.
- Under irrigation, the bulbils can be ready for transplanting in 12 months.
- The nursery should remain free of weeds since young sisal bulbils are very sensitive to weed competition. This can be done by use of herbicides, hand tools or directly pulling out the weeds.

Figure 7:Nursery ready for Transplanting

2.8 Field Establishment

- It is recommended that planting is done before onset of rains.
- The bulbils are lifted from the nursery and graded into equal sizes to be planted in various fields. This sorting is necessary to ensure uniform establishment so that the crop matures uniformly.
- Once uprooted the roots are trimmed. This encourages faster development of new roots.

- The plants are then left to cure in the sun for 2-4 weeks before transplanting but not in heaps to avoid rotting.
- The planting material should be 40 -70 cm weighing 1 - 4 kg
- Sort out the planting materials so that same size of are suckers are planted in the same field.
- Before planting, the materials are dipped in fungicides and insecticides, recommended by PCPB, to prevent insect and fungal attack.
- Planting should be done using manual implements and preferably 4 – 6 weeks before onset of rains to enable sisal derive most benefits and take advantage of nitrogen flush
- For suckers, it is recommended to tie the leaves together around the central spike. This requires a little more labor but plants are then more convenient to transport and transplant. It also allows for first weeding to be done with ease and thereafter, the strings are cut or disintegrate naturally.
- Depending on the size of the sucker, the planting hole should be shallow to allow only the roots to fit well.

Figure 8: An Estate Worker Planting Sisal

2.8.1 Spacing and Planting Depth

When planting, remove the dry leaves surrounding the rooting base and plant in shallow holes where the roots of bulbil nursery material fits well. The correct planting depth depends upon the size of the plant, normally, 6-8 cm is sufficient for plants that are 35 cm – 40 cm tall.

The recommended spacing depends on whether the operations on the farm are mechanized or manual. Mechanized operations require wider spacing as shown below

a) Double row spacing	Population (plants/ha)
- 4m x 1.2m x 1m	3,846
- 4m x 1m x 1m	4,000
- 4m x 1m x 0.75m	5,333
- 4m x 1.25mx 1.25m	3,040
- 3.75m x 1.25m x 1.25m	3,200
- 3.5m x 1.5m x 1.315m	3,040
- 3.1m x 1.5m x1.5m	2,900
- 3.0m x 0.7m x 0.7m	7,700

Figure 9: Double Row Spacing

Figure 10: Single Row Spacing

b) Single row spacing (mechanized)	**Population (plants/ha)**
- 3.5m x 0.95m	3,000
- 3.0m x 1m	3,333

c) For smallholders, the spacing recommended is 1.25m between plants and 2.5m between rows (2.5m x 1.25m), giving a population of 3,200 plants/Ha.

2.9 Intercropping

Intercropping sisal with food or cash crops in the first 2-3years helps to offset the costs of establishment and maintenance. The intercrops are planted between the sisal rows at 1-1.5m from the nearest row of sisal.
Other uses of intercrops include suppression of weeds and provision of soil cover hence reduction of soil erosion.

Crops that do not shade the young plants and add nitrogen to the soil are recommended. These include deep-rooted legumes e.g.
i) Brown Dolichos lablab
ii) Pigeon peas
iii) Cowpeas
vii) Beans
viii) Velvet and Soy beans

Other recommended crops include: -
i) Early maturing maize varieties,
ii) Sorghum,
iii) Millet,
iv) Cotton and
v) Aloe vera (use recommended varieties)

The following crops should not be intercropped with sisal:-
- All Perennial crops like bananas, coconut, sugarcane, cashew nuts etc – their shade affects the sisal crop
- Root crops like cassava, sweet potatoes, - their harvest may interfere with the root system of sisal

2.10 Soil Nutrient Amendments (Fertilizer Application)

The application of commercial fertilizers on sisal is not a common practice in sisal farming, mainly because it affects the profitability of the crop. Nitrogenous fertilizers, in particular, increase yield of leaf flesh without increasing fibre yield.

Sisal does well in fairly arid conditions and in soils left fallow for some time. However, soil fertility declines drastically affecting fibre yield after 3-4 cycles of production. Application of 40-120MT/ha of sisal waste is very beneficial to the crop and increases yield by up to 32%.

Fertilizer application in general should be done after soil tests have been carried out to establish the specific nutrient deficiencies.

2.11 Sisal Field Maintenance

2.11.1 Weed Control

Weeds on young sisal plantations compete for water and nutrients and must be removed. Their control also reduces the incidence of pests and diseases that affect sisal.

During the first 3-4 years, weeding should be done as need arises. Weeding is done by hand, mechanical, grazing or by use of herbicides. Weed control can also be done using cover crop. The method used should not injure the crop or cause damage to the environment.

For weed control using herbicides, recommended products by PCPB should be used. The table below shows some of the PCPB recommended herbicides in sisal.

Table 3: PCPB Recommended Herbicides in Sisal

Trade name and type of formulation	Registration Number	Active ingredients (Common name/s)	Uses
BASTA 20 SL Water Soluble Liquid	PCPB(CR)0164	Glufosinate - Ammonium 200g/L	Herbicide for the control of grass and broad-leaved weeds in crop land and shrubs in non-crop land.
GESAPAX COMBI 500 FW (Flowable)	PCPB(CR)0142	Atrazine 235g/L + Ametryn 245g/L	A broad spectrum herbicide for annual weed control
HYVAR X WP Wettable Powder	PCPB(CR)0072	Bromacil 80% m/m	Herbicide for weed control in sisal, non-crop areas and railroads.

Subsequent years, the fields should have a grass-cover checked by slashing or targeted chemical weeding using Glyphosate.

2.12 Pests and Diseases

Pests and disease control may be done using cultural and chemical methods.

Agave sisalana is relatively free from pests and diseases, though sisal weevil is a major pest of economic importance. Hybrids are more susceptible to pests and diseases. Where required, the choice of pesticides and fungicides should be determined by the results of pest and disease scouting and as recommended in the Pest Control Products Act, Cap. 346 of the Laws of Kenya.

The table 4 below show some common pests and diseases, their symptoms and control measures.

Table 4: Sisal Pests, Symptoms & Control

Pest	Symptoms	Control
Sisal weevil (Scyphophorus acupunctatus) 	Damage starts at the nursery. The adult weevil bores into the bole of the young plant making a tunnel. Rotting ensues and the plant dies. The adult weevil feeds at the axils of the upper most leaves, adjacent to the growing spike leading to staining of the fibre. Damage is also a result of egg-laying at the base of the spike, where larvae eat through the leaves causing a spiral of holes.	- Cultural control: use of non-infected planting material, removal of dead boles and avoid contaminated fields. - Use of guard rows (trap crop) supported by placing split boles whose cut surfaces are dusted with insecticide to reduce infestation. - Chemical control: application of insecticides
Scales 	Aphids are soft-bodied insects that use their piercing sucking mouthparts to feed on plant sap. Aphids produce large amounts of a sugary liquid waste called "honeydew". A fungus can grow on honeydew deposits that accumulate on leaves and branches, turning them black.	Early detection is the key to reducing aphid infestations Most products used for aphid control work as contact insecticides. This means that the aphids must be hit directly with spray droplets so that they can be absorbed into the insect's body. Nervous system insecticides, such as malathion, Dursban (chlorpyrifos), and Orthene (acephate), are recommended.
Pigs, baboons, elephants Monkeys, and livestocks	Damage the centre of the growing spike, stunting growth.	Trapping and scaring. Seek assistance from KWS.

Table 5: Sisal Diseases, Symptoms And Control

Disease	Symptoms	Control
Korogwe leaf Spot	Tiny spots which develop into corky grey brown circular scab-like spots	Cultural measures; maintaining clean fields, soil fertility management, and use

Disease	Symptoms	Control
	on leaves, on both lower and upper surfaces.	of clean planting material. Use recommended fungicide.
Bole rot (Aspergillus niger or Pythium/Phytopthora) 	Soft or yellowish rot at leaf bases which gradually girdle the bole. Affected leaves collapse, and turn yellow, while the bole rots completely.	Application of calcium-rich fertilizers and in water-logged or highly acidic soils, agricultural lime must be added. Use recommended fungicides such Ridomil
Zebra disease (Phytopthora nicotianae) 	Stripped lesions on the leaves and rotting of the bole and spike.	Prevent any part of the plant from contact with surface drainage water.
Dieback disease	Leaves turn purple, leaf tip dieback starting at the	Causal agents not known though

Disease	Symptoms	Control
	spine, spreading downwards.	probably related to phosphorus deficiency.

2.13 Harvesting

Harvesting of leaf should be done at most bi-annually per plant depending on variety and age. A typical plant will produce 200-250 commercially usable leaves in its life-time (hybrid varieties up to 400-450 leaves).

The onset of the cutting cycle depends on the growth rate of the plants, which is dependent on:-

- Amount of rainfall and distribution during the growth of the crop
- Soil type and fertility
- Sisal variety
- Planting material used – bulbils or suckers
- Management practices on the crop

In general, leaf cutting starts 2-3 years after planting in the farm

Thereafter harvesting will continue for a period of 8-15 years depending on variety. The general practice is to cut all leaves below those which point upwards at an angle of about 45 degrees. The plant will have produced 30 – 65 leaves at this point.

Figure 11: Sisal Plant ready for the First Cut

Cutting is done all year round except in wet weather, when drying of fibre and transport of leaf to processing plant is difficult.

This operation affects plant growth and total production. When cutting the following should therefore be observed;

i) Delaying the first cut from 2-4 years results in reduction of fibre. This is greatest in fast growing crop. It also promotes early polling meaning heavy losses in production.

ii) Early cutting on the other hand increases fibre yield irrespective of population density.

iii) Severe leaf cutting causes the reduction in leaf weight, fibre content and could stunt the plant

2.13.1 Leaves to be cut

Plants ready for cutting usually have a height of 1.25 m with at least 60 leaves. The general practice is to cut all leaves below those which point upwards at an angle of about 45^{o} and at least longer than 60 cm.

At initial harvest, the lowest leaves (sand leaves) which do not produce useful line fibre should be cut and discarded.

2.13.2 Leaves not to be Cut

For Agave sisalana, 30 leaves should remain uncut during the initial harvest.

Subsequent harvests 20 leaves should be left uncut and incase of prolonged drought periods 30 leaves should be left.

For H 11648, a total of 70 leaves should remain after the first cut and 60 for subsequent cuttings.

2.14 How Leaf Cutting is Done

Sisal leaf cutting is done with a special small knife with a straight blade (See figure 9). The knife should be sharp enough and of approximately 18 cm or more. A *Panga* or a blunt knife should not be used.

Figure 12: Sisal Harvesting Knife

Each leaf is cut at least 3 cm near the base of the stem, after the spine has been removed (if not it is removed immediately).
The cut leaves are tied into bundles of 25 or 27 leaves.

The cutter's daily task is cutting, bundling, tying and pilling one metre of leaves at the field-road. A total of 100 or 110 bundles make one leaf metre (2700 leaves). One leaf metre weighs approximately one tonne. Generally, 25 leave meters (67500 leaves) will yield approximately one MT of fibre, though these will depend

on the age, size and variety of the crop and the decortication of the corona. It is recommended that field and corona tests are undertaken regularly.

The next cutting is done 10-12 months later. Hybrid 11648 is cut every 6 months in the first 5 years, and then 7-8 months thereafter, whereas for *Agave sisalana* the frequency of 10-12 months is maintained throughout.

The cutting frequency depends on variety and this continues until poling.

2.15 Precautions when Cutting

In order to maintain high quality of fibre, the following precautionary measures are necessary.

- Cut leaves must be shielded from direct sunlight
- Leaves must be decorticated within 24 hours for better fibre recovery and quality maintenance.
- To avoid diseases like boll rot, it is advisable not to cut the leaf so close to the stem
- Overcutting should be discouraged as it causes the plant to be stunted

Figure 13: Overcut Sisal Plant

3.0 PROCESSING

Sisal line fiber is found in the fleshy tissue of the leaf. Separation of this fibre from the flesh tissue (about 95-97% of leaf weight) is called decortication. On average, about 3-5 % of the leaf is extracted as fibre, of which extract 85% is recovered as line fibre. The rest is either lost or recovered as flume tow.

3.1 Methods of Decortication

There are two types of decortication methods, **the wet** (which involve introduction of water during decortication for cleaning fibre and washing away byproducts) and **the dry (**where the fibre is extracted without using water). For best practice, the fibre should immediately be washed after decortication to improve its quality

3.2 Equipment used for Decortication

i) Coronas

- These are wet decortication equipment with capability for huge output production of fibre.
- The leaves are passed through the decorticators by a conveyor belt system and ropes that grip the ends of leaves and feed them into the machine,
- The leaves are fed in at right angles to the line of flow,
- Each decorticator has two drums; one decorticates the butt end, and the other the tip,
- Much water is needed at this stage, to wash the fibre and carry away the waste,
- The decorticator runs most of the year in order to achieve an annual output of 1200- 1500MT of fibre. This amount of fibre is produced from 40,000-50,000MT of leaf, and on average this is supplied from about 1,200 ha of field sisal

Figure 14: A Corona in Action

ii) Raspador

- This is a dry decorticating equipment
- A Raspador has a beating drum and a concave
- The leaf is introduced by hand into the gap between the drum and concave at right angle to the drum.
- The butt end is first fed into the raspador, the other end being held by the operator.
- The half decorticated leaf is then removed and the tip is fed into the machine, while the operator holds onto the fibre of the butt end.
- Improved raspador can process upto 2MT of leaves (5400 leaves) giving about 80kgs of fibre
- The raspador-processed fibre needs to be washed before drying so as to improve the quality.

Figure 15: A Stationary Raspador in the Field

iii)Hand Decortication

- This is a traditional dry decortication method. The method encourages sisal harvesting from the growing points which are soft, immature and easy to decorticate. This should be discouraged as it kills the sisal plant
- Mature Leaves are split into longitudinal strips and are decorticated by pulling them between a wooden piece and a metal blade set into a frame. To improve the quality, hand processed fibre must be rinsed immediately before drying.

iv) Mobile Decorticator

Figure 16: Mobile decorticator

3.3 Important Issues to Consider after Decortication

In order to maintain high fibre quality it is important before drying the fibre to ensure the following:-

- Hang fibre so that all the water drops to the ground
- Use adequate clean water during decortication and after depending on the method of decortication
- If water is unavailable, then spread the fibre immediately after decortication on the hangers
- Maintenance of the coronas is important so that the no leaf parts remain inside the machine during decortication.
- To ensure no much loss in the fibre, sort out the fibre waste and separate the fibre from the other waste.

3.4 Drying

- After decortication the fibre is taken to the drying ground where it is spread over galvanized wires. Lines of three parallel wires, with the central one slightly raised, are used to prevent kinking of the fibre.
- For best quality, fibre must be dried to a moisture content of 10%. Sun-drying is done for 6-8 hours. Drying for longer hours lowers the quality of the fibre.

Figure 17: Sisal Drying Lines

3.5 Brushing

- Before baling, sisal must be brushed to remove hanging impurities and to impart a shine to the fibre...
- Brushing also frees individual fibres from each other and removes the short fibres, which are called tow.
- A Brushing machine contains revolving metal beaters; hanks of fibre are fed into them by hand, one end first and then the other.

Figure 18: Sisal Brushing Unit

3.6 Grading

Grading is done for marketing purposes as different grades attract different prices. This is the process of separating the brushed fibre into various categories according to length, color and presence of impurities, length being the predominant character. Grading is a continuous process that starts from leaf cutting, when leaves are sorted into similar sizes.

Below shows a list of grades as defined by East African Sisal Growers Association and the London Sisal Association:

Table 6: Grades Description

Grade	Description
No. 1	Length from 3ft. upwards, average 3ft. 6in. Free of defective decortication, properly brushed free of tow, tousled and bunchy ends, knots and harshness. Color creamy-white to cream.
No. 2	Length from 2ft. 6in. upwards. Free of defective decortication, properly brushed, free of tow, tousled or bunchy ends, knots and harshness. Color creamy-white to cream.
No. 3	Length from 2ft. upwards. Brushed fibre with minor defects in cleaning permissible, but must be free of tow, knots, barky or undecorticated fibre. Color may vary from creamy-white to yellowish, but a higher proportion of spotted or discolored fibre is permissible.

Grade	Description
3L (3 Long)	Length from 3ft. upwards. Brushed fibre with minor defects in cleaning permissible, but it must be free of tow, knots, barky or undecorticated fibre. Color may vary from creamy-white to yellowish but a higher proportion of spotted or discolored fibre is permissible.
UG (Under grade)	Fibre that does not conform to the above grades as regards color, cleaning and length. Defects in cleaning, some imperfectly decorticated fibre or barky runners allowed but must be free from undecorticated leaf and knots. Length must not be less than 2ft.
S.C.W.F. (Short clean white fibre)	Length from 18-24in. Free of defective decortication, properly brushed, free of tow, tousled and bunchy ends, knots and harshness. Color creamy-white to cream.
U.H.D.S. (Unwashed hand decorticated sisal)	Shall not be graded in accordance with sisal grading definitions, but shall be sold by sample.
Tow 1	Proper tow from brushing machines. Free of line fibre cuttings, dirt and reasonably free of dust but entirely free of sweepings, knots, barky or undecorticated fibre. Color creamy-white to cream.

3.7 Baling

- Baling and packing are aimed at achieving the lowest possible volume, in order to realize savings on freight charges, while facilitating ease of handling. Sisal fibre is therefore baled under great pressure to achieve high density (1.7m^3/T).
- In the baling process, bales are labeled indicating the grades, origin, date, and mark of the producer.
- The Standard bales are normally in units of 100kg, 200kg and 250kg.

Figure 19: A bale of Sisal

3.8 Labelling

The bales shall be labelled legibly and indelibly in accordance to KS 1829 with the following information.

a) product name;

b) grade;

c) trade mark of the producer;

d) country of origin;

e) bale number;

f) date of production (baling); and

g) bale net weight in kilograms.

NOTE: The label should preferably be made from natural fibre fabric. Where ink is used for labelling, it should not penetrate to the fibre to avoid contamination.

3.9 Storage

Storage space should be sufficient to store fibre waiting for brushing, already brushed fibre and bales waiting for transportation to the port of export. The storage facility must have adequate ventilation and should prevent water from entry. The bales should be stored properly to avoid direct contact with walls, bare floor, and any other contamination. The bales should not be stored for a very long period.

4.0 MARKETING OF SISAL FIBRE

There are both local and export markets for sisal fibre. Up to 90% of the sisal fibre produced in Kenya, mainly from Estate farms is exported to over thirty overseas destinations worldwide. The export markets include Saudi Arabia, Nigeria, China, Spain, Egypt and Morocco among others. Most of the smallholder farmers' fibre is locally sold to processing factories for manufacturing of dartboards, sacks, bags and cordage for local and export markets.

Prices of sisal fibre is influenced by quality levels, global stocks and fluctuation of the exchange rates. In addition, sisal fibre prices may be affected by the cost of other fibres, price offered for sisal fibre produced in other countries, demand and supply forces.

The base price of sisal fibre is determined by the prevailing global market price and contracts between buyers and sellers to ensure transparency in compliance with the Crops Act and communicated to the players in the industry by the Authority.

Retailers for sisal fibre in the domestic market are registered and licensed by Agriculture and Food Authority through the Fibre Crops Directorate. Exporters and

importers are also registered and licensed by the Authority through the Directorate for overseas destinations (*see Annex 1 Contacts for licensed exporters/importers for sisal fibres*).

4.1 Sisal Fibre Products

Apart from marketing of raw fibre, the fibre can be processed into various products at bag and cottage industries or at cottage industry level. The products are marketed locally or exported to various destinations in the world.

4.1.1 Traditionally end uses

Agricultural baler twine, gunny bags, and general cordage (coffee drying cloth and tying twine). Others include ropes, mats and carpets, dartboards, handicrafts.

Table 7: Traditional uses of sisal fibre

Baskets - hand woven baskets (cyondos)	
Ropes and Twines - hand made and baler twine	
Mats and carpets - carpets and mats	 

4.1.2 New End Uses

Geotextiles, stabilization of soil blocks, reinforcement of plastics, pulp for paper manufacturing, insulation of buildings and reinforcement of concrete and plaster.

In recent years, sisal has been utilized as a strengthening agent to replace asbestos and fiberglass and is increasingly a component used in the automobile industry, where its strength, "naturalness" and environmentally friendly characteristics are greatly appreciated.

5.0 RETURNS FROM SISAL GROWING

5.1 Smallholder Production System

Under smallholder, sisal farming as an enterprise requires 20 hectares of the crop to take advantage of economies of scale and make reasonable profit. This will sustain decortication with a raspador machine throughout the year.

Cost of establishing sisal, 1 ha from Suckers

To establish one Ha of Sisal the total Establishment cost in the first 3 years will be Ksh 50,500. These costs will include Nursery management, land preparation and transplanting the bulbils from the nursery as shown in shown in Table 8. It is assumed that the farmer will use bulbils and not suckers as planting material. The suckers are sourced from the existing commercial sisal nursery.

Table 8: Cost of Establishment 1 ha

ITEMS	year 1	year 2	year 3
Land preparation			
1st ploughing per ha	6,000		
*Cost of planting material @10/- x 3200	32,000		
Transplanting @ 500 x 25 MD	12,500		
Subtotal 1	**50,500**		

*Plant population is 3,200 plants/Ha at a spacing of 2.5m x 1.25m

Nursery, transplanting Maintenance, Harvesting and Processing

Table 9 shows all the costs including nursery upto processing for ease of calculations, in 1 ha. It is assumed that the farmer will purchase a mobile decorticator for decortication in the third year. This will be investment cost and hence not factored in the costing.

Table 9: Maintenance, Harvesting and Processing

Maintenance	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8	YR 9	YR 10
Nursery	50500									
1st weeding	3000	3000	3000							
Slashing			0	1500	1500	1500	1500	1500	1500	1500
Harvesting and processing										
Labour for cuttings per year (yielding 30tons of sisal leave)			9000	9000	9000	9000	9000	9000	9000	9000
- transporting the leaf for decortication*										
- Decortication (cost of fuel for machine)			12000	12000	12000	12000	12000	12000	12000	12000
- Decortication (labour for running the machine)			13500	13500	13500	13500	13500	13500	13500	13500
- Water for washing the fibre			1000	1000	1000	1000	1000	1000	1000	1000
- Motorized Decorticator (maintenance)					1000	2000	2000	2000	2000	2000
transport(fibre to market)										
sub- total	**53,500**	**3,000**	**3,000**	**37,000**	**38,000**	**37,000**	**13,500**	**39,000**	**39,000**	**39,000**

Note

* No need to transport leaf since decortication will be done at farm level

The Fibre will be sold at Farm gate - hence no need of transport

5.1.1 Expected returns

Under good management, harvesting can continue up to 15th year when the crop will reach the end of its productive period, however, due to genetic degradation of the source of planting material, 10 years has been used as the average production cycle.

Return to investments will be realized in the third year of Ksh 78,000 and positive net income inflows in the following years for this enterprise as shown in table 10 below.

To ensure maximum returns from the investment, in the first to the fourth year, intercropping the sisal field with other crops to maximize the returns from the farm is recommended.

Table10: Expected returns (Gross & net)

OUTPUT	year 1	year 2	year 3	year 4	year 5	year 6	year 7	year 8	year 9	year 10
Annual Gross INCOME-Yield/ha - 1000 kg @ 80/= /kg*			80000	80000	80000	80000	80000	80000	80000	80000
Sale Poles- 3200 @ kshs 50 per pole										
sale of tow - @ kshs 30 per Kg			1000	4500	4500	4500	4500	4500	4500	4500
A: Total Annual Gross output	0	0	81000	84500	84500	84500	84500	84500	84500	84500
B: Total Annual Costs	**53500**	**3,000**	**3,000**	**37,000**	**38,000**	**37,000**	**13,500**	**39,000**	**39,000**	**39,000**
Annual Net Income/ Ha **(A-B)**	-53500	-3000	78,000	47,500	46,500	47,500	71,000	45,500	45,500	45,500
Cumulative Net income	-53500	-50,500	27,500	75,000	121,500	169,000	240,000	285,500	331,000	376,500

Gross Margin/Year/Ha = Ksh 37,650

Gross Margin Per Ha per Year = Ksh 37,650 (Assumes market interest rates are constant through the years – Discounting of the 10th year income has not been factored)

* The fibre will be sold at farm gate price of Ksh 100/= per Kg. This is ungraded hand decorticated Sisal (UHDS) grade

5.2 Sisal Estate Farms Production System

Sisal Production systems in Estates are organized and efficiently managed in comparison to smallholder farmers' farms.
The operations are predetermined and well planned, basing operations on daily targets set for fibre production.

After harvesting, the leaves are transported to a central factory and decorticated to extract the fibre. Wet decortication is used during extraction. A lot of water is introduced to extensively wash the fibre during this process followed by sun drying of the fibre. Thereafter fibre is brushed to separate and align the individual strands of fibre, then graded and packed into bales.

The following parameters are key and very important in day to day operations in sisal Estates:

a) No. of leaf metres cut daily – this will determine the approximate quantity of fibre per day even before decortication starts.

- One leaf metre is between 2500-2700 leaves and is about 1 ton. A total of 25 leaf metres (67500leaves) will yield approximately one MT of fibre.
- Sisal leaf cutters are paid per leaf metre, hence labour cost for harvesting easily determined.

b) Sisal decortication is centrally done in a factory. The leaves are transported from the farm to the factory by use of tractor drawn trailer

c) The factory has the following units

- The decortication unit – this is the main processing unit where sisal fibre is separated from the green matter by use of huge decortication machines known as Coronas. Water is introduced during this process to wash the fibre, after which it is carted away to the drying lines. At least 6 people are required in this unit
- Brushing unit – the dry fibre is brushed using brushing equipment. Four people required for each machine
- Sisal grading unit – various grading boxes are used isolate various grades from the brushed fibre
- Baling unit- graded fibre is mounted on the pressing unit which compresses the fibre into the minimum sisal possible. At least four people are required.

The following factory costs have to be considered for accurate calculation of returns from sisal

i. Transportation of sisal leaf from farm to factory
ii. Transportation of sisal fibre from factory to the port for shipment
iii. Labour for decortication, (number of ton per machine in a day), brushing, grading and baling
iv. Cost of water in decortication
v. Cost of electricity in brushing and baling

Table 11: Cost of Nursery Establishment

ITEMS	year 1	year 2	year 3
Establishment costs			
Nursery establishment(rainfed)			
- Transportation of bulbils	2500		
- Land preparation for nursery - 0.1 acre	1000		
- Curing the bulbils			
- Insecticides	500		
- Fungicides	500		
- Uprooting & replanting in blocks-sorting	600		
- Weeding	1000	1000	1000
- Top dressing with CAN- labour	500		
- Fertilizers	0		
- CAN	500		
- DAP	600		
Field establishment for Nursery			
- Land preparation			
- 1st ploughing per ha		5000	
- 2nd ploughing per ha		4500	
- Transplanting			
- Lifting the bulbils & tying them		1000	
- Planting		3000	
total costs(ksh)	**7700**	**14500**	**1000**

Note: To establish a nursery of bulbils enough to plant 1 ha, you need 3200 bulbils which can be planted in an area of 400m^2 i.e. 0.1 of an acre.

5.3 Maintenance, Harvesting and processing

Two harvestings can be achieved under good management, yielding 50MT of green leaf. It is estimated that 4% of the leaf is what constitute the fibre (in our case it is 2MT of fibre). The table below shows the cost of maintaining 1 ha of sisal, harvesting and processing. It is assumed that the farmer will purchase a mobile decorticator for decortication in the third year.

Table 12: Maintenance, Harvesting and Processing

Maintenance	yr 1	yr 2	yr 3	yr 4	yr 5	yr 6	yr 7	yr 8	yr 9	yr 10
1st weeding	2250	2250	2250							
2nd weeding	2250									
slashing			0	1500	1500	1500	1500	1500	1500	1500
Trimming sand leaves			5000							
Harvesting and processing										
2 cuttings per year			20000	20000	20000	20000	20000	20000	20000	20000
- transporting the leaf for decortication			1000	1000	1000	1000	1000	1000	1000	1000
- decortication (cost of Water)			30000	30000	30000	30000	30000	30000	30000	30000
- decortication (labour for running the machine)			20000	20000	20000	20000	20000	20000	20000	20000
- Maintenance of decorticator			8000	8000	8000	8000	8000	8000	8000	8000
- Drying labour storing			3000	3000	3000	3000	3000	3000	3000	3000
Brushing labour			5000	5000	5000	5000	5000	5000	5000	5000
Baling labour			15000	15000	15000	15000	15000	15000	15000	15000
Electricity for running baling press and brush			15000	15000	15000	15000	15000	15000	15000	15000
transport(fibre to market)			2000	2000	2000	2000	2000	2000	2000	2000
sub- total	**4,500**	**2,250**	**126,250**	**120,500**	**120,500**	**120,500**	**120,500**	**120,500**	**120,500**	**120,500**

Table 13: Cost summary & Gross Output/Margins

	year 1	year 2	year 3	year 4	year 5	year 6	year 7	year 8	year 9	year 10
Establishment costs	7700	14500	1000	0	0	0	0	0	0	0
Maintenance, Harvesting and Processing	4,500	2,250	126,250	120,500	120,500	120,500	120,500	120,500	120,500	120,500
Total costs	12200	16750	127250	120500	120500	120500	120500	120500	120500	120500
OUTPUT										
Annual Gross INCOME-Yield/Ha-1200kg @ Ksh160/kg	0	0	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000
Sale Poles-3200@kshs30	0	0	0	0	0	0	0	0	0	96000
Total Annual Gross	-	-	192,000	192,000	192,000	192,000	192,000	192,000	192,000	288,000
Annual Net Income/Acre	(12,200.00)	(16,750.00)	64,750	71,500	71,500	71,500	71,500	71,500	71,500	167,500
Cumulative Net income	(12,200.00)	(28,950.00)	35,800	107,300	178,800	250,300	321,800	393,300	464,800	632,300

Gross Margin per Ha	**Ksh 63,230.00**

Annex 1: List of sisal marketing agents licensed by AFA

FIBRE CROPS DIRECTORATE

CONTACTS FOR LICENSED FIBRE CROPS DEALERS AS AT 30TH JULY, 2020

	MARKETING AGENTS LICENSES (SISAL EXPORT)					
1	Alepp Kenya Limited	Managing Director	P. O. Box 56146 - 00200 NAIROBI	TEL: 0722-514186	aleppkenya@yahoo.com	RENEWED
2	Agro International (K) Processors Limited	Managing Director	P. O. Box 85985- 80100 MOMBASA	TEL: 0732-236314	sisalprocessors@gmail.com kiliware@africaonline.co.ke	RENEWED
3	Gilfreight Cargo Services Limited	Managing Director	P. O. Box 49983 NAIROBI	TEL: 0722-752264	maseckomichael@yahoo.com	YET TO RENEW
4	M & W Exporters Limited	Managing Director	P. O. Box 1084 THIKA	TEL: 0722- 472091	wilsonmaru@gmail.com	RENEWED
5	Majani Mingi Sisal Estates Limited	Managing Director	P. O. Box 25128 NAIROBI	TEL: 0722- 647946	harryhorn65@gmail.com josephnzambu@gmail.com	YET TO RENEW
6	Migotiyo Plantations Limited	General Manager	P. O. Box 47608 NAIROBI	TEL: 0731-636193, 0722-202475 0727-400668 (Komen) 0722-244860 (George)	venugopal@lelgoi.com georgemateli@gmail.com	RENEWED
7	Teita Estate Limited	Managing Director	P. O. Box 18488 - 00500 NAIROBI	TEL: 020- 6551606/7, 6559755/ 6552844	info@teitaestate.co.ke insurance@teitaestate.co.ke	RENEWED
8	The Don's Fibre Limited	Manager	P. O. Box 54627 NAIROBI	TEL: 020-2713334/ 0722-368855	info@thedonsfibre.net eli@thedonsfibre.net	RENEWED
9	WigglesWorth Exporters Limited	Manager	P. O. Box 90501-80100 MOMBASA	TEL: 041-2225244,222738/ 2220642	e.karachiwalla@wel.reavipingo.co.ke	RENEWED
10	Renaissance Limited	Managing Director	P. O. Box 26158 NAIROBI	020-2016164, 020-651228, 0722-292908	info@renaissance.co.ke	YET TO RENEW

				0725 - 030520 (Agnes)	kioko.agnes@renaissance.co.ke	
11	Al Naquel Holding Limited	Managing Director	P. O. Box 8 KARUNGU	0722 - 751261 (Zien) 0728-008969	zien_37@yahoo.com	RENEWED
12	Shanaco Industrial Co. Ltd	Director	P. O. Box 30056 - 00100 NAIROBI	0702-740766	smnngure@yahoo.com jnkarume@yahoo.com	YET TO RENEW
13	Hillview Investments (2015) Limited	Director	P. O. Box 219 - 40600 SIAYA	0728 - 183641(Jane) 0721 - 463550 (Paul) 0708 - 192401 (Victoria)	hillviewinvestments2016@gmail.com james.ohas@gmail.com	YET TO RENEW
14	Aolanda Limited	Director	P. O. Box 25867 - 00100 NAIROBI	0791 183 990	swankenya2010@gmail.com	YET TO RENEW
15	Alyaf Farms Limited	Director	P. O. Box 723-00517 NAIROBI	0798 211 902 0722 910 007	info@alyaffarms.com m@alyaffarms.com showlid@hotmail.com	YET TO RENEW
16	Kichaka Best Limited	Director	P. O, Box 3489 - 80100 MOMBASA	0722 329 365 0731 570 004 0720 279 967	kichakabestlimited@gmail.com	YET TO RENEW
17	Voi Growers Limited	Manager	P. O. Box 10 - 80300 VOI	0716 430 888 0721 399 818 0734 399 818	voipointlimited@gmail.com zul@nazerally.com	ISSUED
18	Kilifi Plantations Ltd	Managing Director	Private Bag KILIFI	TEL: 020-3558170/ 0714-734790	info@kilifiplantations.co.ke	ISSUED
19	The African Mirage Training & Management Consultants Limited	Managing Director	P. O. Box 105603 - 00101NAIROBI	0726 764 229, 0708 004 952 0786 596 550, 0740 924 998	africanmirage1@gmail.com	ISSUED

20	Tuzera International Limited	Director	P. O. Box 69634 - 00400 NAIROBI	0725 635 044 0706 188 714	lilianagola@gmail.com greatemperor2014@gmail.com	ISSUED

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- Ikitoo E.C and Khayrallah W.A, 2001: Sisal Past research results and present production practices in East Africa. Common Fund for Commodities Technical Paper No. 8
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