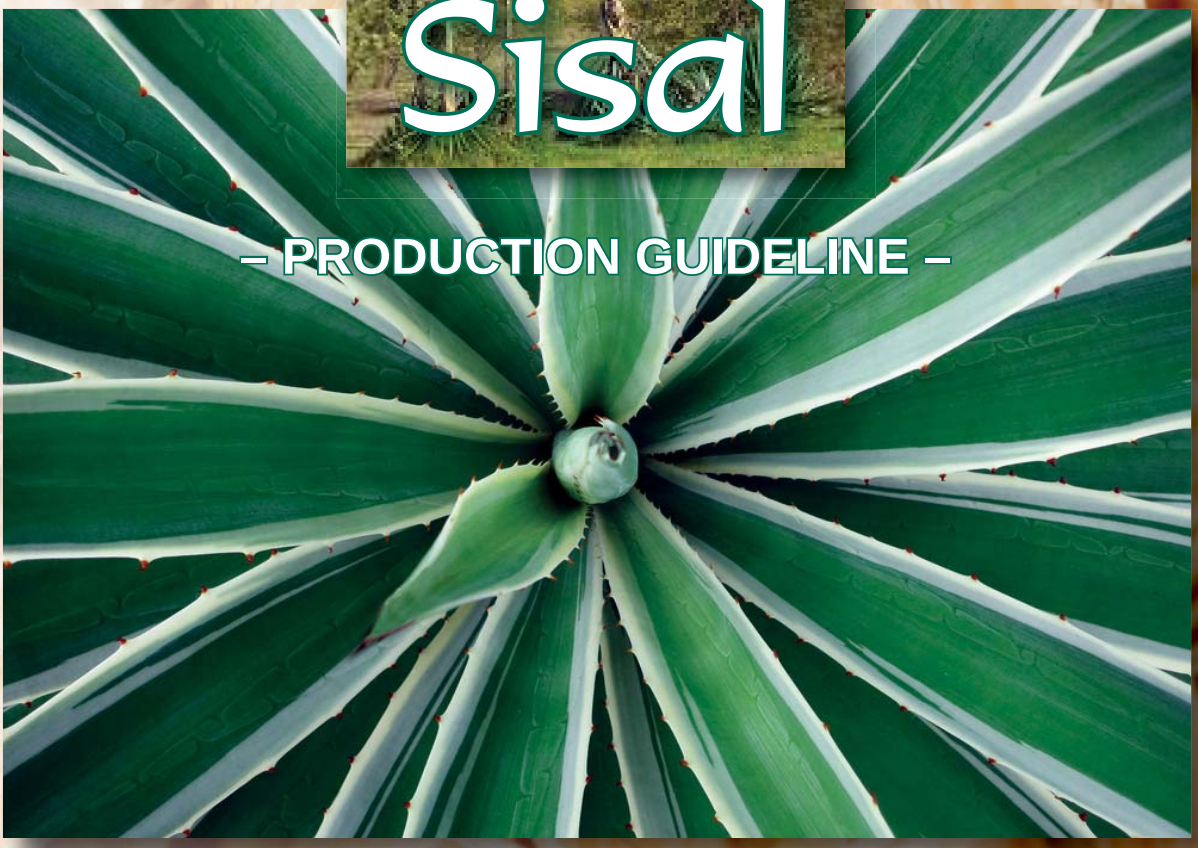
Sisal

– PRODUCTION GUIDELINE –



agriculture,
forestry & fisheries

Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

– PRODUCTION GUIDELINE –

Sisal

2015

Department of Agriculture, Forestry and Fisheries

2015

Printed and published by

Department of Agriculture, Forestry and Fisheries

Design and layout by

Directorate Communication Services

Obtainable from

Resource Centre
Directorate Knowledge and Information Management
Private Bag X388
PRETORIA
0001

CONTENT

GENERAL ASPECTS

Classification

Scientific name: *Agave sisalana* (Agavaceae)

Common names: sisal (English); garingboom (Afrikaans)

Sisal is a species of Agave native to southern Mexico and widely cultivated and naturalised in many other countries. It yields a stiff fibre that is used in making various products. In the past, several species of Agave were used for fibre production, but presently *A. sisalana* is commercially grown species. The botanical name of the sisal plant is *Agave sisalana* and the genus *Agave L.* of the Agavaceae family, which contains about 300 species.

Origin and distribution

Sisal was originally grown in southern Mexico but widely cultivated and naturalised in many other countries. It has been widely introduced in the tropics and subtropics, in India between 1885 and 1892, in Tanzania in 1893, in Brazil at the end of 19th Century, and in Kenya between 1903 and 1908. The first commercial plantings in Brazil were made in the late 1930s and the first sisal fibre exports from there were made in 1948.

Until the 1960s, Tanzania was the leading producer of sisal, but since then Brazil has become the major world producer of sisal, followed by Tanzania, Kenya, Madagascar and China. Other countries in Africa that commercially produce sisal include Guinea, the Central African Republic, Ethiopia, Malawi, Mozambique, Angola, South Africa and Morocco. Sisal has also been grown in Uganda, Zimbabwe and Mauritius.

Production levels

South Africa

The production area under sisal in South Africa is 17 000 ha. Of this, 10 000 ha is situated in the homelands and 7 000 ha in commercial farming areas. Production has increased slightly due to replanting maturity.

South Africa produces 2000 tons of sisal a year, of which 1 800 tons come from three commercial farms and 200 tons from the remaining 20 state-owned farms—many of which are just starting to become operational again after a decrease in sisal over the past decade.

TABLE 1 Sisal production average quantities/values in South Africa from 2005 to 2012.

Years	Average quantities/values in tons
2005	1,300.00
2006	1,260.00
2007	972.00
2008	854.00
2009	996.00
2010	1,169.00
2011	1,347.00
2012	1,347.00

Source: FAOSTAT, 2014

Internationally

In terms of production, sisal occupies the 6th place among fibre plants, representing 2% of the world's production of plant fibres, and it accounts for about 70% of the world's hard fibres. The total annual production of sisal fibre varies, depending on demand, climatic conditions and cultivation. In the year 2007, annual production of sisal in the world has been recorded as 250 thousand tons. The main producers are in Africa: Angola, Ethiopia, Kenya, Madagascar, Mozambique, South Africa and Tanzania; and in Latin America: Brazil, Haiti, Jamaica, Venezuela; and in China. The production was also in approximately 110 000 t in Brazil; 90 000 t in Cuba; 40 000 t in China; 40 000 t in Tanzania; 30 000 t in Kenya; 11 000 t in Venezuela; 2 000 t in South Africa and 1 000 t in India.

Production in 2008 was approximately 23,000 tons per annum in Tanzania, plus some 7,000 tons from Lake Sisal (not exported), 23,000 tons in Kenya

and 8,000-10,000 tons in Madagascar. There is also production in Southern China that is estimated to be around 25,000 tons for domestic consumption and smaller quantities in Mozambique, Venezuela and Cuba.

Brazil is the largest world producer of sisal fibre with 130,000 tons/year. Besides Brazil, sisal is also produced in Mexico (45,000 tons/year); China (36,000 tons/year); Tanzania (24,000 tons/year); Kenya (25,000 tons/year) and Madagascar (15,000 tons/year), in 2011. Of Brazilian production, 70% is exported in the form of raw fibre and manufactured products.

In 2011, Brazil was by far the most important sisal producing country, followed by Tanzania and Kenya. Others are South Africa, India and Mexico. China and India are on the way to become important producers of sisal. Sisal in Brazil is produced by smallholders, while sisal in other production countries is commercially produced on medium to large-sized plantations.

World production of sisal continued to be dominated by Brazil in 2012, accounting for 34,6 percent of the global total; followed by China (22,6 percent); Tanzania (16,4 percent); Kenya (12,9 percent); Madagascar (3,8 percent); and other countries (9,7 percent).

TABLE 2 The world's top 5 producer of sisal from 2005 to 2013

Countries	Average quantities/values (tonnes)
Brazil	231,535.75
United Republic of Tanzania	27,460.50
Kenya	24,678.25
Mexico	18,047.50
Madagascar	17,463.75

Source: FAOSTAT, 2014

Major production areas in South Africa

In South Africa the production areas of sisal are the Limpopo Province (Mokopane, Polokwane, Giyani, and the Phalaborwa corridor); KwaZulu-Natal (Hluhluwe, Mtubatuba and Port Shepstone) and Northwest (Madikwe).

Cultivars

There are many varieties of the Agave plant throughout the tropical and sub-tropical world, especially in the Central American region, but the most important variety for fibre production on a commercial basis are *A. sisalana*

and its hybrids, the most common of which is known as Hybrid no. 11648 and *A. fourcroydes* (known as henequen).

Description

Mature Plant

Sisal is a tall perennial monocotyledon. It is a relatively smooth, straight and subtly yellow fibre. Sisal is a hardy plant that can grow well fast all year round and attains a height of only 15,2 cm in 9 months after planting and 0.6 m at the end of 2 years. The plant grows for 7 to 12 years producing from 120 to 180 leaves depending on location, altitude, level of rainfall and variety of plant.

STEMS

Two to three years after transplanting, a 20 cm tall stem is formed, which will reach a height of about 1,2 m when flowering. White, fleshy stems develop from underground buds at the base of the plant, first growing sideways and then upwards to form new plants. These new plants are known as suckers.

ROOTS

The sisal plant has a shallow, fibrous root system that is a maximum of 60 cm deep. The 2 to 4 mm thick root arise from leaf scars at the base of the bole beneath the soil surface and extends horizontally up to 5 m away from the mother plant and form suckers, which can be used for propagation.

LEAVES

The plant has stiff, heavy, persistent leaves that are 0,6 to 1,2 m long, 10,2 to 20,3 cm wide, and 2,5 to 10,2 cm thick when matured. The leaves are spirally arranged around the trunk, greyish-green in colour and covered by a layer of wax. The leaves of the plant contain coarse, cream-coloured or pale yellow fibres of 3 %.

FLOWERS

The sisal plant flowers only once and that are at an age of about 12 years. Before flowering, a flower stalk of 4,5 to 6,0 m develops from the growth point. The flower stalk subdivides to form branches that bear the flowers. The flowers do not produce seed, but form bulbils, which are used for reproduction.

TRUNK

The base of the plant consists of a short trunk of about 30 cm x 150 cm. The leaves are spirally arranged around the trunk. The growth point from where the leaves develop, and eventually the flower stalk, is situated on top of the trunk.

Essential part

The main components of the plant are the leaf, the trunk and the rhizome. The leaf yields the sisal fibre and a pulpy waste. The fibre is by far the most important product of the sisal plant. Pulp waste constitutes about 12% of the sisal leaf. The trunk and rhizome yield various wood and chemical products at the end of their productive life.

Climatic requirements

Temperature

Sisal grows best in subtropical climates. The plant grows well in hot climate with temperatures between 10 to 32 °C. The maximum temperature should be 30 to 40 °C, with minimum temperatures of 5 °C.

Rainfall Requirements

Rainfall plays an important role as far as fibre production is concerned. The plants are not frost tolerant and produce the best in areas with an annual rainfall of 500 mm and higher. An annual rainfall average of between 600 to 1500 mm is required. Sisal can also grow in areas with less or erratic rainfall.

In high-rainfall areas, production may become problematic due to weed infestation and occurrence of diseases. Waterlogging causes stunted growth.

Soil requirements

The plant is not soil specific, but it grows best in well-drained loamy soil. Sisal can be cultivated in most soil types except clay and has low tolerance to very moist and saline soil conditions. Soil pH of between 4.0 and 6.0 is important.

CULTIVATION PRACTICES

Propagation

Sisal is propagated vegetatively with bulbils or suckers.

Suckers: These are produced close to the parent and develop from axillary buds situated on the bole of the parent plant. Suckers are produced throughout the plant's life and may be removed and planted directly into the field.

Bulbils: When the sisal plant reaches maturity it produces a pole or flower head and then senesces. In the axillary buds on the pole a large number of bulbils are produced. Bulbils are preferred as planting material as they are homogenous and produce vigorous plants. The bulbils are planted out in nurseries and subsequently transplanted into the field. The grower prefers this method because it enables him/her to maintain pure lines.

Soil preparation

In preparing the land, soil samples should be taken and analysed. Land should be well prepared before planting by ploughing to a depth of not less than 30 cm; a ripper should preferably be used first, followed by an ordinary ploughing to a depth of 23 cm. The existing vegetation must be destroyed and the sisal plants are then planted in the hole in the ground.

Field layout and design

The recommended planting patterns are a series of double rows of 60 cm apart with a 2.5 m alley between a pair of rows.

Planting

For planting sisal, the bulbils must be established in a nursery first. They are planted in beds at 10 cm x 10 cm apart where they grow for six months. Application of sisal waste in the nursery is beneficial to plant growth. After that they go to secondary beds where they are placed 30 cm x 30 cm apart. After 12 to 18 months the plants are ready to be planted out into the field. Distance between rows should be 1,0 to 1,5 m and 4,0 m. The planting depth should be 3 cm. At transplanting the fibrous roots around the base of the plantlets are usually cut off and the lower leaves may be pulled off.

Transplanting of sisal into the field can be done any time of the year as it is a succulent with good drought resistance. Usually it is done before the beginning of the rainy season when the land is still dry because this will limit disease infection and weevil attacks. Transplanting is done by hand. Planting holes are made by hoe and soil insecticide is applied into the soil. Although roots can be removed during transplanting, care should be taken not to damage the boles.

Suckers may be established directly. Before planting in the field, the soil is cleared mechanically or by hand and it may be ploughed shallowly. If the rainfall is above 700 mm, plant at 1 m by 750 mm, between 500 and 700 mm at a square metre and 300 to 500 mm or alternately 1,5 m and 1 m by 1 m. The planting depth should be 5 to 8 cm.

Fertilisation

Sisal is an environmentally friendly fibre and almost no fertilisers are used in its cultivation. Where sisal is established on new land fertilisation is generally unnecessary, but where it is established on an old land, fertiliser is usually needed. It also recommended that, after the leaf has been decorticated, the waste material should be ploughed back. Where pH is below 6,0 lime should be applied. Urea, lime-ammonium nitrate (LAN) and superphosphate are some of the chemical nutrients that are used for sisal fertilisation.

Irrigation

Growing sisal does not require irrigation, as the sisal plant is drought resistant and cultivated as a rainfed crop. However, the processing of sisal leaves is very water intensive and on average 100 m^3 of water is used to produce one ton of fibre.

Weed control

Weed control is of primary importance during the first two years. Weeds should be controlled in the first 2 to 3 years after transplanting: by hand, or by mechanical or chemical means. Common weeds in sisal plantations include: couch grass (*Cynodon dactylon* (L.) Pers.), nut grass (*Cyperus* spp.), African couch (*Digitaria abyssinica* (Hochst. ex A. Rich.) Stapf), Lalang (*Imperata cylindrica* (L.) P.Beauv.), cow-itch (*Mucuna pruriens* (L.) DC.) and Guinea grass (*Panicum maximum* Jacq.). After 2 to 3 years, weeds may be allowed to grow during the rains and cut down at the beginning of the dry season to conserve moisture and provide mulch.

It is recommended that cover crops should be grown between the rows during the first three years after establishment in order to keep the land free from weeds. Once sisal is mature a medium weed cover is not harmful. Weed control is normally carried out by hand-hoeing when the crop is young and mowing or slashing when the crop is large enough to cut. Under high-rainfall conditions, more cultivation should be done annually.

Pest control

Sisal is relatively free from pests and diseases, though the only serious insect pest of sisal is the agave weevil or Mexican sisal weevil (*Scyphophorus acupunctatus*. Synonym: *Scyphophorus interstitialis*). Sisal is an environmentally friendly fibre and almost no pesticides are used in its cultivation, because it is resilient to disease. Some common pests and diseases are:

Sisal weevil (*Scyphophorus interstitialis*)

DAMAGE

Weevil damage to sisal plants is either done by the adult or the larva. The larvae damage the subterranean parts of young plants and may cause substantial losses.

SYMPTOMS

The presence of brownish-grey speckled patches, usually elliptical or rounded and infested plant grows slowly. The grub (larva stage) bores into the young plant's bole, making a tunnel. Rotting follows 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.

CONTROL

- Cultural control: use of non-infected planting materials, removal of dead boles and avoiding contaminated fields (sanitation measures).
- Use of guard rows supported by placing split boles whose cut surfaces are dusted with insecticides to reduce infestation.
- Chemical control: The application of registered insecticides.
- Biological control by sisal weevil's natural enemies, e.g. predators such as *Placodes ebeninus* Lewis; the beetle that feeds on the living larvae in rotten sisal boles.
- Planting before or in the early rains and the application of registered/ recommended pesticides in the soil around young plants can control the pest.

Pigs, baboons and monkeys

SYMPTOMS

They damage the centre of the spike and stunt the growth of the plant.

CONTROL

Trapping and scaring-off techniques.

Disease control

Bole rot

The most severe disease of sisal is bole rot, a fungal disease caused mainly by *Aspergillus niger* that enters through the leaf bases after leaves are cut.

SYMPTOMS

It causes a wet rot which becomes yellowish-brown and soft, with a pinkish margin, and it may lead to plant collapse and die off. Affected leaves collapse

and turn yellow, while the bole rots completely. The fungus also causes a basal dry rot when it enters the base of the bole through damage.

CONTROL

Application of calcium-rich fertilisers and in waterlogged or highly acidic soils, agricultural lime must be added. The incidence can be reduced through removal of infested material and harvesting under dry conditions.

Leaf-spot

The spots are fairly large, roughly circular, and vary from 5 to 10 mm in diameter. They are brown to dark brown, sometimes with a paler brown edge, and they occur at random on both sides of a leaf and are often less on the upper side towards the base of the leaf.

SYMPTOMS

Tiny spots which develop into corky grey brown circular scab-like spots on leaves of both upper and lower surfaces feeding off the tender white tissue of the spike. The severity of leaf-spotting varies with seasons and it is always worse on slow-growing plants.

CONTROL

Cultural measures: maintaining clean fields, soil fertility management, and use of clean planting material. Recommended chemicals can be used.

Harvesting

Harvest maturity

The development of the plant determines when the first cut can take place within certain age limits. On the other hand, the development of the plant is determined by factors such as soil potential, rainfall, temperature and general managerial practices. Under normal conditions the plant may be harvested for the first time in 3 to 4 years

after establishment. At this stage, the plant already has 120 to 125 leaves that are 60 cm or more in length and is about 1,5 metre high. Only ripe leaves must be harvested. It is ripe as soon as the colour of the thorn at the tip changes from dark brown to a light brown colour. Sisal leaves are harvested at regular intervals during the life cycle of the crop, thereafter only 25 leaves per year can be harvested.

An early start of cutting is conducive to better yields, provided the plants are not cut too severely. If cutting is delayed, plants pole earlier and heavy leaf losses occur through withering. Severity of cutting has a marked influence on yield and overcutting should be avoided. Where the field is uneven, selective cutting should be done to avoid cutting immature plants. Cutting too soon reduces the length of the subsequent leaves grown on the plants; and the length of the leaves is of paramount importance as the fibre content increases as the leaves grow longer.

Harvesting methods

Sisal is usually harvested by hand. The rosette pattern of growth makes it difficult to mechanise harvesting. Leaves are usually cut manually at 2,5 to 5 cm from the plant's bole. It is essential to leave sufficient leaf area at each cutting to enable the plant to continue growing. About 20 to 25 leaves are left on the plant at the first cutting, and this number is usually decreased to 15 to 20 leaves at subsequent cuttings. The terminal spines are removed before or after the leaves have been cut.

POST-HARVEST HANDLING

Decortication

Leaves should be decorticated not later than 48 hours after cutting. Sisal fibre is derived from the leaves of the plant. It is usually obtained by machine decortications in which the leaf is crushed between rollers and then mechanically scraped. The fibre is then washed and dried. During decortications 15 to 20% of the total leaf fibre is lost.

Retting

The leaves are immersed in water for about a week, after which the leaves are beaten on a stone to remove the remaining extraneous matter, and the separated fibre is washed, dried in the sun and baled.

Drying

After decortication and washing, the fibre is dried, either in the sun or in drying machines and this gives the fibre a more uniform quality. Excessive drying in the sun may lead to deterioration in colour. The dried fibre represents only 4% of the total weight of the leaf. This process also combs out the shorter fibre strands/strings of 7,5 to 12,5 cm in length. Once it is dried the fibre is mechanically brushed.

Brushing

After the fibre has dried, it is collected into hanks to be brushed. The brushing process is necessary to straighten the tangled, wavy fibres and to polish them. The fibre is mechanically combed.

Grading

After brushing, the fibre is graded according to length, colour and other/ decortications characteristics. The buyers insist on correct grading and general neatness of the bale. The presence of oil, bits of coal and other impurities in the bale is strongly disapproved.

TABLE 3 different length of classification for fibre

Length/Class	Description
3L	At least 915 mm, without knots and cream to a light straw colour.
3	At least 610 mm.
UG	Darker colour fibre.
PM	Shorter than 610 mm with knots and darker colours.

Packing

Graded fibres are packed into bales using a manually or electrically operated pressing machine. The moisture content of packed fibre should not be more than 10 to 12%. If it is too wet, it becomes stiffly matted and there is a danger of spontaneous combustion in the bales. One full bale is equivalent to 125 kilograms of fibre. One ton is made up of 8 bales.

Marketing

The produced sisal/fibre is either marketed locally to individuals who use them for various activities like mats and basket weaving, farmers for tomato plant support and ropes for reinforcement of ceiling corners, etc., or through the sisal marketing council. Sisal was developed for “traditional” industries such as the rope, twine and carpet backing industries and to a lesser extent, for the specialty pulp and paper market. Sisal fibre is exported to many overseas countries, where it is well received because of the high quality of South African grown fibre. The fibre is also sold to customers in Botswana and Zimbabwe, where the fibre is used to manufacture rope. Another 3 000 tons of sisal, used in the manufacture of ropes and steel cables, are imported.

PRODUCTION SCHEDULES

Year	Activity
1	Planting
2	Weeding
3	Weeding
4	Weeding
5	De-suckering and harvest
6	De-suckering and harvest
7	De-bushing, de-suckering and harvest
8	De-bushing, de-suckering and harvest
9	De-bushing, de-suckering and harvest
10	Harvest
11	Harvest
12	Soil preparation

UTILISATION

Sisal has a wide variety of purposes including:

Traditional

High-grade sisal fibres are made into yarns (either on their own or in blends with wool or acrylic) and used in carpets. Medium-grade fibres are made into cordage, ropes and baler twine for agricultural and industrial use and they are particular useful in a marine environment as they are resistant to deterioration by salt water.

Sisal pulp and paper

Sisal biomass contains a high proportion of cellulose; its pulp is a substitute for wood fibres and adds bulk to paper and cardboard as well as being absorbent and has a high fold endurance characteristic, making it a high-quality input for paper products. It can be used in cigarette paper filters and also tea bags.

Textile

A major use of the fibre is in buffing cloth, because sisal is strong enough to polish steel and soft enough not to scratch it.

Sisal is a reinforcing composite. Sisal can be used to substitute or enhance fibreglass and used to reinforce plastic in automobiles, boats, furniture, water tanks and pipes. Sisal can also be used to add strength in cement mixtures for the development of low-cost housing and to replace asbestos in roofing and brake-pads. In addition, it is an insulation material and can be made into fibre-board as a wood substitute.

Plastic and rubber composites

Sisal has good potential as reinforcement in polymer (thermoplastics, thermosets and rubbers) composites due to its low density and good welding specific properties. The sisal composites can be used in automotive components and other furniture. Sisal also continues to make the best material for dart boards.

Sisal waste products

By-products from sisal extraction can be used for making biogas, pharmaceutical ingredients and building material. The waste produced by decortication such as sisal juice, particles of crushed parenchymatous tissue, and fragments of leaves and fibres can be used as a fertiliser or animal feed. The juice of the plant is used to make pharmaceuticals like hecogenin, inulin and others.

Other uses

Bird breeders use the hollow trunks of the plant for nesting. Sisal can be used as a geotextile in land reclamation, stabilisation of slopes and road construction. It is also used to manufacture good cat scratching posts, spa products, lumbar support belts, rugs, slippers, cloths, and disc buffers. Sisal is valuable forage for honey bees because of its long flowering period. The attractive sisal poles are widely used in game parks for bomas and hides.

ACKNOWLEDGEMENT

The Agricultural Research Council-Institute for Industrial Crops (ARC-IIC) is acknowledged for the information provided.

REFERENCES

http://www.academicjournals.org/article/article1408699884_Dlamini%20et%20al.pdf- An Economic viability assessment of sisal production and processing in Limpopo: A stochastic budgeting analysis. *Journal of Development and Agricultural Economics*: Vol.6 (9): 386–393, September 2014

http://www.wildfibres.co.uk/html/sisal_fibre.html - Sisal Fibre, 02 October 2014

http://www.fao.org/economic/futurefibres/fibres/sisal/en/ - Future Fibres, 2014

http://thedonsfibre.net/pests-diseases/–2013

http://faostat3.fao.org/browse/D/*/E

http://faostat3.fao.org/home/index.html

Further information can be obtained from

Directorate Plant Production
Private Bag X250
PRETORIA 0001

Tel. 012 319 6079
Fax 012 319 6372
E-mail Thabo.Ramashala@daff.gov.za
Website www.daff.gov.za