



Fibre crops cultivation: current growth initiatives in South Africa

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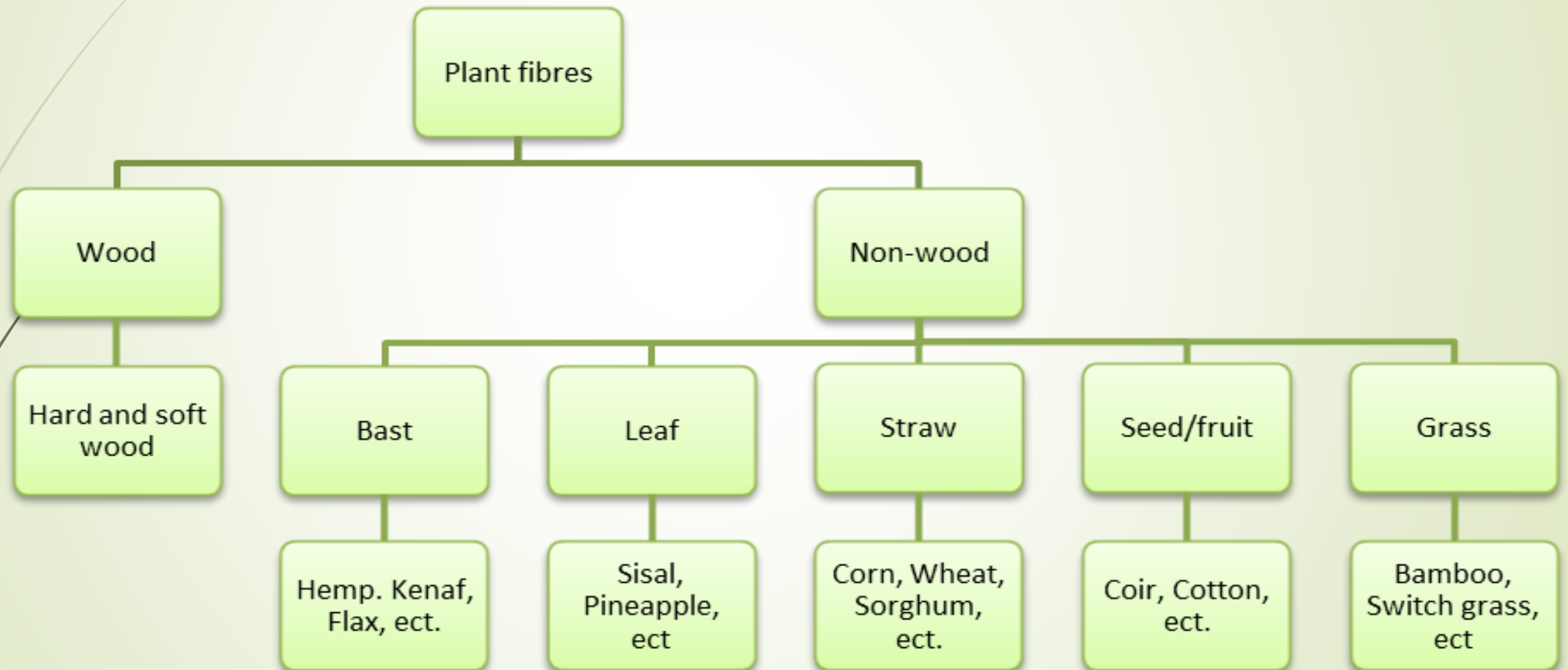
CURRENT GROWTH INITIATIVES



ZERO!

Classification of plant fibres

(Adapted from Anandjiwala & Blouw, 2004)



A decorative red arrow points to the right from the left edge of the slide. Below it, several thin, dark green lines represent plant stalks or roots, extending downwards and slightly to the right.

Mechanical properties of cotton, flax and kenaf used in engineering composites. (CSIRO, Australia)

Fibre	Density g / cm ₃	Elongation %	Strength	
			MPa	cN/tex
Cotton	1.5	7	400	30 – 40
Flax	1.5	3	669	46
Kenaf	1.3	1.6	430	33

Sisal (*Agave sisalana*)

- Indigenous to Central and South America.
- Reproduces vegetatively as suckers and bulbils
- Life span of 10-15 years depending on the variety
- Perennial crop
 - Harvesting starts 18-24 months;
 - Produces 200 - 250 leaves
 - Giving a total of 120 – 150kg leaves.
 - Each leaf contains 3-4% fibre, which equals 3.6-6kg fibre per plant
- Leaves average 120cm in length and are arranged spirally around the thick stem
- Leaves are 75% sclerenchyma bundles



Sisal Fibre

- **Fibre strands** are on average from 80 to 120 cm in length and 0.2 to 0.4 mm in diameter.
- The fibre is divided into three groups:
 - long fibres with minimum of 90 cm,
 - medium fibres that averages 71 – 90 cm
 - short fibres that are 60 – 70 cm in length.
- **Utilisation possibilities of sisal fibre**
- **Lower grades fibre** : Specialty paper, Dartboards, Buffing cloth, Filters, Geotextiles, Mattresses, Carpets, Handicrafts, Wire rope cores
- **Medium-grade fibre**: cordage industry for making ropes, baler and binder twine. Ropes and twines are widely employed for marine, agricultural, and general industrial use.
- **Higher-grades fibre** after treatment is converted into yarns and used by the carpet industry.

Production Requirements

Sisal can flourish in all weather conditions as the crop is drought resistant and very tolerant of a variety of soils. Hence, even arid regions can be brought into production such as would not be possible with other crops.

- Temperature
 - Average temperature 20 to 28°C, with plenty of sunshine
- Rainfall
 - Can be grown in areas with rainfall of 600 mm per annum.
- Soil
 - Sisal prefers well-drained light sandy soils because it has a superficial root system
 - Does the best on a deep red loam or black cotton soil, if well drained and grows poorly on waterlogged soils.
 - Soil with pH values of between 6.0 and 6.9 is also important.
- Spacing
 - Transplanting is done at the beginning of the rainy season.
 - Double rows of (4 x 1) x 1m.
 - The optimum plant population is approximately 4 000 plants/hectare.



Harvesting and Primary Processing

Harvesting

- Cut by hand

Primary Processing

- Known as Scutching/decortication
 - used to extract the fibre from the leaf tissues.
- Leaves are crushed and beaten by a rotating wheel set with blunt knives, so that only fibres remain.
- All other parts of the leaf are washed away by water.
- Decorticated fibres are washed before drying in the sun or by hot air.
- Dry fibres are machine combed and sorted into various grades,



Yield and Current Production

Yield Potential

- The potential production yield is 1 t/ha per annum.
- However normally lower!

Current Production

- Sisal production in South Africa had its beginnings in the early 1960s.
 - The area under sisal reached its peak in the early 1970s with a total of 44 000 ha.
 - In 1973 the major sisal producing areas was Northern KZN (Hluhluwe, Mkuze & Magadu) and the former Transvaal.
 - **Decline after introduction of synthetic fibres**
- Currently two areas where the production of sisal is in a revitalization phase.
 - Near Giyane in Limpopo - 182 ha of sisal
 - Madikwe in the North-West Province ??

FLAX

(*Linum usitatissimum* L.)

- Flax originates from India
- Flax is among the oldest fibre crops in the world. The use of flax for the production of linen dates back 5000 years.
- Flax is divided into two types:
 - seed producing types better known as linseed
 - fibre producing types known as fibre flax.
- Fibre flax is an erect, unbranched, annual plant that grows up to 120 cm tall, with slender stems.
- Linseed plant has a bushy nature, is about 80cm high and has a few branches in order to produce more seed.





Flax fibre

- consists of bundles of fibres or fibre strands of 10 – 40 individual fibres that are about 30mm long and 0.02mm in diameter.
- These flax fibres are bound together end to end to form bundles by pectin and a strand is 60 – 90cm long.
- Consists of 43 - 47% cellulose and 21-23% lignin and is soft and supple but not as flexible as cotton or wool.
- Flax fibre is stronger than cotton fibre, rayon and wool, but weaker than ramie.

Linseed

- Refers to brown or yellow-seeded types containing 35-45% oil and 18-26% protein.
- Linseed oil is perhaps the most widely available botanical source of Omega-3 fatty acids, which makes it extremely valuable.

Utilisation possibilities of flax

Fibre flax is divided into three categories:

- *Long fibre* that is mainly use for linen
 - *Short fibres (tow)*: suitable for spinning into yarns, often mixed with cotton, and also have other uses such as composites, geotextiles, Insulation material, specialty paper, packaging materials, reinforcements for plastics and concrete, asbestos replacement, panel boards, lining materials for vehicles,
 - *Shive* that is used for animal bedding and filler
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- Flax fibre is hollow and able to absorb up to 12% of its own weight in water, and its strength increases by 20% when wet.
 - It also dries quickly, and is anti-static.
 - Suitable substitute for man-made synthetic fibres such as heavier fibre glass.

Linseed oil

- Nutritional additive
- Paint and wood preservative
- Cosmetics

Production Requirements

Temperature: Normally viewed as winter crop

- Cool, moderate coastal climates.
- Normally confined to low elevations up to 770m above sea level.
- Seedlings can withstand a temperature of -4°C but very high temperatures (exceeding 32°C) shorten flowering and thereby affect seed yield.

Rainfall: Needs 450 – 750mm of rain spread evenly through the growing season.

Soils: Same type of soils that are suitable for wheat.

- The soils most suitable, besides the alluvial kind, are deep friable loams, containing a large portion of organic matter, with a pH ranging between 5 and 7.
- Heavy clays are unsuitable, as are soils of a gravelly or dry, sandy nature.

Plant density: Fibre flax varieties are sown at 65kg/ha

- Linseed is sown at 50kg/ha - allows the plant room to form an abundance of branches.



Harvesting and Primary Processing

Harvesting

- Linseed is considered to be fully matured when 75% of the bolls have turned brown.
- Can be harvested by straight combining or by cutting with a swather and threshing later with a combine or by hand.
- Best stage for harvesting fibre flax is when stems yellow – the fibres are long and supple at this stage and most suitable for processing.
- Harvested by hand, mechanically by very expensive machines or by mowing (lose 10% potential fibre yield)

Retting

- Retting is the process of rotting away the inner stalk leaving the outer fibre intact.
- Can be done by field or dew retting, immersion in ponds or chemically

Scutching/decortication

- After retting, the straw is scraped away from the fibre by pulling the stems through hackles that comb the straw out of the fibre – a process called scutching



Yield and Current Production

Yield Potential

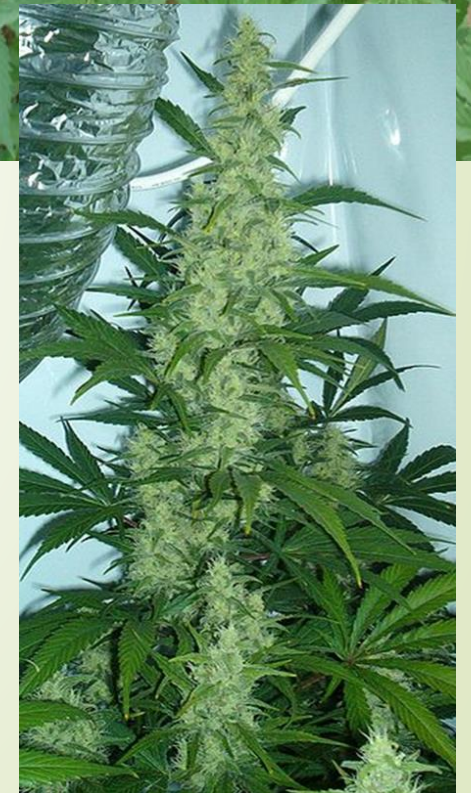
- Fibre cultivars: yield of 6 – 7 t/ha was achieved in South Africa.
- Fibre content of flax straw is between 20 – 25% which is more or less 1 – 2 t/ha
- Yields of more than two tons of linseed per hectare have been achieved in SA

Current Production

- About 500ha was being grown in Western Cape for the linen factory in Atlantis (IDC)
 - **However this has now been closed down!**

Hemp (*cannabis sativa* L.)

- Originates from Central Asia
- Three main groups of *Cannabis* varieties
 - Fibre - Hemp produces both long, coarse fibres, which extend nearly the entire length of the stalk (primary bast fibres), and short, fine fibres which tend to adhere to the woody core (secondary bast fibres). Low THC.
 - Seed: Branched; usually contains from 29 to 34 % oil. Low THC.
 - Medicinal and narcotic properties: Branched. High THC and CBD.
- Annual herbaceous plant with an upright growth habit and its characteristic leaves composed of five to seven leaflets.
 - The hemp plant can reach up to nine metres in height, but under cultivation, it averages between two to four metres.
 - Dioecious: Male and female plants



Hemp Fibre

- Constitutes 8.5 to 30% of the total stem mass.
- Two types of bast fibre:
 1. Primary bast fibres make up approximately 70% of the total fibres, are 20mm long, high in cellulose and low in lignin.
 2. Secondary bast fibres = 30% of the total fibres; medium in length 2mm and higher in lignin.
- The pith or woody part of the stem contains xylem vascular tissue and short fibre bundles.

Uses of Hemp Fibres

- Long fibres that are stronger than cotton are used for:
Textiles (clothing etc.), Technical textiles (sails, tarp, awnings, carpets, ropes, etc.), Paper, Substitute for fibre glass
- Medium fibres that have low lignin levels are used for:
Paper, Non-woven applications, Brake and clutch linings, Hygiene products (nappies etc.),
- Short core fibres or hurds are used for:
Wood-substitute for construction material, Concrete/plaster mixes, Plastics, Animal bedding, Packaging, Insulation material, Fibre board

Production Requirements

Temperature: daytime temperatures of 25°C – 28°C

Day length: Sensitive to short days and long nights - induces flowering. European cultivars have a critical daylight period of between 14 and 16 hours.

Rainfall: The hemp plant requires an annual rainfall or irrigation of at least 500 to 700 mm.

Soil requirements: Hemp makes heavy demands on the soil. Taproot can penetrate deep (2 - 2.5 m) into the soil but lateral roots that are primarily responsible for the uptake of nutrients, water and oxygen grow 60-80cm below the soil surface.

- The hemp plant needs a sufficiently deep, well-aerated soil, as well as a regular water supply.
- It grows best on highly fertile soils which contain abundant organic matter, i.e, neutral or slightly alkaline, well-drained loam soil with a good water holding capacity.

Planting density: 25 to 35 cm inter-row spacing with the seeding rates of 60 to 80 kg per hectare.



Harvesting and Primary Processing

Harvesting

- Harvested when the plants have finished flowering, but before the seeds are mature
- Can be harvested with a specially modified cutter.
- The hemp is cut, laid in swathes, and left to dry.
- Production of good-quality hemp fibre depends largely on the retting process.
- Retting normally takes 21-28 days depending on the weather conditions.

Scutching/decortication

- Breaking is the first step in mechanical separation of the fibre from the stalks.
- Dried stalks is passed between fluted/grooved rollers to crush and break the woody core into short pieces, known as hurds, which is partially separated from the long fibres in the process.
- The remaining hurds and fibres are separated in a process called scutching. This is done by revolving drums that beat the fibre bundles, separating the woody core and short fibres (tow) from the long fibres.
- The long fibres then are cleaned and are ready for combing.

Yield and Current Production

Yield Potential

- Yields of 5-7 ton/ha have been reported in SA



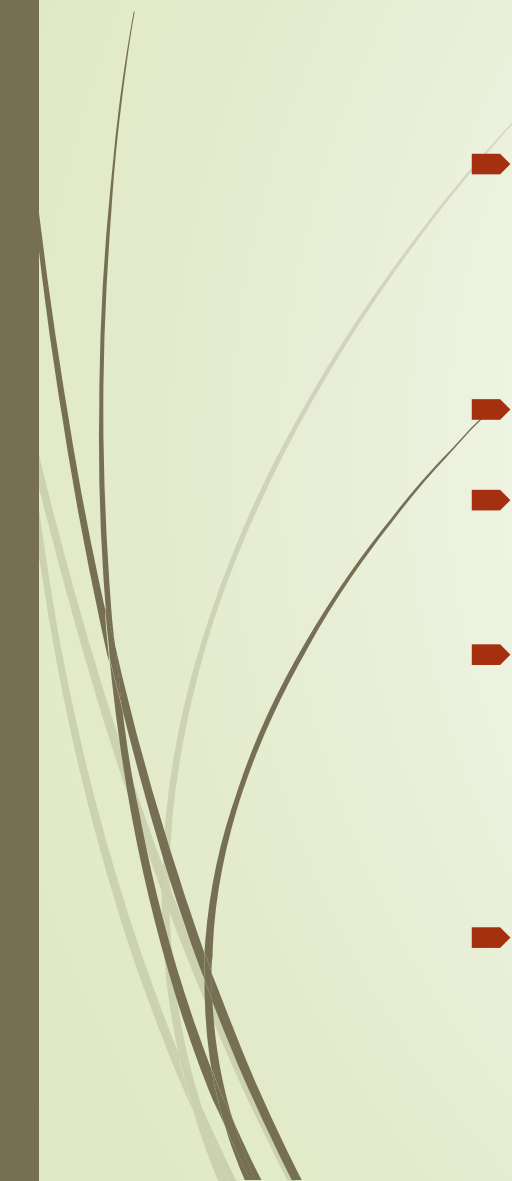
Current Production

- **Restricted due to legislation!**
- House of Hemp
 - 2 ha experimental plots with small holder farmers
 - In W and E Cape and KZN.





KENAF (*Hibiscus cannabinus*)

- Annual or bi-annual herbaceous plant, that grows quickly, rising to heights of 4 – 5 meter in a 4 – 5 month growing season and 20 – 35 mm in diameter.
 - **Cultivars**
 - **Ultra-early:** 70 to 100 days to reach maturity. Their fibre yield is small and their heights seldom exceed 2.0 to 2.5 m.
 - **Early to medium maturing:** 100 to 120 days to mature and will reach a height of 2.5 to 3.5 m under optimum conditions. Their dry bark yield is highly variable and ranges from 1.0 to 4.0 t ha⁻¹. Fibre percentage in the green plant ranges from 3.5 % to 7.5 %.
 - **Late maturing:** Highly insensitive to photoperiod. Require 140 days or more to reach maturity and may grow up to 3.0 to 5.0 m tall. Their green stem yield is usually high and the fibre yield ranges from good to excellent.
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Kenaf Fibres

- The fibre found in the bast and core.
- The bast constitutes 40% of the plant.
- Kenaf single fibres are only about 1 – 7 mm long and about 10 – 30 microns wide, thus too short for textile processing.

Utilization of Kenaf Fibres

- Automotive industry
 - Food
 - Apparel
 - Paper
 - Livestock feed
 - Natural fibre/plastic compounds
 - Construction and housing industry
- **Core:** Packaging material, animal bedding, oil sorbents, poultry litter and potting mixtures.



Production Requirements

Temperature: Kenaf is a tropical and subtropical plant. Grows optimally in temperatures ranging from 15 – 27 °C, with the optimal 25°C

Rainfall: Under rainfed conditions, kenaf requires 500 – 700 mm of rain spread evenly through the 5 – 6 month growing season

Day length: Kenaf is a short-day plant, which remains vegetative until the number of daylight hours fall below 12.5 hours, when flowering occurs

Soil requirements: Kenaf is adapted to a wide range of soil types, from high organic peat soils to sandy desert soils, acid peat, alluvial, silt loam, sandy loam, clay loam, alkaline and saline soils but performs best on the heavier, well drained, fertile soils with a pH of 6 – 7. The principal requirement is soil must possess good drainage.

Plant population: The general seeding rate is 20-35 kg/ha. With a plant population of 270 000 to 300 000 plants/ha a yield of 10t/ha can be achieved.

Harvesting

- Harvested at the beginning of flowering.
- The fibre is then still easy to remove from the wood.
- Four possible methods of harvesting can be used:
 - Cut whole stalks in windrows. Left to dry. Collect in bundles/bales (High cost and high quality)
 - Chipping in pieces by forage choppers. Transport pieces or bale pieces (Economical but low quality)
 - Separation of fibre and core in field of wet stalks. Fibre left to dry in field.
 - Harvested like sugarcane with sugarcane harvester



Primary Processing - Retting

- **Natural or dew retting:** Wind rows; turn several times
- **Water retting:** Ponds, rivers, troughs
- **Ribbon retting:** Strip bark from stems while green. Water ret while green or dry.
- **Bacterial/ Natural retting:** First decorticate with a splitting machine, then retted in open troughs. Water temperature is maintained at 30 ± 2 °C.
- **Staggered retting:** This is the best method for obtaining uniform fibres with immersion of the bases of stalks initially and then the whole stalks. The process takes from 5 to 22 days.
- **Biological retting (3 types):**
 - Stack method – bundles plants are stacked and a fungal culture for retting is used
 - Ribbon method – green bark are extracted and retted in water
 - Steep method – bundles of kenaf are kept standing in 50-60cm water for 3-4 days, and then laying down in the water.
- **Chemical Retting:** Soaking in NaOH.
- **Enzymatic retting:** This method may improve retting and reduce costs.
- **Sugar cane separation method:** physically similarity to kenaf

Yield and Current Production


Yield

- An average dry stem yield of between 6 and 20 t/ha can be achieved depending on the cultivar used, the environmental conditions and soil type.

Current Production

- Was produced on a limited basis in Kwazulu Natal (Winterton)
 - 2 000 ha
- Currently no kenaf is cultivated on a commercial scale
- On a trial basis kenaf was evaluated in KZN, N West and Eastern Cape
- The only processing facility is in Winterton.
 - **Sustainable Fibre Solutions**
 - **Owned by IDC**





THANK YOU!