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Sisal: A Viable Natural Fibre

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Sisal fibre is one of the most widely used natural fibres and is very easily cultivated. It has short renewal times and grows wild in the hedges of fields and railway tracks. Sisal (*Agave sisalana*) is a species of flowering plant native to southern Mexico, but widely cultivated and naturalized in many other countries. Sisal fiber is a vegetable fiber obtained from the leaves of the sisal plant. It belongs to the family "Asparagaceae" and it comes under the genus "agave". World production of sisal fiber is about 300,000 tones. It yields a stiff fibre used in making rope and various other products. Sisal has an uncertain native origin, but is thought to have originated in the Mexican state of Chiapas. Sisal is a tropical and subtropical plant, thriving in temperatures above 25 °C and sunshine. Historically, sisal was used by the Aztecs and Mayans for fabric and paper. It spread to other parts of the world in the 19th century, with Brazil becoming the major producer. Global sisal production in 2020 was 210,000 tonnes, with Brazil being the largest producer, followed by Tanzania, Kenya, Madagascar, China, and Mexico. Sisal farming initially led to environmental degradation, but it is now considered less damaging than other farming types. It is an invasive species in Hawaii and Florida.

Global production of sisal fibre in 2020 amounted to 210 thousand tonnes, of which Brazil, the largest producing country, produced 86,061 tonnes. Tanzania produced about 36,379 tons, Kenya produced 22,768 tonnes, Madagascar 17,578 tonnes, and 14,006 tonnes were produced in China. Mexico contributed 13,107 tons with smaller amounts coming from Haiti, Morocco, Venezuela, and South Africa. Sisal occupies sixth place among fibre plants, representing 2% of the world's production of plant fibre (plant fibres provide 65% of the world's fibre). Sisal (Agave sisalana), is a leaf fibre producing plant belongs to Asparagaceae family, commonly known as Agave in India. It is semi perennial, xerophytic and mainly grown in arid and semi- arid regions of Andhra Pradesh, Orissa, Bihar, Karnataka, Maharashtra, and West Bengal (Nayak *et al*., 2011). In the context of climate change and land degradation neutrality, sisal is an excellent CDM (clean development mechanism) crop for biochemical as well as for afforestation in degraded lands besides improvement in soil carbon sequestration (Sarkar and Jha 2017).

Sisal is a xerophytic monocarp, semi-perennial leaf fibre producing plant. The sisal plant has a 7 to 10 year lifespan and typically produces 200–250 commercially usable leaves. Each leaf contains around 1000 fibres. The fibres account for only about 4% of the plant by weight. Sisal is considered a plant of the tropics and subtropics, since production benefits from temperatures above 25 °C (77 °F) and sunshine. It is propagated using bulbils or suckers and can be improved genetically through tissue culture. The plant has short stem bears rosette of leaves that are sessile, linear lancedate, attains a length of 1-1.5 m or more. Leaves are thick, fleshy and often covered with waxy layer. Each is 60–180 cm (2–6 feet) long and 10–18 cm (4–7 inches) across at the widest portion, terminating in a sharp spine. Life span of this crop is generally 10-12 years having the leaf of 1-1.2 m length and 10-16 cm width at maturity with fibre from 2-5% of green leaves. Sole sisal is generally grown in poor fertile soils, sloppy lands or in degraded soils as live fence, as erosion control measures and for its fibre in various diversified uses. The vacant space in between the paired rows of sisal plantation may be effectively utilized by growing short duration pulses (Malleswari Sadhineni *et al*. 2022).

Sisal fibre is extracted by a process known as decortication, where leaves are crushed, beaten, and brushed away by a rotating wheel set with blunt knives, so that only fibres remain. As a precaution, fibre extraction is done on a bright sunny day and within 2 days of the harvesting of the leaves or else the quality of the fibre will be deteriorated. The fibre colour varies from milky white to golden yellow.

Physical properties of sisal fibres

Characteristics	Properties
Length	1.0 - 2.88 mm
Diameter	100-300 mm
Width	22.6 µm
Tenacity	57.2 cN/Tex
Elongation	3.85 %
Moisture content	10 to 22%

Characteristics of Sisal fibre

- Exceptionally durable with low maintenance with minimal wear and tear
- Does not absorb moisture and dust easily. It is hydrophilic fiber. Its longitudinal shape is a cylinder.
- Fibers have high strength, lustre and good color. Fibers tend to be stiff and rather inflexible
- After careful processing, sisal is of creamy white color
- Strands are strong and consist of many individual fibres held together by natural gum
- Untreated sisal exhibits higher tensile modulus and hardness than the unloaded resin
- Tensile strength is maximum at the middle of yarn while moderate at the tip
- Young's modulus increases with fibre length
- Anti-static, Recyclable
- It exhibits good sound and impact absorbing properties.
- It is 100% biodegradable.

Uses of Sisal

Traditionally, Sisal has been the leading material for agricultural twine, and general cordage, sisal is used in low cost and speciality paper, dartboards, buffing cloth, filters, geo-textiles, mattress, carpets, handcrafts, wire ropes cores and Macrame. Long fibers (> 90 cm long) are used for ropes and binder twine. Besides rope making, there are also other usage in making of brushes, dusters, door-mats, carpets, bags, fishing nets, belts, chappal stripe, hats, dolls, Christmas trees etc. It is also used for cigarette papers and filters, filter papers, tissues papers, tea bag etc. whereas unbleached pulp can be used for electrical cable and telephone cable insulation and in making cement bags and sacks etc. The sisal pulp (about 95 percent) left after fiber extraction is mainly used for making paper / paperboards, hecogenin (a cortico steroid), wax and bio gas. There is a dire need to widen the product base. Traditional products of twines, ropes, carpets and bags need to be sustained and improved to combat competition. But efforts have to be intensified to produce and market those products where sisal has technological, environmental, geographical and cost advantages. There is a wide range of products like geo textiles, buffing cloth, bonding, construction materials, handicrafts, furniture, padding and mattresses can be made with sisal fiber (Shamte 2000). In recent years sisal has also 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

Environmental Benefits

Sisal is a renewable resource par excellence and can form part of the overall solution to climate change. Measured over its life-cycle, sisal absorbs more carbon dioxide than it produces. During processing, it generates mainly organic wastes and leaf residues that can be used to generate bioenergy, produce animal feed, fertiliser and ecological housing material and at the end of its life cycle, sisal is 100 percent biodegradable. By contrast synthetically produced fibres do not possess any of these traits. Moreover, sisal plants reduce soil erosion through its extensive root system and contributes positively to watershed management. Sisal plants used as hedges act as effective vegetative barriers/ fences to protect the crops lands and forests from predatory animals and intruders.

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