Sisal: potential for employment generation And rural development

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Introduction

Utilization of plant fibers for generating employment in rural sector is cost-effective and ecologically sustainable. India has a vast resource for different natural fibers viz., jute, sisal, banana, coir etc., which are abundantly available in many parts. Presently, the production of natural fibres in India is more than 400 million tonnes (Amit Rai and Jha 2004). Among others, sisal has many advantages like thriving in wastelands and yielding superior fiber continuously for 6-8 years with least management input.

The Portuguese introduced agave in India in the 15th century. They are now found throughout the country. The major species of agave available in India are A. sisalana, A. mexicana, A. americana, A.cantala, and A. veracruz. Among the agaves, the most prevalent is Agave sisalana, commonly known as sisal, which is a xerophyte and can survive on poor soils in drought prone tropical regions. Sisal occupies 6th place among fibre plants, representing 2% of the world's production of plant fibres (Rehm and Espig, 1991). The leaves of sisal plants yield a strong fibre, which is traditionally used for making ropes, cordage and twines. Apart from the traditional applications sisal finds its way in environment friendly engineering materials due to low density, high specific strength and biodegradability. Sisal and allied activities like cultivation, fibre extraction, product making etc. are labour intensive, low-tech and has high potential for employment generation in rural and semi-urban sectors. The paper discusses various aspects of sisal, its applications and possibilities for sustainable rural livelihood.

Cultivation of Sisal

Sisal is a perennial hardy plant, which unlike the other fibres is not a seasonal crop. It can establish and easily grow in all states of India covering sub humid to arid and semiarid regions, which cover major parts of India. It can also survive in almost all soil types and its input costs are least for its survival, regeneration and maintenance on sustainable basis. Sisal tolerates prolonged droughts and high temperatures also. It yields parallel hard fibres.

The sisal plant has a stalk on which the succulent leaves are arranged spirally. Its dimensions are about 1 to 2 m in height, with a diameter of ~ 20 cm. The lance-shaped leaves, growing out from the stalk in a dense rosette, are fleshy and rigid, with dark green colour. Each is 0.8 to 1.5 m long, 7 to 8 cm wide at the base, and 10 to 15 cm across at the widest portion, terminating in a sharp spine. Cutting usually starts after 2½ years when the plant has about 100 leaves. The plant matures fully in 4 to 8 years after planting (Fig. 1).

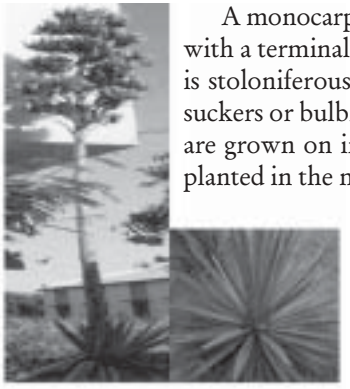

Fig. 1: Sisal (*Agave sisalana*) plant

A monocarpic perennial sisal plant yields 220-250 linear, lanceolate leaves with a terminal spine in the 6-9 years before it poles (flowers) and dies. Sisal is stoloniferous plant, which produces shoots from the stolons, known as suckers or bulbils, which can be used for propagation. The suckers / bulbils are grown on in nurseries until they are about 50 to 70 cm high and then planted in the main field (Wienk, 1969).

Production scenario of Sisal

In India, sisal is not cultivated and the sector is unorganized. However considering the employment and income generation potential, the District Rural Development Agency (DRDA), Koraput, Orissa implemented an integrated "Sisal plantation, Fiber extraction and Rope making" programme under Jawahar Rojgar Yojana (JRY) in the year 1995 (Purandare and Sambi Reddy, 2001). Sisal is currently found on embankments, bunds and roadsides, serving the purpose of soil conservation and protection as hedge plantation. Presently sisal fibers are collected and utilized for conventional purposes like ropes, anchors, cordage and handicrafts. They are not optimally utilized and commercially exploited with respect to their abundant availability, superior characteristics / quality and wide applicability. A high yielding sisal hybrid (Leela) has been developed at Sisal Research Station, NIRJAFT (ICAR), Bamra in 1985 which has a yield potential up to 25 q/ha (http://www.crijaf.org/about/aicrp.html).

Extraction and Properties of Sisal Fibre

Sisal fibre is traditionally extracted by retting, a biodegradation process involving microbial decomposition of sisal leaves, which separates the fibre from pith. The fibres are washed and processed further. This process takes 15-21 days for a single cycle of extraction and degrades the quality of fibre. The retting process is water intensive, unhygienic and not eco-friendly. The other methods available for the extraction of fibre are chemical treatment and mechanical extraction. The mechanical extraction is done with the help of Raspador machine, developed by RRL, Bhopal. It is a semi-automatic machine suitable for small-scale operations (Fig. 2).

Fig. 2: Sisal fibre extraction with Raspador

Sisal fibre consists of 66-72% cellulose, 12% hemicellulose and 10–14% lignin. The superior engineering properties (diameter 50–200 ?m; microfibril angle 10–220, Ultimate Tensile strength of 468–640 Mpa; Modulus of 9.40–15.80 Gpa and elongation of 3–7%) makes it as an excellent material for manufacturing high strength textile and reinforcement in composites for various applications (Navin Chand and Rohatgi, 1994; Soumitra Biswas et al, 2005).

Uses of Sisal

The leaves of sisal yield a strong fibre (Fig. 3), which is traditionally used for making ropes, cordage and twines. It is also being used to manufacture coarse fabrics, rugs, carpets, handicrafts, mats, fishing nets etc. The sisal pulp left after fiber extraction (which is about

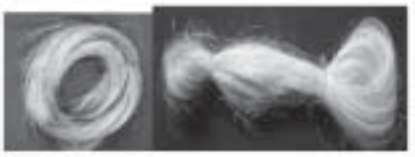

Fig 3: Processed Sisal fibre

95%) is used for making paper / paperboards, hecogenin (a cortico steroid), wax, biogas etc (CFC, 2000).

Sisal: Engineering Applications

Due to superior mechanical properties and recyclable nature, sisal fiber can be used as potential input material for making composites for application in buildings, automobiles, railways, geo-textiles, packaging industries etc. Sisal fibre reinforced composite building materials like; wood substitute products, panels, doors, corrugated roofing sheets and instant houses suitable for disaster (floods / tsunami / earth quake) prone areas would be made which attract prospective entrepreneurs and stake holders due to its durability and cost effectiveness. Asbestos fibres being carcinogenic, sisal fibre cement corrugated roofing sheets, which are eco-friendly, can be an effective alternative.

Present scenario indicates that the use of plant fibre (sisal / flax / hemp etc) based automobile parts like trim parts, various panels, seat backs, shelves, brake shoes etc., are picking up momentum worldwide. Reduction in weight (10%), energy of production (80%) and cost of the components (5%) as experienced elsewhere, attracts the automobile industry to employ sisal fibre composite parts in India. The conservative estimates indicate that about 6,000 TPA plant fibre based composite parts can find their way into passenger cars and multi utility vehicles (OSEC, 2004). Railways are also a potential application area where in it is estimated that about 350 TPA fibre composites is required for manufacture of doors, luggage racks, panels, partitions, seating etc (Nangia et al, 2005).

Packaging materials for bags, boxes, crates, containers, which is now made up of wood, can be replaced by cost-effective sisal reinforced composites. Boats can be made by replacing the conventional polymer composite fibres with sisal as reinforcement. The market potential of geotextiles for roads, paved road networks and railways applications in India is estimated to be 2,72,500 tonnes, of which a considerable portion can be earmarked for sisal-based textiles (Vibrant Gujarat, 2005).

Sisal: Employment Generation

Since sisal is a xerophyte, its establishment in major parts in India is not a constraint and its cultivation involves least water and crop management during its survival period of about 10 years. They can be raised along the bunds, hedges, forest and wastelands for soil conservation. Once established, an assured production of about 2.5 tonnes/hectare/year is possible for 6-8 years. Presently sisal plantations and their allied activities is an unorganized sector localized mostly in rural and tribal areas. Sisal plantation activity has the annual employment potential of about 113 man-days per hectare. The state of Madhya Pradesh has 14.17 lakh ha. barren and uncultivated wastelands, out of which 3.00 lakh ha (20%) can be targeted for sisal plantations, which can generate enormous employment potential for 1.20 lakh people for cultivation and fibre extraction. The sisal fibre is an input material for various rural applications involving cordage and ropes, mats, handicrafts and other utility items, which can augment the employment opportunities for income generation in rural sector.

Sisal: Spin offs

It is discernible that there is a huge quantity of sisal waste (95% of the leaves by weight) can be effectively utilized for composting, vermi-composting and extracting other valuable products. The pilot scale demonstrations show that it is a valuable feedstock for biogas plants to cater to the local and rural energy requirements. One tonne of sisal pulp can generate 54.3 m3 of biogas by the methanogenesis (Leo Oudshoorn, 1995). Sisal leaves are known to contain wax (0.38%) and hecogenin (0.10%). These expected spin offs in the form of secondary / allied activities which are labour intensive and have applications in rural and small-scale industrial sectors.

Sisal: RRL Expertise

Regional Research Laboratory (RRL), Bhopal is involved in R & D activities on sisal fiber extraction, processing and product design. It has developed a versatile machine (Raspador) for the mechanical extraction of sisal fibre (Fig. 2). The laboratory has been imparting training to the rural masses, especially the women folks in making handicrafts (Fig. 4) from sisal fiber. RRL has also developed the vermi-composting technology by utilizing sisal leaf residue to produce eco-friendly manure. Based on the expertise the laboratory has developed sisal-fiber reinforced corrugated roofing sheets (Fig. 5) and sisal fiber-polymer composites, which are alternate building materials superior in quality, eco-friendly, non-carcinogenic and cost-effective. Basic Research and design need to be carried out for the development of crimp property of the fibre for making yarn, various surface treatments and processes to over come the hydrophilic nature, improving the interfacial bonding and mechanical properties of the fibre. The 'Building Materials Characterization and Testing Centre' and 'Technology Enabling Centre' for R-WOOD are the additional expertise and facilities available to substantiate.

Fig. 4 Sisal fibre Handicrafts and Training Program on Sisal fibre Handicrafts organized by RRI Bhopal

Fig. 5 Sisal fibre reinforced corrugated Roofing Sheets

The sisal fibre and its allied activities like cultivation; fibre extraction, processing and making value added products are proven sources of employment opportunity and income generation. The present experience indicates that trained artisans and women are able to sustain with the income generation through the sisal related activities. The engineering applications of sisal fibre like buildings, automotives, railways etc. are the prospective areas where it can generate employment potential. Easy to raise on wastelands in a wide range of agro-climates, sustained fibre yield for a considerable long duration, versatility of the fibre as a potential input material for various applications makes it a viable option for employment generation and rural development.

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