

Coconut - Beyond copra, oil and water

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The coconut palm has been the subject of great adulation and admiration across the world and down the ages. It was domesticated mainly for copra, oil and tender nut water. Coir is another important product out of the fruit botanically the mesocarp. This is perhaps the only tree, which has a systematic recorded history dating back to nearly 3000 years before the birth of Christ. Botanists say that the coconut was domesticated in neolithic, stone age, times. When the 1st Ice Age has frozen much of the waters of the world reducing the distance between the islands and continents, seafaring tribes found it easy to move between landmasses. They carried coconuts for food and water during their voyages and planted whatever was left over in their new home.

The word 'Coir' refers to a stiff coarse fiber from the outer husk of a coconut fiber, a slender and greatly elongated solid substance. Indian coir industry is an important cottage industry contributing significantly to the economy of the major coconut growing States and Union Territories, i.e., Kerala, Tamil nadu, Andhra Pradesh, Karnataka, Maharashtra, Goa, Orissa, Assam, Andaman & Nicobar, Lakshadweed, Pondicherry, etc. About 5.5 lakh persons get employment, mostly part time, in this industry. Coconut husk is the basic raw material for coir products. Around 50 per cent of the available coir husk is used to produce coir products. Hence, there is scope for growth of coir industry.

TYPES OF COIR

Brown fibre

The fibrous husks are soaked in pits or in nets in a slow moving body of water to swell and soften the fibres. The long bristle fibres are separated from the shorter mattress fibres underneath the skin of the nut, a process known as wet-milling. The mattress fibres are sifted to remove dirt and other rubbish, dried and packed into bales. Some mattress fibre is allowed to retain more moisture so that it retains its elasticity for 'twisted' fibre production. The coir fibre is elastic enough to twist without breaking and it holds a curl as though permanently waved. Twisting is done

by simply making a rope of the hank of fibre and twisting it using a machine or by hand. The longer bristle fibre is washed in clean water and then dried before being tied into bundles or hunks. It may then be cleaned and 'hackled' by steel combs to straighten the fibres and remove any shorter fibre pieces. Coir bristle fibre can also be bleached and dyed to obtain hanks of different colours.

Brown coir is used in brushes, doormats, mattresses and sacking. A small amount is also made into twine. Pads of curled brown coir fibre, made by needle-felting (a machine technique that mats the fibres together) are shaped and cut to fill mattresses and for use in erosion control on river banks and hillsides. A major proportion of brown coir pads are sprayed with rubber latex which bonds the fibres together (rubberized coir) to be used as upholstery padding for the automobile industry in Europe. The material is also used for insulation and packaging.

White Fibre

The immature husks are suspended in a river or water-filled pit for up to ten months. During this time micro-organisms break down the plant tissues surrounding the fibres to loosen them - a process known as retting. Segments of the husk are then beaten by hand to separate out the long fibres, which are subsequently dried and cleaned. Cleaned fibre is ready for spinning into yarn using a simple one-handed system or a spinning wheel.

The major use of white coir is in rope manufacture. Mats of woven coir fibre are made from the finer grades of bristle and white fibre using hand or mechanical looms. Coir is recommended as substitute for milled peat moss because it is free of bacteria and fungal spores.

Coir processing

Coir or Cocos - Nature's wonder fibre is extracted from the protective husk of the coconut. This golden fibre is spun in a breath - taking range of textured yarn and woven into a spectrum of colorful floor covering

The husks separated from the nuts are retted in lagoons up to ten months. The retted husks are then beaten with wooden mallets manually to produce the golden fibre. The fibre is later spun into yarn on traditional spinning wheels called "Ratts", ready for dyeing and weaving into myriad shades of floor coverings. A score of varieties/grades of coir yarn are produced and each variety is associated with certain specific characteristics, used for industrial, agricultural and domestic applications.

The starting point of the industry is the process of dehusking after harvesting of the mature coconut crop. Coir fibers are extracted from the husks surrounding the coconut.

In most areas coir is a by-product of copra production, and the husks are left on the fields as mulch or used as fertilizer due to high potash content.

For production of light coloured fibre of spinnable quality green husk of 10 to 12 months old coconuts is ideally suitable. India and Sri Lanka are the main areas where the fibres from the husk (termed 'coir') are extracted by traditional methods for the commercial production of a variety of products (brushes and brooms, ropes and yarns for nets and bags and mats and padding for mattresses). However, world wide, only a small part of the fibres available are currently used for these purposes.

Fibre Extraction

The processes of fibre extraction are varied, and depend on the effectiveness of the wet processing such as bleaching and dyeing of coir and also varied end uses.

Traditional fibre extraction

The traditional production of fibres from the husks is a laborious and time-consuming process. After separating of the nut, the husks are processed by various retting techniques generally in ponds of brackish waters (for three to six months) or in backwaters or lagoons. This requires 10-12 months of anaerobic (bacterial) fermentation

By retting, the husks are softened and can be decorticated and the fibre is extracted by beating, which is usually done by hand. After hackling, washing and drying (in the shade) the fibres are loosened manually and cleaned. The remaining residual pith - which was previously considered a waste problem -

has recently found new profitable markets as a peat moss substitute for horticultural production.

Traditional practices of this kind yield the highest quality of (white) fibre for spinning and weaving. Retted fibres from green husks are the most suitable fibres for dyeing and bleaching. For the production of more coarse brown yarns shorter periods of retting may be applied. These find an increasing outlet in geo-textile applications.

Mechanical Extraction

Alternatively, mechanical processes using either de-fibering or decortivating equipment process the husks after only five days of immersion in water tanks. Crushing the husk in a breaker opens the fibres. By using revolving "drums" the coarse long fibres are separated from the short woody parts and the pith. The stronger fibres are washed, cleaned, dried, hackled and combed.

Green decortication and Microbial treatments

New environmentally friendly methods for fibre production are of interest. These can be locally exploited on relative small-scale, and have the potential to produce a more constant quality of fibres. Novel developments by the Central Coir Research Institute, under Coir Board, using a bio-technological approach with specific microbial enzymes have reduced the retting time substantially to three to five days. High quality fibre production has been maintained.

Similar protocols can be developed to enhance the properties of the fibres in regard to surface properties such as smoothness and porosity. By using specific (microbial) lignolytic enzymes (laccase/phenoloxidase), the fibre surface can be bleached (or activated to react more easily with the dyes).

Formation of Yarn

Hand Spinning

The usual practice in hand spinning is to roll the fibre into short length of 6 to 9 inches, giving a clockwise twist by hands. When a sufficient quantity has been made, two of these short lengths are taken in hand together and made into yarn of two plies by giving a counter twist, using both palms.

When the counter twist reaches near the end of the striking, further pieces of short lengths kept ready are added one after other, while the counter twist by

hand is continued till the required length of yarn for a knot is reached. This is reeled in the form of a hank and a knot is made at the end. Handspun yarn always has a soft twist.

Traditional Ratt Spinning

Spinning is usually done on the 'Charka' or spinning wheel. Wheel spinning is gradually displacing hand spinning.

From the middle of the 19th century, coir spinning wheels have been introduced with a view to increasing production and obtaining the hard twist required for the manufacture of matting, etc.

To prepare two-ply coir yarn on the spinning wheel, one set of two wheels, one stationary and the other movable is required. The stationary wheel usually contains two spindles set in motion through the centre of the wheel. The movable wheel contains one spindle only. Two persons take the silvers of 'coir' prepared and kept ready after willowing.

Usually women keep them in their arm pits, make a loop with a small quantity of fibre and then puts the loop thus formed into the notch of one of the spindles on the stationary wheel and gives the fibre a uniform thickness while walking backward. Another operator then gives the twist to the fibre thus led by turning the handle of the spinning wheel. This operation is continued till the required length of strand is reached. The strands are then passed through a grooved rod and tied together into the notch of the spindle, the grooved rod being allowed to move forward. The movable wheel is turned in the opposite direction.

The object of the grooved rod is to regulate the twist of the yarn and to prevent entanglement of the strands at the time of doubling. When the grooved rod reaches the stationary wheel, the turning of the spindles of the spinning wheel is stopped and all the ends from that of the stationary wheel are cut off and the yarn is tested to see whether there is sufficient twist. If more twist is required, the movable wheel is turned toward its original direction till the required twist is obtained, if it contains more twist than desired, the movable wheel is turned in a direction contrary to the original twist. Traditional Wheel spinning using a spinning wheel requires three people, who may produce 12-15 kg of yarn per day.

Motorised Traditional Ratt

Motorised Traditional Ratt is a developed form of a coir spinning 'charka'. Here, the stationary ratt is rotated using a suitable contrivance attached to an electric motor. By attaching the rotating system to the stationary ratt one worker is avoided and the productivity is increased. The wages thus earned are divided among the two workers resulting in enhancement of wages of spinners. This system has been introduced recently and found successful in the industry for spinning all varieties of yarn.

Motorised Ratt

The research and development in coir industry was mainly aimed for reducing the drudgery of the workers involved in the spinning of coir yarn on traditional and motorized traditional ratts. Two or three spinners are engaged for exercising the production activity in yarn spinning, where they are exposed to changing weather conditions, which ultimately affects the production. They are also forced to walk up and down in the spinning yard for taking the individual strands and for doubling operation.

It was a long time dream of the coir industry to introduce a contrivance for reducing the drudgery of the labourer and improve the productivity and also enhance the earnings of the workers engaged in the spinning. As a result of research and development, a spinning device for attaining the real goals of reducing the drudgery, improving the productivity and to improve the working environment, the motorised ratt was introduced in the industry.

In the case of a motorised ratt the spinner is made to sit on a chair /stool and roll the well cleaned fibre stacked in the spinning trays attached to the spinning device where the yarn is spun and wound over the bobbins attached to the ratt.

The simple device is now popular in the industry and the benefit of the device has been extended to all spinning areas, all over India. Coir B'oard has taken all efforts to popularise this spinning device and a scheme has been evolved under 'Mahila Coir Yojana Scheme' for providing motorised ratt to spinners at a subsidised rate. The introduction of the motorised ratt in the industry has paved way for increasing the employment opportunity, as the new generation has taken up the spinning activity in the coir sector as the change in the working environment. All varieties of coir yarn in the industry are produced on ratt with a slight alteration on the equipment.

Automatic Spinning

The production turnover in the case of hand spinning was less. The efforts to maximise the productivity of the yarn resulted in the introduction of automatic spinning machine units.

The automatic spinning machine units are capable of production of yarns of runnage varying from 50 to 300 meters/kg and twists from 10 to 30 twists/feet. Coir fibre in the form of bales is the raw material for the unit. These fibres are soaked in water for one hour and are cleaned in the willowing machine. Pith content and the hard bits are removed in the process. Manual attention is also required to remove the hard bits to the fullest extent. These cleaned fibers are passed in to the feeder of silvering machine where the fibers are paralleled and drawn by draw rollers. These paralleled fibers are twisted and taken on to drum.

The twisted paralleled fibers are called silvers. These silvers are fed on to the feeder of the spinning machine and are combed and made to fall on to "W" tray. Core threads of nylon/cotton/HDPE/LDPE assign in the tray are used as carrier agent for the coir fibres. These fibres are entwined on to the thread and are twisted by the grip nozzles/rollers. Two such strands are doubled and wound on to a bobbin to form the yarn of required twist and runnage. The automatic spinning machine facilitates spinning of any varieties of yarn according to the requirement of the industry by varying the parameters of the machine to vary the twist and/or runnage. The yarns thus formed are wound in the form of balls for the easy transportation.

Rope making

Hand spun yarn; spun from coir fibers which are less cleaned and extracted from inadequately retted husks; containing varying amounts of pith; characterised by its extraordinary thickness; unclean in appearance; very less hairy. The runnage ranges from 50 mts to 60 mts & above.

The major types of ropes are as follows

Beypore: Hand spun yarn; spun from coir fibres extracted from insufficiently retted husks; of bluish brown colour comparable in thickness to thinner types of roping; containing small amounts of pith and husk; less dirty than the other types of inferior varieties of yarns. The runnage ranges from 70 to 90 metres

Beypore - Z: Hand spun yarn; spun from coir fibres extracted from insufficiently retted husks; of bluish brown colour; comparable in thickness to thinner types of roping; containing small amounts of pith and husk, less dirty than the other types of interior varieties of yarns. The runnage ranges from 70 to 90 mts.

Quailandy: Hand spun yarn; spun from fairly well cleaned coir fibres extracted from retted husk, natural bright golden to greyish in colour; similar in appearance and texture to Ashtamudy; fibres being insufficiently opened lie adhering to each other in the yarn. The runnage ranges from 110 to 130 mts.

Dyeing

Dyeing of coir fibre/yarn is essential for improving the marketability and aesthetic value of coir products and according to customer taste. A dyestuff is most commonly an organic compound, which can be used to impart colour to a substance. A Wide range of dyes capable of yielding bright shades of excellent fastness are available for the dyeing of yarn.

In dyeing, the fibre absorbs the dye from the aqueous solution is more or less uniformly coloured. The uniformity of dyeing depends upon the absorptive power of coir fibre, the nature of the dye and condition of dyeing. The dyed shade usually must be matched against a sample and the fastness of the dyeing must conform to the specified requirement of the consumer.

Traditional method of dyeing coir

In the conventional method, the dyeing is carried out in copper or aluminium/Indalium or G.I. vat of 1.2 M diameter and 0.75 height place on hearth made out of country bricks, fired from below using country wood. The dye vat is sufficient to process 60 kg. of coir yarn or 30 kg. coir fibre with a material to liquor ratio of 1:12 for coir yarn and 1:20 for coir fibre.

After filling with required quantity of water, it is heated from below till the required temperature is reached. The required quantity of dyestuffs and chemicals are added to the dye bath after making into a paste. The dye bath is stirred well and the material is entered and turned manually at frequent intervals for level dyeing. At the end of dyeing the material is taken out washed in cold water and dried under shade.

Improved method of dyeing coir

The improved method of dyeing process is carried out by highly skilled professionals in the industry using

dye vats made of stainless steel and fitted with drainage valve for proper draining of dye effluents.

The vats are fixed on hearths made of firebricks with flue pipes for efficient air draught for maximum utilization of the heat energy. The dyes are taken as per recipes formulated by the Central Coir Research Institute (CCRI), which is available in the shade cards. The quality of dyeing is improved compared to the traditional method of dyeing.

Mechanized System of Dyeing

In the mechanized system of dyeing, coir yarn is dyed, comprising of dye vats with forced circulation of the dye liquor in two-directions on uniformly arranged coir yarn for uniform level dyeing. The temperature is controlled as per the requirement by regulating the flow of heating system. After the dyeing operation, hydro-extractors are used to drive out of the major part of the mechanically held up water and finally these materials are dried on the endless conveyor dried, for efficient drying. This system of dyeing helps to improve the penetration, shade consistency, uniform dyeing on coir fibre/yarn by the action of temperature efficient and forced circulation of dye liquor and period of dyeing. This method help to dye large quantities of material at a time avoiding shade variation compared to the other two processes.

The classes of dyes used in coir industry

Dyes belongs to the classes of Basic Acid and Direct dyes are suitable for achieving better fastness properties, penetration and brilliant shade with less cost are common in use in coir industry. These dyes are applied to the materials from their solutions in water with the aid of chemicals like acetic acid, sulphuric acid, formic acid, common salt etc. This facilitate the transfer of dyes from the dye bath to the fibre/yarn under appropriate conditions of temperature for specified periods depending on the dyestuff that is being used. The basic dyes have high tincture value and affinity to coir but are fugitive to light and rubbing. The acid dyes have better fastness to light but of less brightness than basic dyes. Direct dyes find use in producing shades having fastness properties better than acid dyes but they produce dull shades and require longer processing time.

Dyeing of coir with reactive dyes (ATIC - Procion Brand cold dyeing)

The dye bath is set with the required quantity of

dyes stuffs dissolved in water in cold (1:10 m:l ratio) with half the required quantity of salt. The wetted/coir yarn is entered and treated for 20 minutes. The remaining part of the salt is added and worked for another 20 minutes. Half of the prescribed quantity of soda ash is then added and worked for 15 minutes. After wash the remaining part of soda ash is also added and worked for 20 minutes. 10 gl litre urea is added in the dye bath for fixing the dyes to the material at the final stage of dyeing and the material is allowed to remain in the bath for 15 minutes. After dyeing, the material is taken out, squeezed and washed in cold water. Finally the material is soaped with 3 grams per litre soap at boil for nearly 15 minutes, to remove the excess dye stuffs. The material is thoroughly washed in cold water and dried in air under shade. During the process of drying the material is subjected to thorough agitation to have excellent contact of the material with the dye liquor.

The major quantity of dyeing of coir fibre/yarn is done in the small-scale sector using conventional process. With a view to improve the quality of dyed material, modern dyeing methods are also adopted by the industry.

Coir dyeing with Nucifex dyes from Triade BV Rotterdam

The Nucifex dyestuffs range is specially developed for natural fibre such as coir yarn etc.

Compatibility

Nucifex dyes ranging with their almost similar dyeing properties, they can be freely applied together in combination.

Substrate	Bleached coir yarn
Types of Dyes	Nucifex
% based on	Yarn dry weight

Process Dyeing

Fresh bath	1:15	Liquor at 50 C
	X %	Nucifex dyes Run 10 min at 50 C, followed raise temperature to 80-85 C. Continue dyeing for 90 min.
		Add 1-2% Formic acid (1:10) Run 30-45 min.

After treatment (Use fresh bath) 0.5-2 % Fixing agent (improves wet fastnesses)

Cool down, rinse very well and drying

Bleaching

Bleaching of coir fibre/yarn is essential for improving the colour. This is widely used in coir industry for the purpose of ornamentation of coir products. There are certain shades of dyestuffs to be used in the production of coir matting/carpets, which require bleaching of yarn to improve its penetration and brightness especially in the case of pastel shades.

It is estimated that about 20% of the coir yarn/fibre used for the manufacture of coir mats, mattings rugs and carpets are made out of bleached coir yarn in the coir industry. Bleaching of coir fibre/yarn is generally being carried out using hydrogen peroxide.

The oxidation process using hydrogen peroxide is in vogue in the coir industry. There are two process followed in the industry viz; Hot and cold process. It is also observed that none of the factories are using imported chemicals for bleaching of coir materials. Generally, the chemicals used for bleaching are hydrogen peroxide and sodium silicate. However, there are wide variations in the recipe of different factories as well as the degree of whiteness.

Global trade

Total world coir fibre production is 250,000 tonnes. The coir fibre industry is particularly important in some areas of the developing world. India, mainly the coastal region of Kerala State, produces 60% of the total world supply of white coir fibre. Sri Lanka produces 36% of the total world brown fibre output. Over 50% of the coir fibre produced annually throughout the world is consumed in the countries of origin, mainly India.

Traditional uses for the coir fiber include rope and twine, brooms and brushes, doormats, rugs, mattresses and other upholstery, often in the form of rubberized coir pads. since 2001, a rising Chinese demand for coir, an expanding market for coir-based erosion control products, and the spread of coir pith as a peat moss substitute in horticulture has further pushed up global production and prices. In turn, other coconut growing countries, including Philippines, Thailand and Vietnam are now expanding their production and export of coir fiber. These changes are also reflected in the international trade in coir. Historically, Sri Lanka had been the world's largest exporter of various fiber grades, whereas India

exports largely value added products – yarn, mats, and rugs. While in 1990 about 80% of global production was exported, growth of the Indian domestic market dropped that rate to below 40%. Global trade volume for coir fiber, value added products – yarn, mats, rugs – and coir pith now stands at about \$140 million per year with India and Sri Lanka respectively accounting for about \$70 and \$60 million of that amount. This may not seem much but in the coconut regions of producing countries coir is an important economic factor. In Sri Lanka, coir related exports account for 6% of agricultural exports, over 1% of all exports and 0.35% of GDP. Moreover, coir milling and value addition, mostly spinning and weaving, are important regional employers, particularly in rural Southern India and coastal Sri Lanka. They give work to 500,000+ people, many of them women working part-time. Yet, working conditions and productivity are generally poor.

Schemes operated by Coir Board

There are several schemes under implementation by coir board viz., Rejuvenation, Modernization and Technology Upgradation of the Coir Industry, Scheme of Fund for Regeneration of Traditional Industries (SFURTI) and Skill Upgradation and Quality Improvement Scheme etc

Coir research:

Research on coir is conducted at the following institutes.

Central Coir Research Institute, Kalavoor, Alappuzha, Kerala.

Central Institute of Coir Technology, No. 3A, Peenya Industrial Area, Bangalore-560 058, Karnataka

Prospects

The challenge for industry is to sustainably expand markets for this versatile renewable resource while maintaining its role as employer for the rural poor. This may require producers to innovate production, improve product consistency, and in particular develop novel applications – jointly with their customers in importing countries. Businesses, public agencies and research institutes are now addressing this challenge in multilateral projects worldwide – setting examples that global trade can be beneficial to all parties involved.

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