Ramie:

A fibre crop of new opportunities

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Ramie (Boehmeria nivea) is used commercially for fiber production. The fiber obtained from ramie plant is one of the strongest vegetable fiber known in the world today. It possesses highest strength and length, good durability and absorbency with excellent luster. These remarkable characters make it rather more suitable for use in the manufacture of wide variety of textiles and cordage products. However, despite its unique quality, ramie has received comparatively less prominence in the calendar of important crops of the world. Recently with the availability of more technical know how, the crop has started getting slightly more importance and the countries like China, Korea, India, Brazil and the Philippines have come forward with commercial cultivation with some or larger extent.

'R 1411' at its flowering stage

Sprouted ramie rhizome ('R 6734')

Ramie (*Boehmeria nivea*) commonly known as Chinese grass, white ramie, green ramie and rhea is one of the group referred as bast fibre crops. It differs from the other bast fibre crops in various features. One of the feature is that ramie is a perennial crop and under suitable conditions it can be harvested up to six times a year. The life of this crop ranges from 6 to 20 years. The other feature is that the bark contains gums and pectins which require a chemical treatment to recover the bast fibres. Ramie fibre has an ditchshaped cavity and multi-holes on its wall, so the ventilative quality is about three times higher than the cotton fibre. At the same time, ramie fibre contains pyrimidine and purine which can bate the golden staphylococcus and coliform. It has the properties like anti-decay and anti-bacteria. It is suitable to weave many kinds of

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health-care products, it has been regarded as the "King of all natural fibres". It is predominantly being grown in the north-eastern region of India. Although this crop has also been successfully tried in other parts of India like Maharashtra (Chiplun), Goa (Old Goa) and Tamilnadu (Chinacoonoor) etc. However, China is the highest producer of ramie.

Germplasm resources

Globally germplasm collections of ramie in different countries are in place. In India, 130 ramie germplasm lines have been collected and maintained at Ramie Research Station (RRS), Sorbhog, Assam. Among the five elites (R 1452, R 1449, R 1412, R 1411 and R 6734) available with RRS of Central Research Institute for Jute and Allied Fibres (CRIJAF), 'Kanai' (R6734) is well accepted because of its increasing demand and good quality.

Botany

Ramie is known for the troublesome variability and is one of the most difficult genus for the taxonomist throughout the distribution range, i.e. the tropical to temperate regions of Asia, Oceania, America and some islands in Indian Ocean. The crop ramie has more than 100 species. Cytological studies revealed that the basic chromosome number of the genus *Boehmeria* is x=14 and diploid, triploid, tetraploid and pentaploid are known of which diploid plants propagated sexually while polyploids showed agamospermy. It is a hardy perennial which produces a large number of unbranched stems from underground rhizomes. The true ramie or 'China grass' is also known as 'white ramie' and is the Chinese cultivated plant. It has large heart shaped, crenate leaves covered on the underside with white hairs that give it a silvery appearance.

A second type, *Boehmeria nivea* var *tenacissima*, is known as 'green ramie' or 'rhea' and is believed to have

Bleached ramie fibre

originated in the Malay Peninsular. This type has smaller leaves which are green on the underside and it appears to be better suited to tropical conditions. In India, the green ramie is reported to be as another species namely, *Boehmeria utilis.*

The stems of ramie grow to a height of 1 to 2.5 m. The plant produces a large number of erect and slender stems or stalks, usually non-branching and grows from 4 to 7 leaves that are silvery white underneath, 7.5 to 15 cm long with clusters of small greenish flowers, ranging from 8 to 16 mm in diameter. The stalks turn brown and woody on maturity.

Crop features and microclimate for regeneration

The crop is generally propagated vegetatively, using rhizome or stem cuttings. Production begins to decline once roots become overcrowded. Roots suffering overcrowding require thinning out or the area must be replanted. The most suitable climate for ramie is one which is warm and humid with an annual rainfall (or irrigation) of at least 1000 mm, evenly spread over the year. The relative humidity of 80% during the growing period is found to be best. The optimum temperature for the good harvest is around 20-31^{0}C and the relative humidity should be at least 25%. The crop can be cultivated up to an altitude of within 300 m above mean sea level. The crop is tolerant of a range of soil types but is reported to be sensitive to waterlogging.

Well established plants can tolerate moderate drought and frost but grow better where these are absent. The crop prefers slightly acid soil conditions with pH in the range of 5.5 to 6.5. As productivity is high, ramie can rapidly deplete the soil of nutrients so it is therefore important to either return the plant residues to the soil or add organic or inorganic fertilisers. In acid soil (pH 4 to 5) the crop can be grown with the application of lime @ 4 to 6 tonnes/ha.

Research reports from China reflects that the fiber yield is reduced when ramie is produced under drought stress. Fiber yield used to be better in drought tolerant cultivars of ramie, because these cultivars had adapted root systems, leaf responses, cellular responses, and biochemical activities to allow plants to continue higher levels of photosynthesis and carbon deposition under more stressful environments than the less drought tolerant cultivars.

Researches from other countries like China shows that *in-vitro* tissue culture of ramie could serve as an important means for its improvement through genetic transformation. To improve the regeneration capacity of ramie, the effects on plant regeneration of donor plant age, basal medium, plant growth regulators, and culture conditions have been researched using explants derived from the cotyledon, hypocotyl, leaf, petiole, and stem of ramie seedlings.

Phytomedicinal properties

Ramie plant is having the properties of antiphlogistic,

Ramie crop in the field at its growing season

demulcent, diuretic, febrifuge, haemostatic and vulnerary etc. It is commonly been used to prevent miscarriages and promote the drainage of pus. The leaves are astringent and resolvent. They are used in the treatment of fluxes and wounds. The root contains the flavonoid rutin. It is antiabortifacient, antibacterial, cooling, demulcent, diuretic, resolvent and uterosedative. It is used in the treatment of threatened abortions, colic of pregnancy, haemorrhoids, leukorrhoea, impetigo etc. The fresh root is pounded into a mush and used as a poultice as well. There is a United States patent 7431946 on method for producing extracts of *Boehmeria nivea* for hepatitis treatment.

Crop husbandry and fibre yields

Ramie crop can be grown from rhizome, seed and stem cuttings. However, ramie is propagated vegetatively mainly through rhizomes for commercial production throughout the world. The practice of propagation through rhizomes ensures good sprouting, clonal purity and is economical. The quantity of rhizomes obtained from an unit area depends on the age of plantation and variety. Usually the quantity of rhizomes obtained from one hectare of 2-4 years old plantation can give enough planting material to cover at least 20 hectares of land. Ramie rhizome is pale brown in color and grows parallel to soil surface. In any ideal agro-climatic condition rhizome can be planted at any time but preferable planting time is May to October. Rhizomes of 10-15 cm in length are usually planted horizontally at 5-6 cm depth in furrows with a spacing of 30 cm between pieces and 60 cm between rows to have the optimum yield.

Seeds are very small and almost black or blackish grey, blackish brown or light brown in color. For land preparation 3-4 cross ploughings followed by laddering are generally been practiced. Application of $N_{20}P_{10}$ and K_{10} kg/ha after two months of planting is recommended in India. Afterwards the application of $N_{30}P_{15}K_{15}$ kg/ha per cutting results in higher fibre yield. Application of manure (water hyacinth/farmyard manure/leaf manure/green manure) maintains soil health. It has been calculated that production of 1q of undegummed fibre removes 15.3, 4.2, 9.3 and 27.5 kg of N,P_2O_5,K_2O and CaO respectively. Researches shows that intercropping with coconut, arecanut, rubber, tea, pineapple etc. is good. Intercropping with pea, wheat and mustard has also been reported to be remunerative for the farmers.

In Indian situation, fibres up to 4-5% by weight of total biomass may be obtained from ramie. Raw fibre yield up to 16-22 q/ha fibre may be harvested per year under ideal condition.

According to international reviews the dry weight of harvested stem from both tropical and temperate crops ranges from about 3.4 to 4.5 tonnes/ha/year; a 4.5 tonne crop yields about 1,600 kg/ha/year of dry undegummed fibre. The weight loss during degumming can be up to 25% giving a yield of degummed fibre of about 1,200 kg/ha/year.

In Philippines, reports there are that ramie has an average yield of 1,575 kg of dry fiber based on three cuttings per hectare per year. Approximate potential yield of ramie per hectare (per year) may reach 2,700 to 4,800 kg of fiber per year. Dry fiber recovery ranges from 3.5 to 5%.

Regarding pest it has been reported that there are 4 types of pests in ramie, like that of lucern caterpillar, leaf roller, hairy caterpillar, black caterpillar, orange caterpillar, cockchafer beetle and *Afridenta* beetle.

No major diseases has been reported in ramie while mild incidence of *Cercospora* leaf spot, *Phyllostica* spots and eye rot have been observed in ramie plantation. Under moist humid condition of Assam a number of saprophytic fungi has been found in the decorticated fibre.

Extraction and degumming of fibre

Extraction of the fibre occurs in three stages. Firstly, the cortex or bark is removed, either by hand or machine, in a process called decortication. The CRIJAF has developed one such machine has a capacity to decorticate 800-1000 kg fresh canes from an area of 500 m^2 yielding about 35-40 kg dried fibre per day. The CRIJAF has also developed a more user friendly and cost-effective 1 HP motorized Bast Fibre Extractor for this purpose in the recent past. The second stage involves scraping the cortex to remove most of the outer bark, the parenchyma in the bast layer and

some of the gums and pectins. The third stage involves washing, drying and degumming of the residual cortex material to extract the spinnable fibre. Details of the degumming processes tend to be regarded as commercial-in-confidence information. Most of the processes involve a treatment with caustic soda to dissolve the residual pectins and gums. The process of degumming improves the tenacity, fineness and luster of machine extracted fibre. The fibre may also be chemically and microbially degummed.

Ramie fibre (chemical and physical attributes)

Ramie fibre is one of the premium vegetable fibres. The ultimate fibres are exceptionally long and are claimed to be the longest of vegetable origin, with one report claiming the fibres range up to 580 mm, averaging about 125 mm. Another report describes the ultimate fibre as ranging between 48 and 290 mm in length. One US study reported the range of bark fibre length as 5 to 36 mm and the fibre width as 41.8 microns. Ramie fibre is very durable, is pure white in colour and has a silky luster.

Tables 1 & 2 show the chemical composition and the physical properties of some plant fibres in comparison with ramie fibre. As it is evident that cellulose is the main constituent of plant fibres followed by hemi-celluloses and lignin interchangeably and pectin respectively. Cellulose is also the reinforcement for lignin, hemi-celluloses and pectin. This makes plant fibres exhibit characteristics of a composites material. The physical properties shown in Table 2 are those of the single cell (ultimates) fibres, i.e. the physical properties of leaf and bast fibres. Ramie is having highest aspect ratio of 4639 (1/d) in comparison to other plant fibres which exhibit highest tensile properties provide high surface area advantageous for reinforcement purposes.

Ramie is also reported to have a tensile strength eight times to that of cotton and seven times greater than silk. However, other reports claim that the tensile strengths of cotton, flax, hemp and ramie are similar. These discrepancies can be partly attributed to the effects of source of supply, method of processing, the test conditions, temperature and humidity, on the fibre strength.

Usage of ramie

Ramie fibre is generally been used in fine linen and other clothing fabrics, upholstery, canvas, filter cloths, sewing threads, gas mantles, fishing nets and marine packings. When used in admixture with wool, shrinkage is reported to be greatly reduced as compared with pure wool. High quality papers, such as bank notes and cigarette papers can be produced with short fibres from processing wastes. Pulping trials conducted in the USA rated ramie as among the best of the potential pulp sources. Very specifically when the gum content of ramie comes out to be below 3-5%, it can be used for textile mill for fabric manufacture and also suitable for cotton system of spinning. If the gum content ranges from 3-6%, the fibre is generally used for apparel and cordage industries. If the gum content is above 6%, the fibre is used for making hose pipe, water bags, shoe threads and commercial canvas etc. Ramie can be used as very good pig feed and overall its forage and fodder value is a researchable issue as well.

Economics of cultivation

Ramie has been proved quite remunerative when grown under favourable agro-climatic situations. The income generally starts from the second year and onward. After five years of cultivation, sale of fibre (Rs. 41 /kg) and rhizome (Rs. 25 /kg) produced thereof a conservative estimate reflects that in Sorbhog, Assam situation the net profit comes out to be of Rs. 582,985 per hectare.

Potential production areas in India

In India, ramie can be grown successfully under suitable soil and edaphic conditions in north-eastern parts like Assam, Arunachal Pradesh, Manipur, Nagaland, Tripura and northern parts of West Bengal. Successful trial plantings of ramie have been conducted at Maharashtra, Goa and Tamilnadu etc.

SUMMARY

It is difficult to obtain accurate information on the level of current imports of ramie fibre and fabric into India and the value of those imports. Ramie fibre is acknowledged as a high quality fibre but its production is labour intensive. The need for chemical treatment to extract the fibre has also been seen as a serious disadvantage. However, experience with many other crops shown that all facets of production and processing can now be mechanised and this could make Indian-grown fibre competitive with production from traditional growing areas. ■

When god created the first man he took him and led him around all the trees of the Garden of Eden and said to him: Look at my works, how beautiful they are! Take care that you do not corrupt and destroy my universe, for if you destroy it no one will repair it after you.