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AGRONOMY

Exploration of Profitability in The Cultivation of Ramie (*Boehmeria nivea* L. Gaudich.) Fibre for Sustaining Rural Livelihood

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ABSTRACT

Ramie or (*Boehmeria nivea* L. Gaudich.) is one of the most valuable bast fibre yielding crops of the world. Ramie fibre is much more superior than the other commonly used plant fibres like jute, cotton, flax, etc. in terms of bundle tenacity, wet strength, fineness, ultimate fibre length and the length to breadth ratio. It is one of the strongest but stiffest bast fibre due to its high cellulose to hemicellulose ratio which favours a high degree of cellulose crystallinity. Besides having the unique physical properties, its silk-like appearance and anti-microbial property of the fibres as well as the medicinal value and antioxidant property of the ramie leaves make the plant utmost valuable in the International market. China is the chief ramie producer followed by Brazil and Philippines. In India there is a huge scope to exploit this fibre economically to get maximum benefit. The sandy loam soil with slopping land and hot-humid weather conditions that are required for ramie cultivation is available in the North Eastern parts of India. The foothills of Himalaya and the Brahmaputra valley of Assam, along with Western Ghats and Arunachal Pradesh have great natural resource to promote ramie cultivation. There is a great demand of ramie fibre in the market but the production is not enough to meet the need. This is an opportunity for the Indian farmers to start ramie cultivation in a wide range besides the regular cultivation of jute, cotton, mesta, flax, sisal, etc. As ramie has an inherent property to tolerate a wide range of temperature, soil and climatic factors, it isn't difficult to cultivate ramie in a large scale. Moreover, ramie being a perennial crop helps in soil conservation and can also be intercropped with other plants to get the economical benefit of both the crops. Scientific cultivation of ramie, therefore, can pave a new path for sustaining rural livelihood.

Highlights

- The ramie fibre has a diversified application in textile, paper, apparel industry, and household goods.
- Mechanical extraction followed by degumming is the proper way of the extraction of ramie fibre.
- The tensile strength, absorbency, drying properties of ramie fibre is often superior to cotton, flax and jute.
- The cultivation of ramie has been found to be profitable with proper agricultural practices and it may sustain rural livelihood.

Keywords: Ramie, bast fibre, International market, rural livelihood

Ramie is one of the valuable bast fibre yielding perennial plant the world has ever come across. It is the world's oldest, longest, strongest and finest bast fibre (Banerjee *et al.*, 2014). From time immemorial it has been serving human civilization. Historians pointed out the use of ramie fabrics by the Egyptians, where it was used to wrap the mummies. The Indians however, were well

acquainted with the use of ramie fibre. In Indian literature, there are instances where cloths made of ramie fibre were widely used. The fibre of ramie has a diversified application in textile, paper, apparel industry, household goods, etc. The ramie fibre has a great quality in terms of strength, lustre, microbial resistance property and fineness (Satya *et al*., 2015). China is a pioneer in ramie fibre production and this fibre is used in popular fashion products such as women's dress materials, shirts, suits, and other handicraft products. Coarse ramie fibres are suitable for making twine, rope and nets. Wet-spun, it produces a fine yarn with high lustre, suitable for a wide range of garments, ranging from dresses to jeans. Fabrics of 100% ramie are light-weight and silky, similar in appearance to linen. The Korean traditional costume, the ramie *hanbok*, is renowned for its fineness. Ramie fibre is often blended with cotton to make woven and knit fabrics that resemble fine linen to coarse canvas. However ramie based technologies and fashion products have not spread to a greater extent in other parts of the world due to its expensive post harvest technology (Ray *et al*., 2014b).

Production and trade

FAO estimates world production of ramie green plant at 280,000 tonnes in 2005, almost all of it grown in China. Most of the extracted ramie fibre is used in producing countries, and only a small percentage reaches international markets. The main importers are Japan, Germany, France and the UK. The leading global producers of ramie are Taiwan, Korea, Philippines and Brazil, apart from China. In recent times, India is cultivating ramie in a wide scale and aiming to meet the industrial demand in the National level.

In order to promote research and developmental activities of ramie in the country as a whole and North Eastern States in particular, the Indian Central Jute Committee in April, 1960 established Ramie Research Station at the Village Kamargaon in Sorbhog, (earlier in Kamrup District) under the Jute Agriculture Research Institute (JARI), Kolkata (WB). In 1966 JARI was taken over by the Indian Council of Agriculture Research (ICAR) and in 1990 Jute Agriculture Research Institute (JARI) was renamed as Central Research Institute for Jute and Allied Fibres (CRIJAF). Ramie Research Station is a central government research and development station of Central Research Institute for Jute and Allied Fibre with its headquarter at Barrackpore, Kolkata, W.B. with an area of 69.02 ha, consisting three farms.

Mechanization of ramie fibre extraction

Ramie is processed into fibres in two steps, the first being extraction, and the second being degumming. The extraction is done manually by defoliating the stems and removing the entire bast fibre ribbon, which is then scrapped to remove the outer bark, non-fibrous parenchyma and much of the gummy material. After proper decortications, the fibre is subjected to degumming using hot alkali solution.

Step 1: Mechanical extraction of ramie fibre

Manual extraction of harvested fibres is a labour intensive process. Ramie is decorticated mechanically using machine based on the same principles as those used for kenaf or sisal (Brink and Achigan-Dako, 2012). Ramie fibre cannot be extracted satisfactorily by conventional retting process practised in jute because of presence of high amount of gummy substances (Banerjee *et al*., 2015). The nature of the gum is such that it does not dissolve in normal water. The pectin and hemicelluloses which constitute the major portion of the gum, is not soluble in water. Thus, the pH of the water remains unchanged and the microbial action is not initiated. The fibre is extracted when the stems are fresh, as it is very difficult to extract fibres from the dried stem, with the help of the decorticating machine. If the extraction is not initiated just after harvesting, then the stems are kept in water to keep them fresh. The decorticating machine operates on raspador principle and works at a speed of 600 to 700 rpm with the help of a diesel oil engine or an electric motor (Singh, 1991). The extraction of ramie fibre by the mechanical means is quite expensive, needs man-power and consumes a large amount of energy. The machine requires a minimum of three persons for efficient operation.

The machine removes the outer bark, crushes and removes the entire woody portion along with some gums and waxes. The extracted fibres are washed in the running water and hung over poles for 1-3 days to dry and bleach in wind and in sunlight. Drying is done as early as possible to prevent the attack of

fungi and bacteria. After drying, the fibres may be brushed to reduce the gum and other undesired components sticking to the fibres. The product obtained through machine is crude decorticated fibre still containing 19-30% gum. However, the fibre is free from cortical tissues.

Step 2: Degumming of extracted fibre

Generally, large scale degumming is done by 0.5-1% hot sodium hydroxide solution in a digestor so that the degumming liquor could be recycled (Das Gupta *et al.*, 1976). After degumming, the fibres are subjected to acetic acid treatment for neutralization and washed thoroughly with hot and cold water. Besides this chemical degumming technology, there are microbial and enzymatic degumming (Brühlmann *et al.*, 2000) which are very expensive.

Properties of ramie fibre

Ramie fibre is a cellulosic fibre just like cotton, linen, and rayon and it contains 91% alpha cellulose, 5-13% hemicelluloses, 1% lignin, 2% pectin and 2-4% ash (Brink and Achigan-Dako, 2012). The hemicelluloses and pectin together cements the fibre bundles strongly such that single fibre cannot be obtained easily. Thus, hemicelluloses and pectin in ramie together form the gummy substances (Banerjee *et al.*, 2015; Ray *et al.*, 2014a). The Indian variety of ramie fibre consists about 19-27% of gum which must be lowered to 5-6% to obtain spinnable quality fibre (Banerjee *et al.*, 2014). The morphological properties of ramie fibre are shown in Table 1 (Kalita *et al.*, 2013).

Table 1: Morphological properties of ramie fibre

Properties	
Fibre Length (mm)	
Maximum	60.40
Minimum	30.00
Average	40.00
Fibre diameter (μm)	
Maximum	20.00
Minimum	8.00
Average	10.00
Cell wall thickness (μm)	2.80
Lumen width average (μm)	12.80

Prospects of ramie fibre over other natural fibres

Generally ramie fibre is strong, lustrous and durable compared to any other major textile fibres. The tensile strength, absorbency, and the drying properties of ramie fibre is often superior to cotton, flax and jute. The ramie is considered as the finest among all the textile fibres and its fineness is comparable only to that of cotton and silk. The ultimate fibre length and tenacity of ramie is highest among all bast fibres.

Some physical properties of this fibre are compared to jute and cotton in Table 2.

Table 2: Physical properties of three major textile fibres

Physical properties	Ramie	Jute	Cotton
Length of ultimate cell (mm)	20-250	0.8-6	15-60
Length to breadth ratio of ultimate cell	3500	110	1300
Tenacity (g/tex)	40-65	30-50	20-45
Extension at break (%)	3-4	1-2	6-7
Gravimetric fineness (tex)	0.4-0.8	2-5	0.1-0.3
True density (g/cc)	1.56	1.45	1.55
Degree of crystallinity (qualitative by X-Ray)	17.5 Very high	36 High	24 Very high

Diversified application of ramie

Fibre: Fibres from ramie are used for clothing fabrics, industrial packaging, twines, cordages, canvas, car outfits, etc. Recently, ramie fibres were tested for fibre reinforced composites. Un-degummed fibre is used for marine applications, rugs, carpets, sacks and other containers. There is no universally accepted grade of ramie fibre and each country has its own way of grading.

Green Fodder: ramie foliage has a relatively high nutritional value for the use as cattle feed.

Gum: The degraded hemicelluloses obtained from degumming liquor of ramie fibre were an acidic polysaccharide having rhamnose and galactose as predominant sugars (Bhaduri *et al.*, 1995). When the hemicelluloses were used as additive in small concentrations (0.5% to 25) during the beating operation of the jute stick kraft pulp in a PFI mill, it helped to reach the improved strength properties of the pulp with less energy consumption, thereby

reducing the time of beating. Strength properties, such as tensile index, folding endurance and burst index of paper sheets made from the jute stick pulp with the additive improved significantly. The beneficial effect of added hemicelluloses on the strength properties of paper is attributed to its hydrophilic properties imparting fibre flexibility due to greater swelling of cell wall which, in turn, favours inter fibre bonding. In addition, increased concentration of added hemicelluloses on the external fibre surfaces and degradation of the hemicellulose during isolation also have significant effect in raising its property for fibre bonding.

Medicinal use: Ramie has Antiphlogistic, demulcent, diuretic, febrifuge, haemostatic and vulnerary properties. It is 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 is antiabortifacient, cooling, demulcent, diuretic, resolvent and uterosedative (http://practicalplants.org/wiki/Boehmeria_nivea)

Others: Ramie can be also used for the preparation of bio-composites, bio-composts, mushroom cultivation, animal feed for fish and poultry and for the extraction of high value compounds like nanocelluloses.

Sustaining rural livelihood through Ramie cultivation

Ramie cultivation is best suited in loamy or sandy loam soil with pH 5.5 to 7.0. Warm humid climate with well distributed annual rainfall of 1500-3000 mm is essential for ramie cultivation. Optimum temperature for ramie growth is 25°C-35°C. It can be planted throughout the year in an irrigated land and April to September in rain-fed areas. It is a perennial plant and can be harvested up to six years. The cost of planting material, planting cost and land preparation is required only for the first year. From the next year onwards there is no extra cost for this purpose. The ramie plant is usually propagated by means of rhizome, stem cutting and seed. The yield of fibre is 16-24 quintal/ha/ year and 1.5-2.0 quintal dry fibre/day. Raw ramie fibre costs ₹ 60/kg. The basic parameters regarding ramie cultivation and costing are given in Table 3 and 4.

CONCLUSION

The cultivation of ramie may be a lucrative option for the Indian farmers who are looking out for something new. The perennial plant helps to improve soil fertility and needs minimum care to cultivate. Weed management and proper N-P-K dose is enough for ramie cultivation. The agronomic

Table 3: Yield and value of ramie plant parts for sustaining livelihood

Planting materials requirement/ha/year			
Rhizome	***Plantlets/stem cutting***	***True ramie seed***	
8-10 quintal/ha	60,000 pieces/ha	250-300 g/ha	
Yield/ha/year			
Fibre	***Rhizome***		
16 quintal to 24 quintal	20-22 million ton (after 5 years)		
Fibre percentage			
Over green weight 3-5			
Requirement of rhizome/sq m			
12 pieces			
Decortication (by one decorticator)			
1.5-2.0 quintal dry fibre/day			
Requirement of man days/ha			
₹ 300-350/ha in first year and ₹ 200-250 in second year			
Price			
Ramie fibre	***Rhizome***	***Plantlets***	***Stem cuttings***
₹ 60/kg	₹ 25/kg	₹ 6050 (55000-60000 pieces/ ha)	₹ 2500 (55000-60000 pieces/ ha)

Table 4: Cost of ramie cultivation (Sharma *et al.,* 2014)

Operation	Expenses	
	1st Year (₹/ha)	2nd Year (₹/ha)
Land preparation	4000	—
Planting material	6050	—
Planting cost	2000	—
Fertilizer and chemicals	6000	12,000
Weed management	2000 (herbicide spray)	4,000
Harvesting (@ ₹ 3000 per cutting)	9000 (3cuttings)	18,000 (6 cuttings)
Irrigation (@ ₹ 1000 per irrigation)	1000	2000
Labour cost in Decortications (@ ₹ 2000 per cutting)	6000 (3 cuttings)	12,000 (6 cuttings)
Decortication charges (fuel) (@ ₹ 400 per cutting)	1200 (3 cutting)	2400 (6 cuttings)
Total input cost	37,250	50,400
Profit	42,000 (7 quintal yield)	1,08,000

practices are quite simple in case of ramie compared to post harvest technology. Ramie is an eco-friendly plant and produces one of the best quality bast fibres in the world from which the farmers can earn a huge benefit. North Eastern provinces of India have a suitable climatic condition and soil parameters to cultivate ramie. The ramie cultivation may boost up rural livelihood as the demand of raw and decorticated fibre in the International market is increasing day by day. There are some reports that ramie can remove heavy metals from soil and hence helps in maintaining the soil fertility. Thus, it reduces environmental hazards and helps in sustaining an ecological balance.

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