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Crop diversification for profitability in jute and allied fibre crops

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ABSTRACT

Jute (*Hibiscus cannabinus* L. & *H. sabdariffa* L.) and allied fibres (mesta, sunnhemp, ramie, sisal and flax) play an important role in Indian economy. Raw jute (jute and mesta) farming, industry and trade provide livelihood support to about 5 million people in India and is grown in an area of about 1.0 million ha. Despite a two-fold increase in the productivity of jute since independence, the area is stagnant for last two decades. The acreage of other fibre crops like ramie and sisal has not increased substantially though ramie and sisal fibres are costlier than raw jute, sunnhemp and cotton. The increased cost of cultivation of jute and the fluctuating market price often affects the farmers. So to enhance the profitability of jute and allied fibre farming, we have to introduce high value crops as components of jute-based cropping systems besides extending their cultivation to non-traditional areas. Ramie has shown a good growth and yield at Nilgiri hills, Goa, Maharastra while sisal has a great potential in the dry areas like western Orissa, Madhya Pradesh, Jharkhand. Diversification and value addition to the end products is needed as there is wide scope in the global market and the part of the additional profit must reach the farmers to motivate them. Jute (*Corchorus capsularis* L. & *C. olitorius* L.) is the main commercial crop of the eastern and north eastern India providing livelihood security to about 5.0 million people (4.0 m farmers, 0.25 m mill workers and 0.50 m people engaged in jute based ancillary sectors). It is grown in an area of little over 0.8 m ha, producing nearly 10 million bales (1 bale 180 kg.) of fibre, which is about 40% of the worlds' production. Mesta is grown in an area of 0.15 m ha with a production of 1.0 m bales. The major jute growing states are West Bengal, Bihar, Assam, Orissa, Uttar Pradesh, Meghalaya and Tripura while mesta is mostly cultivated in Andhra Pradesh, Maharastra, Orissa and Bihar. Sunnhemp (*Crotalaria juncea* L.) is cultivated mostly in Bihar, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharastra and Tamil Nadu.

Key words: Diversification, Fibre Crops, Profitability, White jute

Since independence, there has been a two-fold increase in productivity of jute and mesta which was possible mainly due to the development of high-yielding varieties along with improved production technologies and also due to proper policy support from the government. Despite this tremendous increase in productivity, there is still a wide disparity in the yield level among the states as well as the agro-climatic zones with in the state. For example in jute, among the 87 jute growing districts, only 9 have above the national productivity (2,200 kg/ha) and the rest are well below that. Besides, the area of jute, mesta and sunnhemp is confined in few states and has not spread much, though they are of commercial importance. Similarly the acreage of ramie and sisal has not increased substantially though they are several times costlier than raw jute (jute and mesta), sunnhemp and cotton. Jute and allied fibre production under the present system of cultivation is labour intensive and costly, around 65-70% of the total cost of production being spent for weed management and retting. As a result, farmers are not getting better returns which is definitely influencing their choice for the crop. So to enhance the profitability of jute and allied fibre farming, we have to introduce high value crops as components of jute-based intercropping or multiple cropping, besides, extending their cultivation to non-traditional areas. The ICAR funded Network Project on Ramie, showed that it can be grown successfully and profitably in the non-traditional areas like Nilgiri hills, (Tamil Nadu), Goa and Dapoli (Maharashtra) both as a sole crop or as an intercrop. Crop diversification in jute, as in other crops, may be achieved through several ways and the same is discussed below.

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Approaches for crop diversification in jute and allied fibres

Single crop to multiple crops

During the initiation of First Five-Year Plan, total acreage under jute was only 0.26 m ha with a total production of 0.7 m bales of raw jute. The jute varieties available during that period, i.e., D154 (white jute) and Chinsurah Green (*tossa* jute) were of 150-160 days duration with yield potential of 1.5-1.8 q/ha only. The increase in irrigation potential and subsequent advent of intensive agriculture and introduction of multiple cropping systems exposed jute crop to stiff competition from other major crops and it was necessary to fit jute crop in multiple cropping sequences and make it more remunerative through the development of short duration, high-yielding varieties with judicious manipulation of the agrotechniques like advancing sowing time; optimising planting geometry, fertilizer dose, plant-protection measures, retting techniques, etc. Development of pre-mature flowering resistant varieties, *viz.,* JRO-878, JRO-7835 and JRO-524 and reducing the crop duration from 150 to 120 days not only advanced the sowing time to as early as middle of March, but also enabled jute to be fitted in multiple cropping sequence with transplanted *Aman* paddy. This led to a paradigm shift in jute agriculture as the entire jute growing area of the country was taken over by the *tossa* jute. (Das and Maiti, 1998).

On rainfed uplands of West Bengal, Assam, Orissa, Bihar and Uttar Pradesh several promising jute-based sequences were evolved. Similarly for rainfed lowlands, in Bengal, Bihar, Orissa and Uttar Pradesh, jute-paddy-lentil sequence was found promising Assured irrigation facilities, has led to development of promising cropping systems (Mitra *et al*., 2006) under upland condition (Table 1).

Under irrigated condition, the net return and benefit : cost ratio were found maximum in jute-paddy-tomato followed by jute -paddy-mustard, jute-paddy-pea and jute-paddy-*rajmash* in farmers' field at North 24 Pargana district of West Bengal. Thus the introduction of high value crops in the conventional jute-rice cropping sequence increased the profitability of the system (Table 2) by Rs 4,825 (*rajmash*) to Rs 19,436 (tomato) which implies that choice of component crop is very important (Chapke and Jha, 2006). Growing sunnhemp as green manure crop in *kharif* rice in jute - rice-potato, jute-rice-lentil and jute-rice-mustard cropping sequences at Coochbehar, West Bengal (AINPJAF, 2005) resulted in an additional return of Rs 2,944, 1,555 and 2,662/ha respectively (Table 3). Mixed cropping of jute, red amaranth, white amaranth and summer raddish produced 06 t jute fibre, 09-09 t red amaranth (at 21 DAE), 0.7-0.9 t white amaranth and 0.57-0.9 t summer raddish/ha under irrigated condition and fetched additional net return of around Rs. 4,000/ha (Ghorai, 2007). Intercropping of jute + groundnut or jute + blackgram increased the fibre yield of jute with an additional grain yield of 300-400 kg/ha from legumes. Intercropping of groundnut, soybean, or blackgram with roselle (*Hibiscus sabdariffa* L.) in 1:2 or 1:3 row ratios

Table 2. Economics of cultivation of jute based crop sequences in south Bengal under irrigated condition

Crop sequences	Cost of cultivation (Rs/ha)	Net Return (Rs/ha)	Benefit : Cost
Jute	25,282	13,286	1.53
Paddy	18,945	6,176	1.33
Tomato	29,752	19,436	1.65
Total	73,979	38,898	1.53
Jute	25,143	12,172	1.48
Paddy	18,901	6,275	1.33
Mustard	13,896	6,744	1.49
Total	57,940	25,191	1.43
Jute	25,118	12,776	1.51
Paddy	19,645	5,562	1.28
Pea	25,354	6,115	1.24
Total	70,117	24,453	1.35
Jute	25,642	12,286	1.48
Paddy	19,209	6,486	1.34
Rajmash	22,480	4,825	1.21
Total	67,331	23,597	1.35

Table 3. Economics (Rs/ha) of cultivation of jute based crop sequences at Coochbehar, West Bengal.

Cropping sequences	Cost of cultivation	Gross return	Additional return*
Jute - paddy + sunnhemp - potato	25,455	44,129	2,944
Jute - paddy + sunnhemp - lentil	25,309	43,082	1,555
Jute - paddy + sunnhemp - mustard	24,842	40,286	2,662
Jute - paddy- potato	25,023	41,185	
Jute - paddy- lentil	25,071	41,527	
Jute - paddy- mustard	24,518	37,624	

Source : AINPJAF (2005)
*over corresponding crop sequences without sunnhemp.

Table 1. Jute based cropping sequences for different land situations

Land situation	Crop sequences	Location
Rainfed uplands	Jute-lentil, jute-blackgram, jute- greengram, jute-*toria*	North and South Bengal
	Jute-blackgram-*toria*/wheat, jute-rice-*toria*, jute-*toria*	Assam
	Jute-mustard-cowpea	Orissa, Bihar, Uttar Pradesh
	Mesta - horsegram	Andhra Pradesh, Tamil Nadu
Irrigated uplands	Jute-rice-potato, jute-rice-vegetables, jute-rice-mustard, Jute-rice-potato/wheat/pea, jute-rice-wheat, jute-radish, jute-onion, jute-berseem	North and South Bengal, Assam, Katihar, Bihar
Rainfed lowlands	Jute-rice-lentil	Bengal, Bihar, Orissa, Uttar Pradesh

Source : Kundu and Mandal (1995) Roy and Choudhary (1989), Mitra *et al.*(2006)

was found more remunerative than sole roselle when the intercrop was sown 15 days after the main crop. Similarly at Amadalavalasa, Andhra Pradesh, inter-cropping of roselle with redgram, maize and cluster bean increased the economic yield of the system under rainfed condition with maximum system yield (in roselle equivalent yield) being observed in roselle + maize (3:1) intercropping followed by roselle + cluster bean (3:1) intercropping system (Table 4), respectively (AINPJAF, 2008).

Table 4. Effect of spacing on yield attributes and yield (kg/ha) of mesta-redgram cluster bean intercropping systems

Treatments	Mesta fibre yield	Intercrop yield	Mesta eqivalent yield
Mesta sole crop	2,851		2,851
Redgram sole crop		467	873
Mesta : redgram (2:1)	1,961	154	2,251
Mesta : redgram (3:1)	2,513	123	2,744
Mesta : redgram (1:2)	1,392	206	1,783
Mesta : maize (2:1)	2,120	19,500*	2,861
Mesta : maize (3:1)	2,841	12,500*	3,316
Mesta : cluster bean (2:1)	2,057	515**	2,382
Mesta : cluster bean (3:1)	3,023	295**	3,208
SEm ±	135		141
CD (P = 0.05)	286		299

Source : AINPJAF (2008)
*no. of cobs for maize; ** - green weight for cluster bean

Intercropping of maize with mesta (1:4) and strip cropping of blackgram with mesta (4:4) produced 3.1 t equivalent fibre yield (2.4 t fibre + 7,692 cobs/ha) and 29 t equivalent fibre yield/ha (1,400 kg fibre + 752 kg blackgram seed/ha) respectively under rainfed environment. The sole crop (mesta) fibre yield was 2,000 to 2,100 kg/ha in the similar environment (Ghorai *et al*., 2008).

Jute, on an average, adds about 15 t/ha of green leaves into the field, which enriches the organic matter as well as available nutrient status of the soil for utilization by the succeeding crops. Results of the 'Long-term fertilizer trial' in jute - rice - wheat cropping sequence on new Gangetic alluvial soil at Barrackpore revealed that the soil organic C after initial depletion showed an increasing trend after 36 years of continuous cropping when farmyard manure was applied along with NPK (Saha *et al*., 2008). Replacement of rice - rice -fallow crop sequence by jute-rice-jute sequence maintained better organic C status of the soil in Orissa (Sadanandan and Mahapatra, 1975), while total P in the soil increased after each cycle in jute-rice-rice and groundnut - jute - rice sequences (Sadanandan and Mahapatra, 1972). In soybean - jute - rice sequence, the net gain of total N was 27 kg/ha, while in fallow - jute - rice system total N showed a deficit balance in Bangladesh (Patwary *et al*., 1989). Thus the fertility status of soil can definitely be improved through judicious selection of crops and crop sequences along with appropriate management practices.

Introduction of ramie in non-traditional areas

Introduction of new crops in non-traditional areas is an effective way of crop diversification. The adaptability of the crop in the new agro-climatic conditions and the profitability of the crop / cropping system over the existing ones are the key to their acceptance. It is essential to develop the complete package of practice and to demonstrate the performance of the system before the farmers for its successful introduction to that area.

Ramie fibre is the longest, strongest and costliest textile fibre of plant origin and has a huge demand in the international market, but the supply of this fibre is well below the demand. Globally the trade of this is dominated by China, as it ranks first regarding the area (0.085 m ha), production (0.133 m tonnes) and productivity (15.37 t/ha) of the crop followed by Brazil and Phillipines. In India, there is a huge potential for ramie cultivation as our ecological conditions are quite congenial for its growth and development. However, ramie cultivation in India, as on date, is confined in a small area of about 200 ha in the north eastern hills state viz., Assam, Meghalaya and Nagaland and did not spread as it should have, though the economics of ramie cultivation had been found to be quite impressive in north-eastern region. The cultivation of sole ramie in this region fetched a net return of Rs 25,000 to 35,000 ha/year during 2nd to 4th year while in the 5th year the net return was around Rs 3,00,000/ha/year of which Rs 15,000 to 17,000 ha/year came from sale of fibre and the rest from the sale of rhizome (around 20 t/ha).

The edapho-climatic conditions of Nilgiri hills area, Goa, Dapoli and other areas of the region were found suitable for successful cultivation of ramie provided suitable location specific agro-techniques have been developed. Ramie has been introduced successfully in these areas by CRIJAF and ramie based multi-tier cropping system was also established in these zones. Ramie + rubber and ramie + cinnamon intercropping in Tamil Nadu, ramie + coconut and ramie + coconut + black pepper in Goa, ramie + mango and ramie + mango+ black pepper at Ratnagiri, Maharashtra as well as ramie + arecanut at Assam were particularly found to be encouraging (CRIJAF, 2008).

The experimental results under ICAR Network Project on Ramie revealed that cultivation of ramie alone resulted in to an additional profit of Rs 8,112 over sole arecanut cultivation while the net profit from ramie + arecanut cultivation was Rs 38,807 ha/year more than that from sole arecanut in Assam (Table 5). Similarly at Goa, sole ramie plantation recorded an additional profit of Rs 28,980 ha/ year as compared to sole coconut plantation. However, coconut + black pepper + ramie intercropping system recorded slightly lower return as compared to sole ramie, but it was considerably higher than sole coconut. Thus introduction of ramie increased the profitability of the cropping system (CRIJAF, 2008) in both the traditional and the non-traditional areas (Table 6).

Table 5. Economics of ramie + arecanut multi-tier cropping at Sorbhog, Assam

Cropping systems	Net Return* (Rs/ha/yr)
Sole areca nut	25,138
Sole ramie	33,250
Ramie + areca nut	63,945

Source : CRIJAF - Final Report, Ramie Network Project, 2008.
* - mean of 3 years

Table 6. Economics of coconut + black pepper + Ramie multi-tier cropping at Goa

Cropping systems	Net Return* (Rs/ha/yr)
Sole Coconut	28,140
Sole ramie	57,120
Coconut + Black pepper + Ramie	40,270

Source : CRIJAF - Final Report, Ramie Network Project, 2008.
* - mean of 3 years

At Barrackpore which is situated in southern part of West Bengal, application of irrigation based on IW/CPE ratio of 0.6 to 0.9 during pre- and post-monsoon periods produced 1.5-1.7 fibre t/ha in 5 cuts as compared to 1.0-1.2 t fibre/ha in 3-4 cuts under rainfed condition in north eastern states like Assam and Nagaland (Mitra and Sarkar, 2006).

Effective utilization of less productive lands with remunerative crops

Introduction of sisal cultivation for improving the livelihood of resouce-poor farmers in the marginal and drought prone areas are discussed here.

Agriculture in the drier parts of the country is risk prone with poor return due to the climatic uncertainty, which often endangers the livelihood security of the resource poor farmers of the region. In these areas, particularly poor rainfall along with very high temperature range, make majority of the lands unproductive or less remunerative for arable crops. Sisal due to its xerophytic nature can adapt well in such situation and with certain management gives adequate fibre yield, the fibre being extracted from its leaves through decorticator machine. The sisal fibre can be successfully utilized for manufacturing of diversified products and introduction of sisal in these semi-arid drought prone areas of our country may have a huge positive impact on the socio-economic condition of the people. Western Orissa, is a typical drought prone area where agriculture is mostly non-remunerative. The case study of sisal-based agroforestry models established at Sisal Research Station, Bamra, situated in the western Orissa, revealed that both *Agave sisalana* and hybrid sisal recorded better growth and yield when planted in double row system in between two rows of teak (*Tectona grandis* L.) or gambhar (*Gmelina arborea* L.) at a planting density of 4,742 plants/ha for sisal and 470 trees/ha for teak or *gambhar*, respectively. Similarly sisal could be successfully introduced in exisiting and / or new teak plantations at Amadalavalasa, Andhra Pradesh in similar planting density and application of N: P_2O_5: K_2O @ 120: 30: 60 kg/ha recorded significantly higher number of sisal leaves with increased length and breadth (AINPJAF, 2008).

Sisal crop, on an average, produces 1.5 to 2.0 t/ha of dry fibre, which is extracted from the sisal leaves starting from 3rd year and continues upto 12th year. Besides, sisal crop also produces around 100 t/ha of green biomass which can be recycled after composting and the fertilizer cost can be significantly reduced. The long-term experiment on sisal cultivation at Sisal Research Station, Bamra, Orissa revealed that the net income from a well managed sisal plantation of 4 ha area was around Rs 1,00,000 to 1,20,000/year with an additional earning of Rs 50,000 at the end of 11th or 12th year from the sale of bulbils.

Value addition to end products : Golden incentive for diversification in future

Jute, recently is facing stiff competition from cheaper synthetic fibres, especially in the sacking and packaging sector and it is indeed a matter of serious concern to us. But the silver lining is that the consumers today, in the developed countries, are more concerned about the environment and prefer products from natural sources. So to reap the benefit, it is the high time to think for product diversification and value addition in jute instead of sticking to only hessian and sacks. Blending of jute fibres with ramie, cotton, or other natural and synthetic fibres for apparel making, jute or jute and sisal blended geo-textiles, jute-based handicraft items, etc. should be the focal items as these products has huge market both within and out side the country. The export earning of jute based products has increased from 233 crores in early eighties to 1,200 crores in 2005-06. The market share of value added jute diversified products (JDP) has increased from 2% in mid eighties to 18% in 2005-06. The present international market potential for jute geo-textiles (JGT) alone is 95 billion US $ which must be tapped. The paper and newsprint production is around 5.8 million MT and demand is likely to increase to 8.53 million MT in the year 2010. The whole jute / kenaf plants having similar strength of hard wood, have emerged as potential pulp and paper material and can meet the shortage of raw material. A farmer cultivating a *kenaf* variety MT-150 for paper pulp in place of fibre, can earn an additional profit of Rs 40,000/ha within a duration of 140 days.

The ramie fibre produced in traditional and non-traditional areas may go to hand spinning and weaving sectors in the rural areas and the rest to major industries. This will create a significant amount of employment generation as well as infrastructure build up. The huge amount of biomass waste during decortication (fibre extraction) can be effectively utilized for paper pulp-making, composting, bio-gas generation, etc., which will certainly lead to further value addition. Ramie produces significant quantum of leaves which has high nutrient content and can be potential source for natural anti-oxidants, food supplements, etc. or can be successfully used for developing animal feed. The gum content in Indian ramie fibre ranges from 18 - 29%. The spent liquor after microbial degumming of ramie fibre is a rich source of pectinolytic enzymes, and liquid or solid enzyme formulations can be prepared from it which has tremendous use in textile and food processing industries. The semi-solid waste after degumming can be utilized for preparing biofertilizers.

Similarly in sisal, the excellent characteristic features of the fibre enables it for manufacturing of diversified products like ropes, fancy fibre articles, carpet yarns, reinforcement materials, etc. The huge amount of sisal biomass can also be effectively utilized for generating different value added products, as in case of ramie.

So to make the cultivation of fibre crops profitable and to create a sound market for natural fibres as well as for natural fibre based diversified products, we have to adapt a holistic approach where we should give importance to the adaptation of location specific good agricultural practices for enhanced productivity and improved quality. We also need to develop value chains for these natural fibres which, once established, will certainly assure the supply of quality ramie fibre and / or yarn to handloom and powerloom sectors; create market for fibre, yarns, etc., at local or regional level as well as for the diversified products at national and international levels; and will also create downstream industries leading to entrepreneurship development at rural, semi-urban and urban areas. Besides, these chains will connect the growers of these fibre crops with the end users so that profit of value addition at the end point of the chain can effectively infiltrate to the farmers, who in most of the cases are deprived. Such successful value chains can be the best models for diversification for jute and allied fibre crops in both traditional and non-traditional areas.

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