

Review Article

Varietal Advances of Jute, Kenaf and Mesta Crops in Bangladesh: A Review

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To cite this article:

Mohammad Mahbubul Islam. Varietal Advances of Jute, Kenaf and Mesta Crops in Bangladesh: A Review. *International Journal of Bioorganic Chemistry*. Vol. 4, No. 1, 2019, pp. 24-41. doi: 10.11648/j.ijbc.20190401.15

Received: February 1, 2019; Accepted: March 13, 2019; Published: April 2, 2019

Abstract: Jute is a cash crop of Bangladesh. Jute, kenaf and mesta fibre cultivation, trade and industry provide sustenance to over 4 million people of Bangladesh. The productivity of jute had doubled from 1.50 t/ha during 1970-80 to about 2.04 t/ha during 2015-16. Development of high-yielding varieties were the one of the main specific technologies which made this possible. Therefore a review was undertaken on research and development of jute, kenaf and mesta varieties at Agronomy Division, Bangladesh Jute Research Institute (BJRI), Dhaka during 2018. The sources of secondary data were BJRI annual reports, thesis, news letter, national and international journals and accessing internet. Nearly 8 lack hectares of land cultivated by jute and allied crops per year in Bangladesh, which produced 80-90 lack bales of fibre. Over all 49 jute and allied varieties (White jute 25, Tossa jute 17, Kenaf 4 and Mesta 3 varieties) developed by BJRI. CVL-1, BJRI Deshi Pat-5, BJRI Deshi Pat-6, BJRI Deshi Pat-7, BJRI Deshi Pat-8, BJRI Deshi Pat Shak-1 and BJRI Deshi Pat-9 of *C. capsularis* L., O-9897, BJRI Tossa Pat-4, BJRI Tossa Pat-5, BJRI Tossa Pat-6, BJRI Tossa Pat-7 of *C. olitorius* L., HC-2, HC-95, HC-3 and BJRI Kenaf-4 of *Hibiscus cannabinus* and HS-24, BJRI Mesrta-2 and BJRI Mesta-3 of *H. subdariffa*. found important could cultivated in farmers field. Premature flowering in jute varieties found harmful to fibre production. Premature or untimely flowering happened mainly due to early sowing of jute varieties in short day length period and partly due to prolonged drought, dry air, stunted growth, low fertility of soil, cloudy weather etc.

Keywords: Jute, Kenaf and Mesta Crops, Variety, Research and Development, Maintenance, Premature Flowering

1. Introduction

Jute is a cash crop of Bangladesh. Jute (*Corchorus* spp.) is now universally recognized that jute is the English version of the current bengali word 'Pat', a kind of fibre which is obtained from two species (annual and short day plants) of the genus *Corchorus* belonging to the family *Tiliaceae*. It is a common term used both for plant and the fibre obtained from the bark of the plants, *Corchorus capsularis* L. and *Corchorus olitorius* L. There are over 30 species, which belongs to the genus *Corchorus*. It is grown in the summer season (Kharif-I) [1].

Jute is a rain-fed crop and its cultivation is concentrated in Bangladesh, India, China, and Thailand. The jute fibre comes from the stem and ribbon (outer skin) of the jute plant. The fibres are first extracted by retting. The retting process

consists of bundling jute stems together and immersing them in low, running water. There are two types of retting: stem and ribbon. After the retting process, stripping begins. In the stripping process, non-fibrous matter is scraped off then the workers dig in and grab the fibres from within the jute stem. It is one of the most cheapest and economical vegetable fiber after cotton, obtained from the skin or bast of plant's stem [2-3]. Recyclable, 100% biodegradable and eco friendly jute has low extensibility and high tensile strength. Jute is the versatile natural fiber widely used as a raw material in many textile, non textile, packaging, construction and agricultural applications. Jute is a type of vegetable fiber used to make items such as rope, twine, carpet, rugs, hessian cloth, and much more.

In 2010-2011, 0.803 million ha land cultivated for jute. Production of raw jute was 1.5 million MT by volume in

2010-2011. Jute cultivation area was 6% of total land area of 13 million ha, of which 8.44 million ha belongs to agricultural land. Jute cultivation area was 10% of agricultural land area. Jute production was 26% as of all agricultural crops [4]. Jute, kenaf and mesta fibre cultivation, trade and industry provide sustenance to over 4 million people of Bangladesh. The productivity of jute had doubled from 1.50 t/ha during 1970-80 to about 2.04 t/ha during 2015-16. Development of high-yielding varieties were the one of the main specific technologies which made this possible. In 1970-80 decades

about 15-16 lakh hectare of the total cultivable land was occupied by jute has now (2014-15) been reduced to about 7.00 to 8.00 lakh hectare which produced about 16-17 lakh tons of fibre. However, national average yield is increased from 1.59 to 2.04 tons per hectare. It is happened due to use of high yielding jute varieties and production technologies, which together contributed toward higher yield [5]. Therefore a review was undertaken on research and development of jute, kenaf and mesta varieties at Agronomy Division, Bangladesh Jute Research Institute (BJRI), Dhaka during 2018.

Table 1. Jute cultivated land areas and fibre production.

Year	Jute Cultivated land (Lakh ha)	Fibre Yield lakh/ha	Fibre Production	
			Lakh ton	Lakh bale
2005-06	4.02	2.08	8.38	46.19
2006-07	4.19	2.12	8.86	48.84
2007-08	4.41	1.90	8.39	46.22
2008-09	4.20	2.02	8.49	46.78
2009-10	4.16	2.22	9.24	50.89
2010-11	7.08	2.15	15.24	83.95
2011-12	7.60	2.03	14.52	80.03
2012-13	6.81	2.03	13.81	76.11
2013-14	6.66	2.03	13.49	74.36
2014-15*	6.73	2.01	13.52	75.01
2015-16*	7.25	1.90	13.74	75.58
2016-17*	8.17	2.04	16.67	91.72

BBS, *DAE

2. Materials and Methods

The study was based on secondary information. The secondary data used were collected from different studies of the Library of Bangladesh Jute Research Institute, Dhaka during from January to November 2018. These secondary data were BJRI annual reports, different thesis, Books, Bangladesh Journal of Jute and Fibre Research, Jute and Jute Fabrics, Bangladesh (News letter) of BJRI and other national and international journals.

3. Findings/Results

3.1. Jute

Taxonomy

Jute belongs to the Kingdom: Plantae – Plants, Sub kingdom: Tracheobionta – Vascular plants, Super division: Spermatophyta– Seed plants, Division: Magnoliophyta – Flowering plants, Class: Magnoliopsida – Dicotyledons, Subclass: Dilleniidae, Order: Malvales, Family: Tiliaceae – Linden family, Genus: *Corchorus* L. – corchorus, Species: *Corchorus olitorius* L. – nalta jute and *Corchorus capsularis* L. – white jute, English name: Jute and Bengali name: Pat, Paat, Naila etc.

There are two types of jute (*Corchorus capsularis* L. and *Corchorus olitorius* L.) cultivated in Bangladesh.

3.2. Tossa Jute (*Corchorus olitorius* L.)

Annual or biennial herb, erect, stout, branched, to 1.5 m high; rootstock woody. Leaves lanceolate to ovate-lanceolate,

subobtusate at base, serrate at margin with basal most serrations extending into filiform processes, acute at apex, glabrous except sparsely hairy nerves, 3-5 nerved; petioles 2-3 cm long, pubescent; stipules subulate, 8-12 mm long, glabrous. Flowers in 1 or 2 flowered leaf opposed cymes, 12-15 mm across, subsessile; bracts subulate, 4-5 mm long. Sepals linear-oblong, apiculate, 5-7 mm long. Petals oblong-spatulate, obtuse, 5-7 mm long. Stamens numerous, somewhat connate at base. Ovary cylindrical, sparsely hairy, 5-loculed; style short; stigma 5-lobed, minutely papillate. Capsules solitary or paired, subcylindrical, 2-7 cm long, 10-ribbed, glabrous, 5-loculed; locules septate between seeds; beak entire, 4-8 mm long; seeds 3-gonous, ca 2 x 1.5 mm, inconspicuously verrucose, black (Dr. N Sasidharan (Dr. B P Pal Fellow), Kerala Forest Research Institute, Peechi) [6-9].

3.3. White Jute (*Corchorus capsularis* L.)

Annual, much branched, spreading herbs; stems pilose, often reddish. Leaves 2.5-7 x 1.5-3.5 cm, ovate to elliptic-lanceolate, base rounded, margins serrate, the basal pair of serrations ending in setae or not, apex acute, basally 3-5-nerved; petioles upto 3 cm long; stipules 4-8 mm long, setaceous. Flowers 2-3 in leaf opposed, shortly pedunculate cymes; pedicels c. 2 mm long. Sepals 5, 3-4 mm long, linear-oblong, hooded and apiculate. Petals 5, yellow, 3-5 mm long, obovate, obtuse. Stamens many. Ovary c. 2 mm long, cylindrical, 3-loculed; style 3-fid; stigma 2-lobed. Capsules 1-3 x 0.4-0.6 cm, 6-angled, 3 of the angles winged, 3-loculed. Seeds numerous, dark brown (Dr. N Sasidharan (Dr. B P Pal Fellow), Kerala Forest Research Institute, Peechi) [4, 7-9].



Source: [10]

Figure 1. *Corchorus olitorius* L.

Source: [11]

Figure 2. *Corchorus capsularis* L.**Table 2.** Botanical Comparison of *Corchorus capsularis* L. White Jute and *C. olitorius* L. (Tossa Jute).

Corchorus capsularis L. White Jute	Points	C. olitorius L. (Tossa Jute)
Generally 1.5 to 3.7m tall, can withstand water logging in later stages, herbaceous annual, 3-5 month duration for fibre yield depending upon sowing time. It's stem cylindrical, green to dull coppery red to pink, periderm in the basal portions in later stages. Cylindrical, green to dull coppery to pink; periderm in the basal portions in later stages.	General	Plants generally 1.5-4.5 m tall; cannot withstand water logging; herbaceous annual, 4-5 months duration depending on time of sowing, flowers prematurely if sown very early.
Branched or unbranched; axillary buds may or may not develop into branches.	Stem	Cylindrical, green, light or dark red, fewer shades of colour than capsularis; no periderm but lenticules in later stages.
Leaves are glabrous, 5-13 cm by 2.5-8.2 cm length and bright. Ovate oblong, acuminate, coarsely toothed, lower most pair of serrations enlarged and end in hairy appendages. Petiole 4-8 cm, various from green to pink in different varieties, stipules 0.5-2.0 cm or more, foliaceous in some varieties, tip coloured or green.	Branching habit	Branched, but branches normally develop less vigorously.
Flowers are small generally in extra axillary cymes in groups of 2-5 or more; 0.3-0.5 cm long and 0.5-0.6 cm wide; sepals 5, coloured or green, petals 5, yellow or pale yellow, stamens 20-30; anther yellow to pale yellow, ovary rounded, 5-carpelled, syncarpous, ovals axile, usually 10 in each locale in 2 rows, giving about 50 ovules in each ovary; style 2-4 mm; stigma pubescent.	Leaves	Leaves are glabrous, 7-18 cm by 4-8.9 cm, oblong, acuminate coarsely toothed, lowermost pair of serrations more enlarged than in capsularis and hairy appendages longer, Petiole 4-9 cm, various from green to dark red, stipules 0.5-1.5 cm or slightly more, tip coloured or green, base coloured except in the full green types.
One or two hours after sunrise.	Flower	Flowers generally in extra axillary cymes in groups of 2-5, about 1 cm in length, 2-2.5 times the size of capsularis flower, sepals 5-6, coloured or green, tips prolonged in flower buds. Petals 5-6. Yellow, entire or split. Stamens 30-60, anthers yellow, ovary inengated, 5-variably 6- carpelled, syncarpous, ovals axile, usually 40 in each locale in 1 row giving about 200 ovals in each ovary, style 3-5 mm, stigma globular, entire, pubescent.
Capsules rounded, 1.0-1.5 cm in diameter, wrinkled, rarely smooth, muricate, 5-locular, seed- 7-10 in 2 rows in each ocular, without transverse partitions, 30-50 seeds in each fruit.	Anthesis	An hour or before sunrise.
Seeds are small, chocolate brown, 4-5 faced about 300-350 per gm.	Capsule	Capsule elongated, 6-10 cm long, 0.3-0.8 cm in diameter, ridged lengthwise, 5-6 locular, seed 25-40 in single row in each loculus, with transverse partitions between each seed and 140-200 in each fruit.
	Seed	Seed smaller than those of capsularis, green to steel grey to even black, about 450-500 per gm.

3.4. Kenaf (*Hibiscus cannabinus*)

Taxonomy

Kenaf belongs to the Kingdom: Plantae, *Clade*: Angiosperms, *Clade*: Eudicots, *Clade*: Rosids, Order: Malvales, Family: Malvaceae, Genus: *Hibiscus*, Species: *H. cannabinus*, Binomial name: *Hibiscus cannabinus* L.

Kenaf (*Hibiscus cannabinus* L.) is an annual fibre crop related to cotton and okra. It is native to Africa, where it has been cultivated for use in ropes and animal consumption for at least 4,000 years. This tropical plant thrives best on land with good water-holding capacity and is drought tolerant. Kenaf

grows up to a height of 3-4 metres within a period of 120-150 days, and is then ready for harvesting. Kenaf is a short day, annual, herbaceous plant cultivated for the soft bast fibre in the stem. It belongs to the Malvaceae, a family notable for both its economic and horticultural importance. The genus *Hibiscus* is widespread, comprising some 200 annual and perennial species. Kenaf is closely related to cotton and the holly hocks (*Althea* sp.). The name kenaf is of Persian origin and is most generally used to describe the plant *Hibiscus cannabinus* L. and the fibre. At present, in Bangladesh, so many areas are covered by Kenaf like, Bhrambaria, Voirab, Netrokona, vast areas of Kishoregonj; Laksmipur, Noakhali,

Shriatpur, Madaripur, some sporadic areas of Tangail, Mymensingh and Jamalpur.

Stem: Erect, prickly, cylindrical, branched or un-branched reaching a height of 1 to 4m, either entirely green green with pinkish or raddish pigmentation, or red.

Leaves: Eigher entirely cordated and very shallowly lobed with serrated margins or 3-5-7 deeply palmate, alternate, stipulate, stipulates free lateral, pubescent 0.5 to 0.8 cm long. Petiole 3.0 to 18.0 cm long, finely pubescent on the adaxial surface and bristled on the abaxial surface, green to red, scabrous.

Lamina: Lobed or unlobed, when unlobed ovagte margin serrated, apex acuminagte, 5-7 nerved palmately reticulate, when lobed palmately 5-7 deep, each lobe lanceolate, margin serrated, apex acute, one green gland present on the mid-vein on the under surface, upper surface glabrous, lower surface hairy along with veins, scaberulous.

Flowers: Salitary, axillary, pedunculate, pednecl 0.2 to 0.4 cm long, bristled, pentamerous, 8.0 to 10.0 cm in diameter when open, yellow with red center or completely yellow, showy, bractoles (epicalyx) 7-9, segmented, linear, bristled, 1.0 to 1.5 cm long, green attached to the base of the calyx.

Calyx: Cepals 5, lanceolate, cornate below the middle into a cap, green bristled and tormentosed with a large green gland on the back of each sepal, persistent.

Corolla: Large, spreading, bell shaped, full yellow with or without deep enter, petals 5, free, very slightly united at the base twisted outer side pubescent, 7-9 cm long.

Stamens: Many monadulhous, stamined coluran epipetatous truinicate, 2.5 cm long with glandular hairs, yellow or light red, filaments 0.1 to 0.2 cm long, red yellow anthers semiform, pollen spiny.

Carpels: 5, ovary ovoid, 0.7 to 0.8 cm long. Densely covered weith white silky adressed hairs, 5, chambered with many ovules in each chamber arranged in 2 vertical rows stigma-5, hairy, capitate, red or yellow, exerted.

Capsule: Ovoid, pointed, villose, half of the length of the calyx with about 20 to 26 seeds.

Seed: Traiangular, angles more or less acute, ash gray with pointed light yellowish warty spots. Hilum brown, relatively small. Most of the better known kenaf varieties produce seed

that range from 36000 to 40000 per kg.; however some Africand types from Sadan, Uganda abnd Central African Republic produce small seed that range from 100,000 to 110,000 per kg.



Figure 3. Leaves and plants of kenaf.



Figure 4. Kenaf Flower.



Figure 5. Kenaf seed.

Table 3. A morphological differences between Kenaf and Jute.

Characteristics	Kenaf	White Jute
Stem	Erect, prickly, cylindrical, branched or un-branched reaching a height of 1 to 4m, either entirely green green with pinkish or raddish pigmentation, or red.	It is generally 1.5 to 3.7m tall, can withstand water logging in later stages, herbaceous annual, 3-5 month duration for fibre yield depending upon sowing time. It's stem cytindrical, green to dull coppery red to pink, periderm in the basal portions in later stages.
Leaves	Eigher entirely cordated and very shallowly lobed with serrated margins or 3-5-7 deeply palmate, alternate, stipulate, stipulates free lateral, pubescent 0.5 to 0.8 cm long. Petiole 3.0 to 18.0 cm long, finely pubescent on the adaxial surface and bristled on the abaxial surface, green to red, scabrous.	Leaves are glabrous, 5-13 cm by 2.5-8.2 cm length and breight. Ovate oblong, acuminate, coarsely toothed, lower most pair of serrations enlarged and end in hairy appendages. Petiole 4-8 cm, various from green to pink in different varieties, stipules 0.5-2.0 cm or more, foliaceous in some varieties, tip coloured or green.
Flowers	Salitary, axillary, pedunculate, pednecl 0.2 to 0.4 cm long, bristled, pentamerous, 8.0 to 10.0 cm in diameter when open, yellow with red center or completely yellow, showy, bractoles (epicalyx) 7-9, segmented, linear, bristled, 1.0 to 1.5 cm long, green attached to the base of the calyx.	Flowers are small generally in extra axillary cymes in groups of 2-5 or more; 0.3-0.5 cm long and 0.5-0.6 cm wide; sepals 5, coloured or green, petals 5, yellow or pale yellow, stamens 20-30; anther yellow to pale yellow, ovary rounded, 5-carpelled, syncarpous, ovals axile, usually 10 in each locales in 2 rows, giving about 50 ovules in each ovary; style 2-4 mm; stigma pubescent. Anthesis one or two harms after sun rise.

Characteristics	Kenaf	White Jute
Capsul	Ovoid, pointed, villose, half of the length of the calyx with about 20 to 26 seeds.	Capsules rounded, 1.0-1.5 cm in diameter, wrinkled, rarely smooth, muricate, 5-locular, seed- 7-10 in 2 rows in each ocular, without transverse partitions, 30-50 in each fruited.
Seed	Triangular, angles more or less acute, ash gray with pointed light yellowish warty spots. Hilum brown, relatively small. Most of the better known kenaf varieties produce seed that range from 36000 to 40000 per kg.; however some African types from Sudan, Uganda and Central African Republic produce small seed that range from 100,000 to 110,000 per kg.	Seeds are small, chocolate brown, 4-5 faced about 300 per gm.
Fibre	Fine fibre with lower weight than Kenaf	Course fibre higher weight than white Jute
Growing areas	Brammanbaria, Voirab, vast areas of Kishoregonj; Lakkipur, Shriatpur, Madaripur, some sporadic areas of Tangail, Mymensingh and Jamalpur.	All over Bangladesh except Sylhet, Chattagram Hill Tracts, Southern areas like Barishal, Borguna, Volla, Piouakhali, etc
Processing (Post harvest)	Similar processing as jute	Similar processing as Kenaf
Qualities/grading	Similar grading maintained as white jute	Similar grading maintained as kenaf
Rules and regulations	Not at all	Rules are maintained

3.5. Roselle/Mesta (*Hibiscus subdariffa* L.)

Taxonomy

Roselle/Mesta belongs to 6th Kingdom: Plantae, *Clade*: Angiosperms, *Clade*: Eudicots, *Clade*: Rosids, Order: Malvales, Family: Malvaceae, Genus: *Hibiscus*, Species: *H. sabdariffa*, Binomial name: *Hibiscus sabdariffa* L.

Roselle is the most common name used specifically for *Hibiscus subdariffa* var. *altissimo* Hort, both for plant and fibre, although the edible *Hibiscus subdariffa* L. is called roselle. Other common names for the plant and fibre include: Kenaf in most countries; mesta, roselle, hemp, and pusa or pusa hemp in India; Kasi gogu in Andhra Pradesh, India; roselle in Indonesia; Siam jute and paw keo in Thailand; voam bombazaha in Madagascar; azedinha, Curura-de-guine, and quiabo-roseo in Brazil; and Oiselle-de-Guinee in West Africa. Roselle is a short day, annual herbaceous, bast fibre-bearing plant belonging to the Malvaceae family. The subspecies is the most economically important member of the genus *Hibiscus* in terms of fibre production. It is closely related to kenaf (*Hibiscus cannabinus* L.) and okra (*Hibiscus esculentus* L.), young seed pods of the latter being widely used for food in many temperate, subtropical and tropical continents.

A morphological description of the Roselle/Mesta is as follows:

Stems are erect, solid, cylindrical, unbranched, mostly bristled, rarely glabrous, green, red, or regimented in various shades, reaching a height of 1 to 5 m.

Leaves are simple on young plants, later becoming lobed alternate, stipulate, stipules free lateral, 0.5 to 1.0 cm long, green or red. Petiole 4 to 14 cm long, green to red, pubescent

on the abaxial surface and densely bristled or sparsely hairy on the abaxial surface, green to deep and red, scabrous or smooth. Lamina are mostly 3 to 5, deeply palmately lobed, each lobe ovate to oblong lanceolate, margin serrulose, apex-acute, pubescent and bristled along the veins on both the surface, scabrous or scaberulous, green to red, one green gland present in the mid vein on the undersurface. Flowers solitary, axillary, pedunculate, peduncle 0.2 to 0.4 cm long, bristled, pentamerous, completely yellow or yellow with red center, when open 3.0 to 5.0 cm in diameter, bracteoles (epicalyx) 8 to 10, short ovate, bristled, 0.5 to 0.7 cm long, green or red, persistent, attached to the base of the calyx.

Calyx, sepals 5, lanceolate, connate below the middle in to a cup, 1.5 to 2.0 cm lobes 1.5 to 2.0 times the length of the cup, bristled slightly tomentose, gland not prominent, persistent.

Corolla large, spreading, bell-shaped, full-yellow or yellow with deep red center, petals 5, free, twisted, outside pubescent and with glandular hairs in the inner portion, 3 to 5 cm long.

Stamens many, monadelphous, staminal column epipetalous, truncate, 1.0 cm long, with glandular hairs, yellow or red, filaments 0.1 to 0.2 cm long, yellow to red, anthers reniform, pollen spiny. Carpels 5, ovary ovoid 0.3 to 0.4 cm long, broadly globular ovoid, with dense silky hairs, 5 chambered with many ovules in each chamber arranged in 2 to 3 rows, stigma 5, hairy, capitate, red or yellow exerted.

Capsule ovoid, pointed densely villose with about 30 to 40 seeds. Seeds reniform, smaller than those of kenaf reddish brown with many small yellowish brown warty spots. Hilum reddish brown, relatively long seed average, 60000 per kg.

Table 4. Per hectare production of green jute and different green and dry parts of Jute, Kenaf and Mesta crops.

	Deshi Jute	Tossa Jute	Kenaf	Mesta
Green Plants	34 mt/ha (100%)	46 mt/ha (100%)	36 mt/ha (100%)	48 mt/ha (100%)
Green leaves	5304 kg (15.6%)	5060 kg (11.0%)	5155 kg (14.2%)	7890 kg (16.3%)
Dry leaves	1326 kg (2.9%)	1242 kg (2.7%)	1176 kg (3.26%)	1704 kg (3.58%)
Green Ribbons	13688 kg (40.2%)	17802 kg (38.7%)	12246 kg (34.0%)	16820 kg (35.2%)
Dry Ribbons	3788 kg (11.2%)	5111 kg (11.11%)	3429 kg (9.51%)	4609 kg (9.65%)
Green Wood	15028 (44.2%)	23138 kg (50.3%)	18658 kg (51.8%)	23175 kg (48.5%)
Dry wood	4250 kg (12.5%)	7636 kg (16.6%)	5747 kg (15.95%)	7184 kg (15.03%)
Dry retted fibre	2006 kg (5.9%)	3128 kg (6.8%)	1742 kg (4.83%)	2110 kg (4.42%)



Figure 6. Mesta plant with leaf, flower and fruits.

3.6. Kenaf/Mesta Cultivation

Area under Mesta & Kenaf in Bangladesh: 34,000 ha (Kenaf - 19,611 ha & Mesta - 14,489 ha)

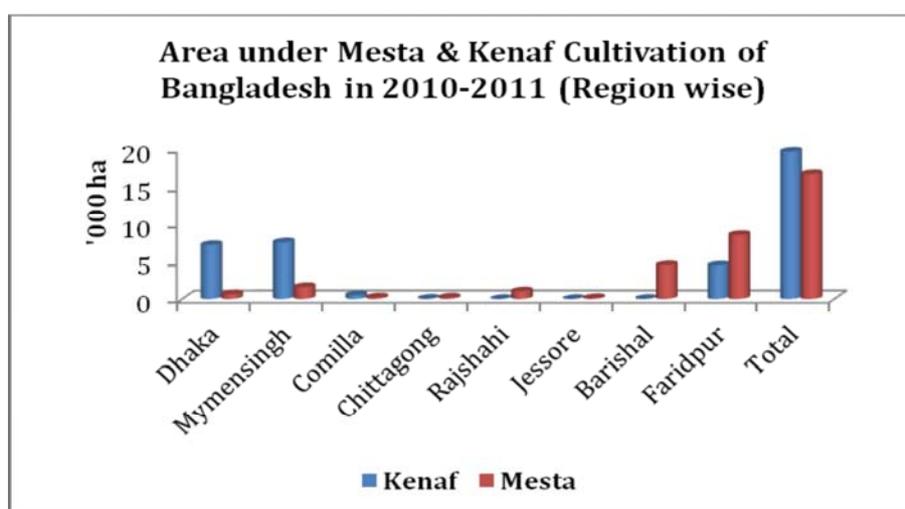


Figure 7. Area under mesta and kenaf cultivation of Bangladesh in 2010-2011 (Region wise).

3.7. Variety Development Related Research Works at BJRI

Ali *et al.*, [12] reported that four irrigation treatments and four nitrogen doses were tested on jute (var. O-9897). The highest seed yield of 745.50 kg/ha was obtained from 30 days of irrigation with the application of 100kg N/ha. The lowest seed yield 236.75 kg/ha was obtained from no irrigation and no fertilizer application. Irrigation at 45 days and 30 and 60 (twice irrigation) days didn't show better seed yield compared to 30 days of irrigation treatment.

Ali *et al.*, [13] reported that significant effect of different NPKS levels on BJRI Kenaf-4 yield and yield contributing characters over control. The highest fibre (3.14t/ha) and stick (7.65t/ha) yield were obtained by the combination dose of N100 Kg/ha with PKS 10-60-20 kg/ha at Kishoreganj. The plant height (3.14m), base diameter (19.47mm) also found highest with the same fertilizer treatment combination. By the same treatment produced higher fibre yield and yield contributing characters at Manikganj though that yield was slightly lower than Kishoreganj. Economic analysis

suggested the best combination is N100-P10-K60-S20 kg/ha. The findings of the present experiment clearly indicated a great prospect of nutrient combination of N100-P10-K60-S20 kg/ha on the growth and yield of fibre production on the variety BJRI kenaf-4.

Ali *et al.*, [14] conducted an experiment to determine the effects of inorganic fertilizer on growth, yield and economic potential of BJRI Mesta-3. The results indicated significant affect of different NPKS levels on Mesta yield and yield contributing characters over control. The highest fibre (3.10t/ha) and stick (7.20t/ha) yield were obtained by the combination dose of N100 Kg/ha with PKS 10-60-20 kg/ha at Manikganj. The plant height (3.08m), base diameter (20.10mm) also found highest with the same treatment of fertilizer combination. By the same treatment produced higher fibre yield and yield contributing characters at Kishoreganj though that yield was slightly lower than that of Manikganj location. Economic analysis favored the use of 100-10-60-20 kg/ha NPKS for yield of 3.10 t/ha Mesta fibre.

Therefore this combination seemed to be optimum for good growth and high potential Mesta production in Bangladesh. Application of modern fertilizer technologies on the mechanized management of Mesta will greatly increase grower profit.

Ali *et al.*, [15] reported that nitrogen, phosphorus, potassium and sulfur are main mineral elements that affect yield and quality in fibre plant production. Experiments to determine the effects of four nitrogen (0, 50, 75 and 100 kg/ha), four phosphorus (0, 5, 10 and 15 kg/ha), four potassium (0, 30, 60 and 90 kg/ha) and three sulfur (0, 10 and 20 kg/ha) levels to increase fibre yield and quality of BJRI tossa (*Corchorus olitorius*) pat 6 plants were conducted in a field experiment. Plant height and stick yield were significantly affected by nitrogen applications. Higher rate of potassium fertilization impact upon plant height and fibre yield was observed. Nitrogen significantly increased fibre yield of plants. Fibre yield was reduced with the highest dose of phosphorus in comparison to yield by the supreme dose of nitrogen. It was concluded that nitrogen mostly improved plant growth and fibre yield while the increase in the level of phosphorus does not have an effect on the increase in yield of fibre and stick.

Akter *et al.*, [16] reported that Bangladesh Jute Research Institute (BJRI) had released an improved variety of high yielding and better quality fibre of *Corchorus olitorius* L. in December 2008 namely "BJRI Tossa-5" (Lal Tossa)/(O-795). The variety was evolved from a single cross between a wild African germplasm (Uganda Red) and a late sowing photosensitive released variety (cv. O-4), where pure line selection was made subsequently. The first red-pigmented tossa jute variety having distinct morpho-agronomic feature, was a great achievement of BJRI. Its stem tall, cylindrical and reddish with red stipule and light reddish petiole. Golden bright better quality fibre than the other existing high yielding cv. O-9897 and cv. O-72 (BJRI Tossa-4). This improved variety performed higher as compared to cv. O-72 in terms of On-Farm yield trails at all the Regional Research Stations during 2004-05 to 2007-08. It was observed less photosensitive than the others having a wider sowing range from 14 March to April. Agronomic trials proved no early flowering occurred even seeding could be done one week before 14 March and crop could be harvested at 110 days of field duration to fit the crop in three cropped pattern. Potential yield of the variety was about 5.0 tha^{-1} by maintaining the plant population 3.5-4.0 lac.ha^{-1} , however in farmers field the average yield was observed 3.4 tha^{-1} , was calculated 10% higher than the check cv. O-72. Pest and disease infestation recorded lower in BJRI Tossa-5 (O-795) than those of Pedi-11/95 and the cv. O-9897 studied.

Hossain *et al.*, [17] reported that an experiment was conducted at Jute Agriculture Experimental Station (JAES), Manikganj; Jute Research Regional Station (RS), Rangpur and Kishoreganj; Sub-station Monirampur, Jessore and Pakhimara, Patuakhali in 2012, 2013 and 2014 to determine the optimum sowing date of white jute breeding line BJC 5003. The

experiment was laid-out in RCBD with three replications. Cultivar CVL 1 was used as control. Crop sown on five different dates like 10 March, 20 March, 30 March, 10 April and 20 April regarded as treatment. All crops were attended normal BJRI recommended cultural practices. Crops were harvested at 120 days after sowing. Results revealed that white jute breeding line BJC 5003 yielded significantly higher fibre than control at Manikganj, Rangpur, Kishoreganj and Jessore. The variety CVL 1 produced higher fibre at Patuakhali than BJC-5003. Results also showed the highest yield at Manikganj sown on 30 March to 10 April, at Regional station Rangpur, Kishoreganj and Patuakhali Sub-station it was 20 March to 30 March. The highest yield produced at Jessore 30 March to 10 April.

Hossain *et al.* [18] reported that an experiment was conducted to determine the optimum sowing date of BJRI Tossa Pat 5 (O-795) for seed production at late season at Manikganj, Jessore and Dinajpur, Jute Research Farms during the year 2010-2013. The experiments were laid out in RCBD design with three replications. The cultivar BJRI Tossa Pat 4 (O-72) was used as control. Five different sowing dates viz., 15 July, 30 July, 15 August, 30 August and 15 September were used as treatment. The crop was harvested at proper maturity of the pods. Results revealed that date of sowing and variety differed significantly in all the locations studied. BJRI Tossa Pat-5 produced the highest seed of 1045 kgha^{-1} at Manikganj and 594.67 kgha^{-1} at Dinajpur on 15 August sowing. On the other hand, seed yield of 973.33 kgha^{-1} was observed the highest in 30 July sowing at Monirampur location. The lowest seed yield and yield attributes were recorded sown on 15 September at all the locations.

Khatun *et al.*, [19] reported that Bangladesh Jute Research Institute (BJRI) had evolved an improved variety of deshi jute (*Corchorus capsularis* L.) in 2007 namely "BJRI Deshi-7" (Basanti)/(BJC-2142). The variety was derived from a single cross between an early sowing photo-insensitive released variety, cv. CC-45 and a blue seeded breeding line BJC-718, where hybridization followed by pedigree method of selection was made subsequently. The first snow white and quality fibre with blue seed coat deshi jute variety having distinct morpho-agronomic feature, was a great achievement of BJRI. This improved variety performed significantly higher yield as compared to cv. CVE-3 at farmers field in Faridpur region during the years from 2003 to 2006. It was observed less photosensitive than the check variety CVE-3, having a wider sowing range from third week of March to Mid-April. Agronomic trials proved absence of premature flowering in appropriate sowing and harvested on 110 days of field duration to fit the crop in three cropped pattern. The variety is suitable for Faridpur jute growing zone. Potential yield of the variety was observed 4.0 tha^{-1} , maintaining the plant population 3.50-4.50 lac.ha^{-1} , however in farmers field the average yield was observed 2.50 tha^{-1} , was calculated 3.24% higher than cv. CC-45 and 9.33% higher than cv. CVE-3. Pest and disease infestation recorded lower in BJRI Deshi-7 (BJC-2142) than those of some other cv. CVL-1, CVE-3 and CC-45.

Table 5. List of varieties of jute and allied crops of Bangladesh.

Sl No	Varieties	Released year	Pedigree
White jute (<i>C. capsularis</i> L.)			
1.	Oocarpus	1910	PLS
2.	Kakya Bombai	1910	PLS
3.	R-85	1916	PLS
4.	D-154	1919	PLS
5.	D-386	1931	PLS
6.	Funduk	1939	PLS
7.	C-212	1939	PLS
8.	C-13	1941	PLS
9.	C-412	1942	PLS
10.	C-1	1952	PLS
11.	C-2	1952	PLS
12.	C-3	1952	PLS
13.	C-4 (C-320)	1955	PLS
14.	C-5 (C-321)	1955	PLS
15.	D-154-2	1961	PLS
16.	C-6 (C-322)	1967	PLS
17.	CVL-1	1977	PLS
18.	CVL-3	1977	PLS
19.	CC-45	1979	PLS
20.	BJRI Deshi Pat-5 (BJC-7370)	1995	D-154 x CC-45
21.	BJRI Deshi Pat-6 (BJC-83)	1995	CVL-1 x Fuleshwari
22.	BJRI Deshi Pat-7 (BJC-2142)	2008	CC-45 x BJC-718
23.	BJRI Deshi Pat-8 (BJC-2197)	2013	CC-45 x FDR
24.	BJRI Deshi Pat Shak-1 (BJC-390)	2014	Cap dwarf red x BINA Pat Shak-1
25.	BJRI Deshi Pat-9 (BJC-5003)	2017	CVL-1 x Acc.1831
Tossa jute (<i>C. octorius</i> L.)			
26.	Chinsura green (D-38)	1915	PLS
27.	R-26	1929	PLS
28.	R-27	1929	PLS
29.	O-620	1939	PLS
30.	O-632	1939	PLS
31.	O-753	1939	PLS
32.	O-1	1955	PLS
33.	O-2	1955	PLS
34.	O-3	1955	PLS
35.	O-4	1967	PLS
36.	O-5	1964	PLS
37.	O-9897	1987	O-5 x BZ-5
38.	OM-1	1995	PLS
39.	BJRI Tossa Pat-4 (O-72)	2002	O-9897 x O-2021 x O-9897
40.	BJRI Tossa Pat-5 (O-795)	2008	O-4 x Uganda Red
41.	BJRI Tossa Pat-6 (O-3820)	2013	PLS
42.	BJRI Tossa Pat-7 (MG-10)	2017	PLS
Kenaf (<i>Hibiscus cannabinus</i>)			
43.	HC-2	1977	PLS
44.	HC-95	1995	PLS
45.	HC-3 (Bot kenaf)	2010	PLS
46.	BJRI Kenaf-4 (KE-3)	2017	PLS
Mesta (<i>H. subdariffa</i>)			
47.	HS-24	1977	PLS
48.	BJRI Mesrta-2 (VM-1)	2010	PLS
49.	BJRI Mesta-3 (SAMU'93)	2017	PLS

3.8. Identifying Characters of Different jute Varieties Developed by BJRI

3.8.1. White Jute Varieties (*Corchorus capsularis* L.)

i. D-154 (2)

Variety D-154 (2) was released in 1961. Its stem green, light coppery red on old branches, upper portion of the petiole is coppery red, leaf length breadth ratio 2:1. Fruit very light pink, single or cluster of 2-4, seed chocolate brown. Medium to

medium low land is suitable for this variety. Seed sowing time last week of March to mid April. Seed rate 7-8 kg/ha. Plant height about 2.50 to 3.00 meter. Fibre recovery rate 6.34%. Time of flowering is 110-120 days after sowing. Time of harvest is 120 days or a bit earlier/later according to need. Yield about 4.89 t/ha (53 mds/acre). Special features are wider adaptability, variation in fruit colour, suitable for medium low land of late sown area. After harvest late Aman can be transplanted [1].



Figure 8. Variety D-154 (2).

ii. CVL-1 (Shabuj Pat)

Variety CVL-1 (Shabuj Pat) was released in 1977. Its plant is full green, stipule green, petiole green, leaf ovate lanceolate, shape and size as D-154. light coppery red on old branches, upper portion of the petiole is coppery red, leaf length breadth ratio 2.1:1. Fruit green, single or in cluster of 2-4, seeds chocolate brown. Medium to medium low land is suitable for this variety. Seed sowing time is end of March to first week of April. Seed rate 7-8 kg/ha. Plant height 3.00 to 3.25 meter. Fibre recovery rate 6.51%. Time of flowering is 120-130 days after sowing. Time of harvest is 120 days or a bit earlier/later according to need. Yield about 5.16 t/ha (56 mds/acre). Special features are most tolerant to mosaic virus. Fine and strong fibre, less cutting, suitable for late sown areas. After harvest late Aman can be transplanted [1]



Figure 9. Variety CVL-1 (Shabuj Pat).

iii. CVE-3 (Ashu Pat)

Variety CVE-3 (Ashu pat) was released in 1977. Its stem green, bright coppery red on older branches, upper portion of the petiole and stipule bright coppery red. leaf ovate lanceolate, length breadth ratio of lamina 2.1:1. Fruit bright red, single or in cluster of 2-5, seeds chocolate brown. Medium to medium low land is suitable for this variety. Seed sowing time is last week of March to last week of April. Seed rate is 7-8 kg/ha. Plant height is about 3.00 to 3.50 meter. Fibre recovery rate 5.91%. Time of flowering is about 105-110 days after sowing. Time of harvest is 120 days or at time of flowering. Yield is

about 4.52 t/ha (49 mds/acre). Special features are suitable for early sown area. Quick growing variety. Early maturing. After harvest early Aman can be transplanted. Fibre fine and lusturous [1].



Figure 10. Variety CVE-3 (Ashu pat).

iv. CC-45 (Jo Pat)

Variety CC-45 (Jo Pat) was released in 1979. Its stem green, upper part of the petiole light coppery red, lamina smaller than D-154, seeds smaller with light brown colour. Leaves nearly ovate, leaf length breadth ratio 2:1. Fruit very light pink, single or in cluster of 2-3, seeds small with light brown colour. Medium low to medium high land is suitable for cultivation. Seed sowing time February to April or beyond. Seed rate is 7-8 kg/ha. Plant height about 3.00 to 4.00 meter. Fibre recovery rate is 6.62%. Time of flowering about 135-180 days after sowing. Time of harvest is 100 days after sowing or as per need. Yield is about 5.16 t/ha (56 mds/acre). Special features are short day insensitive, no risk of premature flowering, very wider time for sowing, suitable for a 3 crop pattern in early sown Aus, So more profitable in early cropping with onion/garlic, Fibre fine and very strong. After early harvest early Aman can be transplanted [1].



Figure 11. Variety CC-45 (Jo Pat).

v. BJRI Deshi Pat-5 (BJC-7370)

Variety BJC-7370 (BJRI Deshi pat-5) was released in the year 1995. Its stem tall, cylindrical and unbranched, leaves serrated, upper surface of the petiole coppery red, fruit round capsule and light coppery red at young stage. Medium to

medium low land of alluvial, loamy and sandy loam is suitable for the variety. Seed sowing time last week of March to second week of April. Seed rate 7-8 kg/ha. Plant height normally 3.00 to 3.50 meter. Time of flowering is about 105-115 days after sowing. Time of harvest is 110 to 120 days after sowing. Yield is about 2.75-3.25 t/ha (Research station yield) and special features are short day tolerant, free from early flowering, produce sufficient seed and can be harvested one month earlier than the existing varieties of white jute, which can provide the land for rabi cropping [1].



Figure 12. Variety BJRI Deshi pat-5 (BJC-7370).

vi. BJRI Deshi Pat-6 (BJC-83)

Variety BJRI Deshi pat-6 (BJC-83) was released in 1995. Its stem tall, unbrabched, cylindrical, leaves serrated, wavy margin, Narrower than CVL-1, fruit round capsule. Medium to medium low land with alluvial loamy and sandy loam soil is suitable for cultivation of this variety. Seed sowing time last week of March to mid April. Seed rate 7-8 kg/ha. Plant height 3.00 to 3.25 meter. Time of flowering 90-95 days after sowing. Time of harvest is about at flowering or earlier/later according to need. Yield 2.50-3.00 t/ha (Research station yield). Special features are its whole plant is green, fast growing and early maturing type and can be harvested at about one month earlier than the existing varieties, suitable for 3 crop pattern [1].



Figure 13. Variety BJRI Deshi pat-6 (BJC-83).

vii. BJRI Deshi Pat-7 (BJC-2142)

Variety BJRI Deshi pat-7 (BJC-2142) was released in the year 2007. Its stem green tall, unbrabched, cylindrical, leaves lanceolate, length breadth ratio 1:2.6. Petiole green, length 6.9cm. Flower regular, sepal-5, petals-5. Fruit round capsule,

green, 5-chambred. Seed is blue in colour, 1000 seed weight – 2.97g (10% M. C). Medium high land with alluvial loamy and sandy loam soil is suitable for this variety. Seed sowing time is March to June. Seed rate is 7-8 kg/ha. Plant height is normally 3.50 to 4.60 meter. Time of flowering is 105-115 days after sowing. Time of harvest is about 110 days after harvest. Yield normally 2.50-3.00 t/ha (Research station yield). Special features are short day and low temperature tolerant, early seeding white jute. Performed better than existing varieties CC-45 and CVE-3 at farm level. Better fibre quality give additional return [1].



Figure 14. Variety BJRI Deshi pat-7 (BJC-2142).

viii. BJRI Deshi Pat-8 (BJC-2197)



Figure 15. Variety BJRI Deshi pat-8 (BJC-2197).

Variety BJRI Deshi pat-7 (BJC-2142) was released in the year 2013. Its stem light coppery red (P₄) tall, unbrabched, cylindrical. Leaves are lanceolate, Petiole slightly red. Flower regular, sepal-5, petals-5. Fruit round capsule, redish green, 5-chambred. Seed is brownish in colour, 1000 seed weight

2.97-3.15g (10% M. C). Medium high land with alluvial loamy and sandy loam soil is suitable for this variety. Seed sowing time is 01-30 April. Seed rate is 7-8 kg/ha. Plant height is normally 3.50 to 4.60 meter. Time of flowering is 110-115 days after sowing. Time of harvest is about 110 days after harvest. Yield normally 2.70-2.90 t/ha (Research station yield). Special features are quick growing, medium salt tolerant and mosaic virus tolerant [1].

ix. BJRI Deshi Pat Shak-1 (BJC-390)

Variety BJRI Deshi pat shak-1 (BJC-390) was released in the year 2014. Plant full green (P₀) short, branched and bushy. Leaves are lanceolate and highly dense. Fruit round capsule, redish green, 5-chambered. Seed is brownish in colour, 1000 seed weight 2.90-3.10g (10% M. C). Medium high land with alluvial loamy and sandy loam soil is suitable for this variety. Seed sowing time is 28 February-15 September. Seed rate is 5-6 kg/ha. Time of flowering is 50-60 days after sowing. Time of harvest is about 35-45 days after harvest. Green leaf yield normally 3.00-3.50 t/ha (Research station yield). Special features are growing not for fibre and leaf taste is sweet [1].



Figure 16. BJRI Deshi Pat Shak-1 (BJC-390).

x. BJRI Deshi Pat-9 (BJC-5003)

Variety BJRI Deshi pat-9 (BJC-5003) was released in the year 2017. Its stem green tall, unbranched, cylindrical, leaves lanceolate, length breadth ratio 1:2.6. Petiole light red, length 6.1cm. Flower regular, sepal-5, petals-5. Fruit round capsule, green, 5-chambered. Seed is blue in colour, 1000 seed weight -2.91g (10% M. C). Medium high land with alluvial loamy and sandy loam soil is suitable for this variety. Seed sowing time is 30 March to 26 April. Seed rate is 7-8 kg/ha. Plant height is normally 3.50 to 4.00 meter. Time of flowering is 100-110 days after sowing. Time of harvest is about 100 days after harvest. Yield normally 2.60-3.00 t/ha (Research station yield). Special features are its fibre comparatively white with low cuttings. Better fibre quality gives additional return [1].



Figure 17. BJRI Deshi Pat -9 (BJC-5003).

3.8.2. Tossa Jute Varieties (Corchorus olitorius L.)

i. Variety O-4

Variety O-4 was released in 1967. It is fully green, unbranched, leaves ovate lanceolate. Length-breadth ratio of lamina 2.9:1, Fruit green, cylindrical dehiscence, seeds steel gray with red in three edges. Medium high to high land with loamy and sandy loam soil is suitable for cultivation. Seed sowing time is mid April to mid May. Seed rate 5-6 kg/ha. Plant height 3.50 to 4.50 meter. Fibre recovery 6.62%. Time of flowering is 118-132 days after sowing. Time of harvest is 100 days after harvest or as per need. Yield normally 3.00-3.50 t/ha at Research station. Special features are wider adaptability, suitable for late sown areas, fibre fine and strong with least cutting, after early harvest late transplanted aman can be grown [1].



Figure 18. Variety O-4.

ii. Variety O-9897

Variety O-9897 was released in 1987. Its plant fully deep green, unbranched, leaves ovate deep green, succulent, fruit indehiscent, leaves ovate lanceolate. Length-breadth ratio of lamina 2.7:1, Fruit green, cylindrical indehiscence, single or in cluster of 2-5, seeds brown with green tinge on seed coat. Medium high to high land with loamy and sandy loam soil are suitable for the variety. Seed sowing time mid March to mid May. Seed rate 5-6 kg/ha. Plant height 4.00 to 5.50 meter. Fibre recovery 6.70%. Time of flowering 130-150 days after

sowing. Time of harvest 100 days after harvest or as per need. Yield 3.00-4.00 t/ha at Research station. Special features are short day insensitive, free from premature flowering, wide time of sowing, suitable for 3-crop pattern, fibre fine, strong and lower cutting, after early harvest early aman can be transplanted [1].



Figure 19. Variety O-9897.

iii. OM-1

OM-1 was released in 1995. Its stem tall, cylindrical and deep green, leaves ovate, lanceolate in shape, Length-breadth ratio of lamina 2.5:1, Fruit long cylindrical indehiscence, seeds brownish. Medium high to high land with loamy and sandy loam soil is suitable for cultivation. Seed sowing time 15 March to 15 May. Seed rate 5-6 kg/ha. Plant height 3.00 to 3.25 meter. Fibre recovery 6.72%. Time of flowering 120-130 days after sowing. Time of harvest 100 days after harvest or as per need. Yield 2.50-3.40 t/ha at Research station. Special features are Less photosensitive, performed better than the existing variety O-9897, suitable for early sowing and for 3-crop pattern, fibre fine, strong and lower cutting than the existing varieties [1].



Figure 20. OM-1.

iv. BJRI Tossa Pat-4 (O-72)

BJRI Tossa Pat-4 was released in 2002. Its stem tall, unbranched, cylindrical and green, length breadth ratio of leaves 1:2.2, flower regular, sepal-5, normal green, petals-5, deep yellow, fruit cylindrical, long pod green, indehiscent,

seeds brownish grey, 120-125 seeds per fruit, 1000 seeds weight-2.21g. Medium high to high land is suitable for cultivation. Seed sowing time 15 March to 30 April. Seed rate 5-6 kg/ha. Plant height 4.00 to 4.50 meter. Fibre recovery 6.75%. Time of flowering 140-155 days after sowing. Time of harvest 110 days after harvest or as per need. Yield 2.50-3.40 t/ha at Research station. Special features are less photosensitive, performed better than the existing variety O-9897, fibre fine, strong and least cutting than the existing varieties [1].



Figure 21. BJRI Tossa Pat-4 (O-72).

v. BJRI Tossa Pat-5 (O-795)

BJRI Tossa Pat-5 was released in 2008. Its stem tall and red or reddish in colour, unbranched, quick growing, cylindrical, leaf ovate lanceolate, length breadth ratio of leaves 1:2.4, flower regular, sepal-5, normal green, petals-5, deep yellow, fruit cylindrical, long pod green, indehiscent, seeds brownish grey, 125-130 seeds per fruit, 1000 seeds weight-2.28g. Medium high to high land is suitable for cultivation. Seed sowing time 15 March to 30 April. Seed rate 5-6 kg/ha. Plant height 3.50 to 4.00 meter. Fibre recovery 6.75%. Time of flowering 140-155 days after sowing. Time of harvest 110 days after harvest or as per need. Yield 2.70-3.20 t/ha at Research station. Special features are less photosensitive, performed better than the existing variety O-9897, fibre fine, strong and least cutting than the existing varieties [1].



Figure 22. BJRI Tossa Pat-5 (O-795).

vi. **BJRI Tossa Pat-6 (O-3820)**



Figure 23. BJRI Tossa Pat-6 (O-3820).

BJRI Tossa Pat-6 was released in 2013. Its stem tall and green in colour, unbranched, quick growing, cylindrical, leaf long lanceolate, length breadth ratio of leaves 1:2.5, flower regular, sepal-5, normal green, petals-5, deep yellow, fruit cylindrical, long pod green, indehiscent, seeds brownish grey, 122-126 seeds per fruit, 1000 seeds weight-2.24g. Medium high to high land is suitable for cultivation. Seed sowing time 01 April to 30 April. Seed rate 5-6 kg/ha. Plant height 3.50 to 4.00 meter. Fibre recovery 6.75%. Time of flowering 135-145 days after sowing. Time of harvest 110 days after harvest or as per need. Yield 2.50-2.80 t/ha at Research station. Special features are less photosensitive, fibre fine, strong and least cutting than the existing varieties [1].

vii. **BJRI Tossa Pat-7 (MG-1)**

BJRI Tossa Pat-7 was released in 2017. Its stem tall and green in colour, unbranched, quick growing, cylindrical, leaf ovate lanceolate, length breadth ratio of leaves 1:2.5, flower regular, sepal-5, normal green, petals-5, deep yellow, fruit cylindrical, long pod green, indehiscent, seeds brownish grey, 122-126 seeds per fruit, 1000 seeds weight-2.27g. Medium high to high land is suitable for cultivation. Seed sowing time 15 March to 15 April. Seed rate 5-6 kg/ha. Plant height 3.50 to 4.00 meter. Fibre recovery 6.75%. Time of flowering 140-155 days after sowing. Time of harvest 110 days after harvest or as per need. Yield 2.70-3.30 t/ha at Research station. Special features are less photosensitive, fibre fine, strong and least cutting than the existing varieties [1].



Figure 24. BJRI Tossa Pat-7 (MG-1).

3.9. **Identifying Characters of Different Kenaf Varieties Developed by BJRI**

3.9.1. **Kenaf Varieties (*Hibiscus cannabinus* L.)**

i. **HC-2 (Joly Kenaf)**

HC-2 was released in 1977. Its stem green pigmented and petiole green, leaves simple cordate, petiole is longer than lamina. Fruit capsule ovoid, indehiscent, seeds subreniform grayish brown. Bright fibre. Medium to medium low land is suitable for cultivation. Seed sowing time mid March to mid April. Seed rate 12-15 kg/ha. Plant height 4.00 to 5.50 meter. Fibre recovery 7.3%. Time of flowering 150-165 days after sowing. Time of harvest 120 days after harvest or as per need. Yield 2.50-2.70 t/ha at Research station. The variety suitable for medium low, less fertile and flood affected land. Fibre is bright and shiny. Green plants are excellent raw materials for paper pulp. Tolerant to water logging [1].



Figure 25. HC-2 (Joly kenaf).

ii. **BJRI Kenaf-2 (HC-95)**



Figure 26. BJRI Kenaf-2 (HC-95).

BJRI Kenaf-2 was released in 1995. Its stem tall cylindrical, unbranched, whole plant deep green, Fibre bright. leaves lobed, the petal is light cream colour with very light pink tinge on the inner basal part of the petals. Fruit capsule ovoid, indehiscent, seeds subreniform grayish brown. Medium to medium low land. Loom or slightly clay to sandy loam are suitable for cultivation. Seed sowing time Mid March to Mid

April. Seed rate 12-15 kg/ha. Plant height 3.50 to 4.00 meter. Fibre recovery 6.23%. Time of flowering 150-170 days after sowing. Time of harvest 120 days after harvest or as per need. Yield 2.80-3.30 t/ha at Research station. This variety is suitable for medium low, less fertile and flood affected land. Fibre is bright and shiny. Green plants are excellent raw materials for paper pulp, seeds contain about 20% edible oil. Tolerant to water logging [1].

iii. BJRI Kenaf-3 (Bot Kenaf)

BJRI Kenaf-3 was released in 2010. Its stem tall cylindrical, unbranched, whole plant deep green, Fibre bright. leaves cordated, the petal is light cream colour with very light pink tinge on the inner basal part of the petals. Fruit capsule ovoid, indehiscent, seeds subreniform grayish brown. Medium to medium low land. Loom or slightly clay to sandy loam are suitable for cultivation. Seed sowing time 15 March to 30 April. Seed rate 12-15 kg/ha. Plant height 3.50 to 4.00 meter. Fibre recovery 6.53%. Time of flowering 150-170 days after sowing. Time of harvest 120 days after harvest or as per need. Yield 2.60-3.00 t/ha at Research station. This variety is suitable for medium low, less fertile and flood affected land. Fibre is bright and shiny. Green plants are excellent raw materials for paper pulp, Tolerant to water logging [1].



Figure 27. BJRI Kenaf-3 (Bot Kenaf).

iv. BJRI Kenaf-4 (KE-3)



Figure 28. BJRI Kenaf-4 (KE-3).

BJRI Kenaf-4 was released in 2017. Its stem tall cylindrical, unbranched, whole plant deep green, Fibre bright. leaves lobed, the petal is light cream colour with very light pink tinge on the inner basal part of the petals. Fruit capsule ovoid, indehiscent, seeds subreniform grayish brown. Medium to medium low land. Loom or slightly clay to sandy loam are suitable for cultivation. Seed sowing time 15 March to 15 May. Seed rate 12-15 kg/ha. Plant height 3.50 to 4.00 meter. Fibre recovery 6.75%. Time of flowering 140-160 days after sowing. Time of harvest 120 days after harvest or as per need. Yield 2.80-3.30 t/ha at Research station. This variety is suitable for medium low, less fertile and flood affected land. Fibre is bright and shiny. Green plants are excellent raw materials for paper pulp, Tolerant to water logging [1].

3.10. Identifying Characters of Different MESTA Varieties Developed by BJRI

3.10.1. Mesta Variety (Hibiscus Subdarifa L.)

i. Variety HS-24 (Tani Mesta)

Variety HS-24 was released in 1977. Its stem green with nodes purple, pigmented leaves fine lobed, petiole is smaller than lamina. Leaves 5 lobed with lanceolate segments which are serrated, central lobe longest, leaf lobed dark green with veins and margins purple, rough, sepals light green with purple spots at maturity, petals yellow with crimson red at the inner basal portion, fruits capsule ovoid hairy, dehiscent seeds dull brown reniform. High land (Less fertile) is suitable for cultivation. Seed sowing time mid February to mid May. Seed rate 12-18kg/ha. Plant height 4.00 to 6.00 meter. Fibre recovery 6.23%. Time of flowering 190-210 days after sowing. Time of harvest 120-130 days after harvest or as per need. Yield 2.00-2.70 t/ha at Research station. This variety is suitable for high, less fertile and drought affected land. After harvest T. aman can be grown. Resistant to root-knot nematodes [1].



Figure 29. Variety HS-24 (Tani mesta).

ii. BJRI Mesta-2 (VM-1)

BJRI Mesta-2 (VM-1) was released in 2010. Its stem red with nodes purple, pigmented leaves fine lobed, Long petiole similar as lamina. Leaves 3 lobed with lanceolate segments which are serrated, central lobe longest, leaf lobed dark green

with veins and margins purple, rough, sepals light green with purple spots at maturity, petals yellow with crimson red at the inner basal portion, fruits red and cone type. Plants are bushy in type. High land (Less fertile) is suitable for cultivation. Seed sowing time 15 April to 30 June. Seed rate 12-18kg/ha. Plant height 1.00 to 1.50 meter. Time of flowering 180-200 days after sowing. Time of harvest from 60 days to onward for fruit or as per need. Red coloured fruit yield 2.00-2.50 t/ha and leaf 6.0-7.0 t/ha at Research station. This variety is suitable for high, less fertile and drought affected land. Could produced 20% edible oil from seeds, Resistant to draught and root-knot nematodes [1].



Figure 30. BJRI Mesta-2 (VM-1).

iii. BJRI Mesta-3 (SAMU'93)



Figure 31. BJRI Mesta-3 (SAMU-93).

BJRI Mesta-3 (SAMU'93) was released in 2017. Its stem green with nodes purple, leaves green and fine lobed, long petiole than lamina. Leaves 5 lobed with lanceolate segments which are serrated, central lobe longest, leaf lobed dark green with veins, fine, sepals light green with purple spots at maturity, petals yellow with crimson red at the inner basal portion, fruits capsule oval hairy, dehiscent seeds dull brown reniform. High land (Less fertile) is suitable for cultivation. Seed sowing time 15 March to 15 May. Seed rate 12-18kg/ha. Plant height 4.00 to 5.00 meter. Time of flowering 180-210 days after sowing. Time of flowering 190-210 days after sowing. Time of harvest 120-130 days after harvest or as per

need. Yield 2.50-2.80 t/ha at Research station. This variety is suitable for high, less fertile and drought affected land. Quick growing and resistant to root-knot nematodes [1].

3.11. Maintenance of Varieties

Maintenance of variety means to maintain the genetical purity and also quality of seed. At the time of variety release a small quantity of seed is available with the breeder. The relatively small amount of seed of variety needs to be multiplied and made available to farmers as quickly as possible. During seed multiplication, varietal purity and identity needs to be maintained. Each multiplication cycle starts from the 'breeder seed'. If the breeder seed is not of high purity, the contaminants present get multiplied several times in the succeeding generations of foundation and certified seed production. The presence of contaminants may even lead to complete loss of the improved features of the variety. Prevention of contamination is the heart of a successful breeder seed production programme. Breeders of Bangladesh Jute Research Institute (BJRI) develop nucleus seed when a new variety released and produce "Breeder seed" from nucleus seed. The seed certification agency (SCA) is not in the network of seed production but plays an important role provides quality control services from Breeder seed to Foundation seed to Certified seed [21].

3.11.1. Nucleus Seed Production of Jute and Allied Fibre

During seed multiplication process, several factors may reduce the genetic purity of seed. The maintenance of genetic purity is largely dependent on the genetic makeup of the variety. Genetic variation may appear within a seed stock for a number of reasons including mechanical contamination, hybrids resulting from undesirable pollination, recombination, residual segregation, selective influence of environment and mutation. These factors ensure that no cultivar is likely to retain the precise frequencies established by the breeder without continuous intervention through maintenance breeding techniques [22].

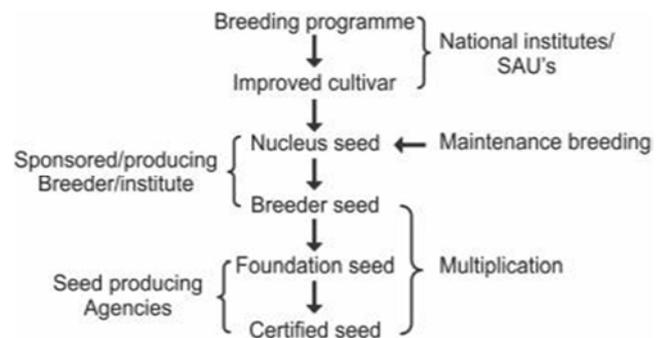


Figure 32. Figure showing the development of a variety, maintenance and multiplication in Bangladesh, which also applicable for jute.

3.11.2. Nucleus Seed

Once a variety is released for cultivation, the breeder usually supplies a small quantity of seed for further multiplication and maintenance. The responsibility of breeder seed production centre is to produce breeder seed and varietal

maintenance. In order to release seed of an improved variety to farmers, it has to be multiplied. Each multiplication cycle has to start from its basic seed stock, 'Nucleus Seed'.

3.11.3. Maintenance of Nuclear Seed Stock

Our basic objective of variety maintenance is to maintain the purity and identity of a variety. The maintenance procedures are in fact the extension of the normal breeding process. The difference is that during maintenance breeding, selection process is relatively mild and breeder's aim is not improvement but to keep the identity unchanged. Selection should maintain the plant type, its uniformity and free from diseases. The fields where plants and progenies are to be assessed should be uniform. Essentially these should be grown under optimal growing conditions.

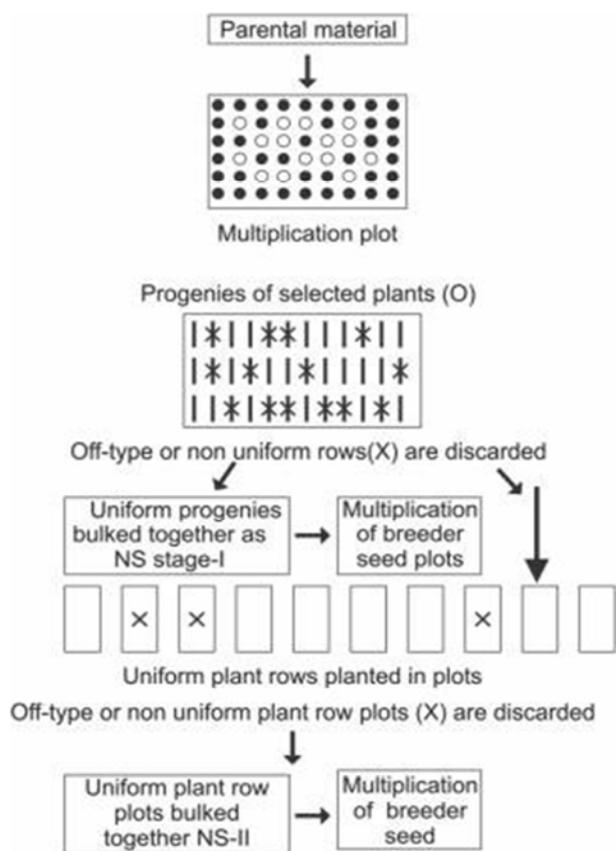


Figure 33. Figure showing the jute and allied varietal maintenance pattern.

3.11.4. Plant to Row Method

The maintenance procedure starts with a small plot raised from the parental material received from the breeder or uniform seed multiplication field in case of released variety. About 100 (depends on requirement) healthy plants typical of the cultivar are selected and marked for progeny testing (Figure 2). The seeds of the marked true- to- type plants are harvested separately. The seeds of each plant are planted in a 3m long progeny row. These progeny rows are assessed critically several times during the growing season. Progeny rows that deviate in one or other characteristics are discarded and entire plant progeny rows is rejected. The plant progenies that are uniform and true to type are selected and bulked

together as nucleus seed. This nucleus seed is used for planting larger breeder seed plots.

All the steps of maintenance a variety are very essential to maintain field standard and also seed standard of jute. The field standard and seed standard of jute seeds are shown in the tables 6 and 7.

Table 6. Field standard of jute seed.

Criteria	Breeder's seed	Foundation seed	Certified seed
Isolation distance(M)			
a) Field of other variety of same species	50	30	20
b) Field of other species	5.0	3.0	3.0
Other varieties (Max%)	0.0	0.1	0.2
Other crops(Max %)	-	-	-
Obnoxious weed(Max %)	-	-	-
Diseases (infection by seed born pathogen: Max% of infected plants)			
1. Stem rot	0.0	0.1	0.5
2. Blackband	0.0	0.1	0.5
3. Leaf mosaic	0.0	0.05	0.5

Table 7. Seed standard of jute seed.

Criteria	Breeder seed	Foundation seed	Certified seed
Pure Seed(Min % by wt)	99.0	98.0	96.0
Seeds of other varieties (Max%)	0.0	1.0	1.0
Seed of other crops (Max%)	0/kg	5/kg	10/kg
Obnoxious weed (Max. no.)	0/kg	5/kg	10/kg
Inert materials (Max %)	1.0	1.0	3.0
Germination (Min%)			
a) Fresh Seed	80.0	80.0	80.0
b) Carry over seed	70.0	70.0	70.0
Moisture content (Max %)			
a)C capsularis L.	10.0	10.0	10.0
b) C olitorius L.	8.0	8.0	8.0
Diseases (infection by seed born pathogen: Max% of infected plants)			
1. Stem rot	0.0	0.1	0.5
2. Blackband	0.0	0.1	0.5
3. Leaf mosaic	0.0	0.01	0.1

3.12. Premature Flowering in Jute Varieties

Experimental evidences are that the proper time for sowing of White jute is after 15th March to 15th April and for Tossa 15th April to 15th May. If sowing made earlier than the actual time produces complication to the plants and gives lower yield. Jute when planted in time, it flowers in the month of August when starts of shortening of day length as it is a short day plant. Like all other plants jute plants are influenced by photoperiods in the formation of flowers. They also appear to be affected by drought or any other stresses though it could not be proved yet. In case of low lands as well as in any year of early rainfall farmers grow jute early and in early sown plots jute plants flower early when they are hardly 1 or 2 feet tall [23]. This early flowering is due to the effect of short photoperiod only. This may be happens if the soil is poor. They have not been proved.

Untimely flowering in jute is mainly due to-

- I. The early sowing in short day length period and may be partly-

II. Prolonged any type stress and drought, dry air, stunted growth, low fertility of soil, cloudy weather, etc.

Effect of untimely flowering in jute-

I. Stunted jute plant growth

II. Starts branching

III. Drastically lower the yield and quality of fibre.

In Bangladesh, the day length is about 12 hours by the end of March and by the mid April it increases to over 12.5 hours. Sowing White jutes from end of March and Tossa from mid

April is safer from induction of premature flowering though some plants here and there may tend to show a few flowering without any harm in fibre production, because those plants continue to grow vegetatively without further flowering until again by the mid August to September when day length begins decreasing from 12.5 to 12 hours [23]. Bangladesh Jute Research Institute developed different White and Tossa jute variety's optimum sowing dates for fibre production are given below-



Figure 34. Normal flowering in jute plants.

Factors responsible for premature flowering in jute variety

Jute is short day length tolerant plant so, some white jute varieties produced premature flowering if sowing completed before Mid March and some before end March sowing. As same if Tossa jute variety O-4 sown on or before mid April will produced premature flowering. So many old jute varieties were produced untimely flower if sown on or before mid April.

Registered or certified jute variety specially Tossa varieties produced premature flower of few percentage which differed with the specific genetic characters of main variety could be identified by seeing their leaves, again sometimes it could be difficult to identify. These Tossa jute varieties seeds could be produced from local varieties and sometimes produced from cross pollination where not maintained standard distance at the time of seed production.

Jute seed sown on soil with high fertility and moisture content, plant germination and growth will be quick and vigorously, at the same time early flowering happened. Same characters of early flowering might be found at the time if drought, water logging, and other stress conditions in early growth stages. Which do not found if jute seed sowing completed after critical photoperiod. However, for more appropriate information, it is depend on more research work in future [23].

Management of premature flowering in jute

Premature flowering is harmful to jute fibre production. It often makes fibre yield and quality loss to the farm level. It may however be said that premature or untimely flowering happened was mainly due to early sowing of jute varieties in short day length period and might be partly due to prolonged drought, dry air, stunted growth, low fertility of soil, cloudy weather etc. Even when day length exceeds the critical level throughout growth, instances of premature flowering in jute have been recorded in Bangladesh. This suggests an effect on flowering additional to simply that of photoperiod but the

actual cause is yet to be identified. Resolution of differing results for jute flowering is required detailed study using controlled environmental facilities set to photoperiods encompassing the range from 10½ to 12½ h. Thus, there is a need to identify the possible reasons and effects of different climatic change and environmental factors that responsible for flowering in jute timely and as well as untimely [23].

4. Conclusion

Nearly 7.0-8.0 lack hectares of land cultivated by jute and allied crops per year in Bangladesh, which produced 80-90 lack bales of fibre. Over all 49 jute and allied varieties (White jute 25, Tossa jute 17, Kenaf 4 and Mesta 3 varieties) developed by BJRI. CVL-1, BJRI Deshi Pat-5, BJRI Deshi Pat-6, BJRI Deshi Pat-7, BJRI Deshi Pat-8, BJRI Deshi Pat Shak-1 and BJRI Deshi Pat-9 of *C. capsularis* L., O-9897, BJRI Tossa Pat-4, BJRI Tossa Pat-5, BJRI Tossa Pat-6, BJRI Tossa Pat-7 of *C. olitorius* L., HC-2, HC-95, HC-3 and BJRI Kenaf-4 of *Hibiscus cannabinus* and HS-24, BJRI Mesrta-2 and BJRI Mesta-3 of *H. subdariffa* found important could cultivated in farmers field. Maintenance of variety means to maintain the genetical purity and also quality of seed. During seed multiplication, varietal purity and identity needs to be maintained. The presence of contaminants may even lead to complete loss of the improved features of the variety. Breeders of Bangladesh Jute Research Institute (BJRI) develop nucleus seed when a new variety released and produce "Breeder seed" from nucleus seed. The seed certification agency (SCA) is not in the network of seed production but plays an important role provides quality control services from breeder seed to foundation seed to certified seed. Premature flowering in jute varieties found harmful to fibre production. Premature or untimely flowering happened mainly due to early sowing of jute varieties in short day length period and partly due to prolonged drought, dry air, stunted growth, low fertility of soil,

cloudy weather etc. The article will help future breeder, higher study students, farm level extension workers and the university teachers as well.

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Biography



Mohammad Mahbulul Islam an eminent Agronomist of Bangladesh was graduated in 1984, completed MSc. Ag. (Agronomy) in 1987 and awarded PhD from Bangladesh Agricultural University in 2008. Dr. Islam obtained 'Seed Research Methodology' training from Edinburgh University, Scotland, UK. Dr. Islam is working as Chief Scientific Officer & Head, Agronomy Division, Bangladesh Jute Research Institute (BJRI), Dhaka from December 2011. He has about 30 years of agronomic and seed technological research experience. Dr. Islam acting as Research Supervisor, Technical Editor and as Editorial Board member of different national and international journals. He is active life-member of Krishibid Institution, Bangladesh; Bangladesh Agronomy Society; Seed Science Society, Bangladesh; Weed Science Society, Bangladesh; Registered Graduate of SAU etc. Dr. Islam has more than 125 publications (Scientific and popular) in different reputed national and international peer reviewed journals including 8 books of home and abroad.