CHAPTER ONE

The Anatomy, Cultivation, and Marketing of Jute

JUTE is obtained from the stems of two plants grown mainly in the Indian sub-continent. All fibres which are extracted from the stems of plants are classified as bast fibres, others in this category being flax, hemp, kenaf, and ramie. The botanical names of the plants from which jute is obtained are *Corchorus capsularis* and *Corchorus olitorius*. About 40 species of *Corchorus* are known throughout the world, being found chiefly in the Tropics but *C. capsularis* and *C. olitorius* are the only ones which are cultivated for their fibre. In the wild state both plants are small and shrub-like but when they are cultivated they can grow up to a height of 15 ft. Both are herbaceous annuals, i.e. they grow from seed to maturity in one year and in doing so produce seeds for the following year's crop. Jute is grown in the rainy season in temperatures of 70–100° F with relative humidities of 65–95 per cent and requires a total rainfall of about 10 in. during the months of March, April, and May.

In general appearance *C. capsularis* and *C. olitorius* are similar, having long straight stems about 1·5 in. in circumference, unbranched except at the top. The main difference between the two species is in their fruits: *C. capsularis* has a rough wrinkled spherical seed-box about 0·3 in. in diameter and *C. olitorius* has an elongated pod like a miniature cucumber about 2 in. long. Besides the shape of their seed-boxes there are other differences: *C. capsularis* tends to be shorter than *C. olitorius*, rarely exceeding a height of 12 ft compared with 15 ft for *C. olitorius*; *C. capsularis* is grown on lower-lying ground than *C. olitorius*; *C. capsularis* yields the 'white' jute of commerce and *C. olitorius* the 'Tossa' and 'Daisee'. Tossa is grown on the higher ground because the crop withstands floods later than white and so does not need to be cut at the normal flood-threat time. Although Tossa has a higher yield per acre and commands a better price, some 60 per cent of the total jute crop is of white jute.

THE ANATOMY OF THE JUTE STEM

The jute fibres lie within the stem of the plant just beneath the bark and surrounded by soft tissue. Figure 1.1 shows diagrammatically what would be seen if a V-shaped wedge were cut out of a jute stem.

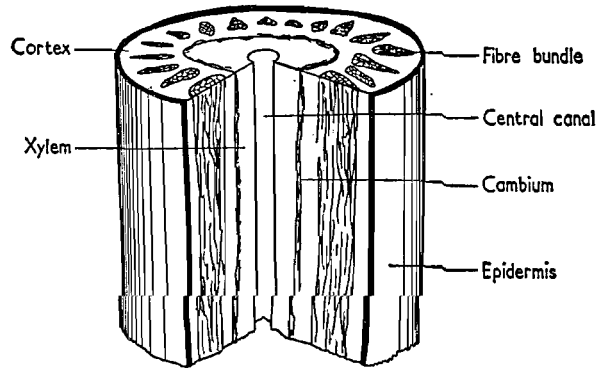

Figure 1.1. Anatomy of the jute stem

On the outside of the stem is the epidermis which in young plants is green and soft but becomes harder, particularly at the root end, as the plant matures. Immediately beneath the epidermis lies the cortex, imbedded in which are the fibre bundles. Continuing to move inwards to the axis of the stem the cambium is found, a continuous layer about five cells thick running completely round the stem. On the inside of the cambium lies the xylem which, as the plant matures, becomes more and more woody and finally, running down the centre of the stem is a canal which in mature *C. olitorius* stems is usually hollow but in *C. capsularis* stems still contains a soft pith.

The cambium plays an extremely important part in the life of the plant and is particularly interesting because it is from it that the fibre bundles develop.

In the young plant the stem is composed of a ring of unconnected bundles of cells, surrounded by the soft tissue of the cortex and encircling the pith, the whole being enclosed by the waxy epidermis which protects the young plant. The inner part of the cell bundles contain the elements of the woody xylem while the outer part will form the 'bast'; separating these two sections are the rudimentary cells of the cambium. As the plant grows, the cambium cells multiply and

divide until they join up with their neighbours in the adjacent bundles to form a complete ring round the plant. On the inside of cambium the cells enlarge and bundles of them become progressively more lignified and form the 'wood' of the stem. On the outside of the cambium interesting and important developments occur. Groups of cells known as medullary rays spread out from the cambium and between them certain cells begin to change by thickening their walls—these are the first fibres. Growth continues and more and more cells develop into fibres until the easily recognizable fibre bundles are formed. The bundles are roughly triangular in shape with their base towards the cambium and their apex towards the epidermis. In the bundle the oldest fibres are at the apex and the most recently formed at the base. Thus the oldest fibres are continually being pushed outwards by the newly formed ones.

These cells in the fibre bundles are, as it were, the building units of the fibres and are called 'ultimates' and are on average about 18 microns in diameter and 2·5 mm long (1 micron = 0·001 mm). The ultimates are cemented together to form the 'fibres' of commercial usage which run along the stem of the plant, branching and dividing, only to unite with their neighbours then divide again, making up a mesh of fibre networks lying in layers around the cambium. The outermost layers are more open than the innermost ones because of the outward growth from the cambium, and as the stem circumference grows the first-formed networks become stretched and open.

THE CULTIVATION OF JUTE

The jute crop is grown on small plots of land and in many districts half the growers have only about 800 lb of fibre to sell at the end of the season. With the normal outrun of fibre being 1,100–1,300 lb per acre, this means that many of the plots are only about three-quarters of an acre. Since it takes around 80 man-days (1 man-day = 1 adult working for 7 hours) to plough, sow, weed, cut, and extract the fibre from 1 acre of ground it follows that about 150 man-days are needed to produce 1 ton of fibre. Some idea of the large labour force required can be obtained when one remembers that about 2,000,000 tons of jute are grown each year.

Low-lying, slightly acidic, alluvial soils in river complexes are particularly suited to jute growing, especially when these soils are revitalized by flooding each year and a deposit of silt is left on them

when the flood-waters recede, but the fibre can be grown on lighter sandy soils provided large quantities of manure are fed into the ground. The characteristic feature of the main jute-growing areas of India and Pakistan is the low-lying nature of the terrain, any slopes are gradual and the river banks have an extremely small gradient. Dacca, in the centre of an important jute-growing region, is less than 50 ft above sea-level although it is 100 miles inland. These low lands, as would be expected, flood very easily when the heavy monsoon rains coincide with the melting of the Himalayan snows about the middle of June or July and even those parts which are not actually flooded may be under a few inches of surface water at times. The lower levels are inundated each year by the overflowing rivers which meander over the whole area and at harvest time parts of the crop may be under several feet of water. Apart from the beneficial effects of this large supply of water from the botanical and agricultural points of view, the widespread river systems provide a very useful means of transporting the fibre as road and rail communications in the country districts are not good.

The time when both types of jute cease strong growth and enter upon their reproductive phase of life by flowering and then forming seed-pods is influenced by the hours of daylight in each day. When the length of the day reduces to about 12 hr at the end of August and the beginning of September the plants flower soon afterwards no matter when they have been sown. *C. olitorius* is more sensitive than *C. capsularis* in this respect and since growth and the yield of fibre depend critically upon the time of flowering the former variety is always sown later than the latter. Most of the more commonly met *C. capsularis* is sown in February, March, or April, whereas the *C. olitorius* type is sown in April and May. Apart from these differences the two species are cultivated in similar ways.

The land is ploughed to a depth of a foot and the soil worked down to a fine tilth by successive harrowings or 'ladderings'. Laddering consists of drawing a rough bamboo ladder or a log of wood about 7 ft long across the plot with the worker standing on it to apply pressure. This breaks up the lumps of earth, levels off the soil, and removes weeds. Since jute seeds are very small (about the size of turnip seeds) they need a fine seed-bed. As jute is a strongly growing plant it requires plenty of nourishment from the soil. Where flooding occurs the fresh silt brought down each season is a ready supply of fresh

nutritional material but where flooding does not occur the land must be manured.

Sowing is usually done by the broadcast method at the rate of 10 lb of seed per acre for *C. capsularis* and 6 lb per acre for *C. olitorius*. The sower walks across the field scattering the seeds to either side, then when the ground has been covered in one direction he repeats the process by walking at right angles to his original line; in this way a uniform distribution of seeds can be achieved. A light covering of earth is then drawn over the seeds until they are 1–1·5 in. below the surface, and the surface is consolidated by laddering. Line sowing, which gives a better yield of fibre is being encouraged by the various jute-growing authorities by means of field demonstrations, etc., but at the moment most seed is sown broadcast.

Within 2 or 3 days the seeds germinate and about a million plants per acre are formed. This high seed-rate is necessary because the individual seedlings are very delicate and this large number makes it easier for the plants to burst through the firm crust of earth which forms when rain follows soon after sowing. The plentiful supply of plants ensures that some will survive if periods of drought occur before the monsoon starts at the beginning of June. Weeding and thinning are carried out manually, usually in two stages when the plants are 3–6 in. tall, until a final count of around 150,000 plants are left, spaced 4–6 in. apart. Weeding is by far the most laborious part of jute growing, accounting for 30–40 per cent of all the labour involved. Depending on the district, the plants are ready for harvesting from the middle of June to the end of September.

The optimum time for harvest is just after the plant has flowered and before the fruits form since at this stage the plant has reached full height, the bark is easily retted, and the fibres are at their best. If the crop is cut early, perhaps because of heavy rains and flooding early in the season, then the yield is low, the fibre short and pale in colour; late harvesting, when the fruits are well set, gives a higher yield but the quality of the fibre deteriorates.

The plants are cut off close to the ground with a sickle and in the plots which are flooded the workers must dive beneath the water to do this. Where the water is only 2–3 ft deep the plants may be simply pulled up by the roots and then the roots cut off when the stems are on the banks. On the higher ground the stems are stacked for a few days to let the leaves fall and then they are bundled ready for the next

stage in fibre extraction. Jute harvested from low ground has its stems bundled immediately after cutting.

As jute is an annual, some of the plants must be left to produce seed for the next year's crop; depending on the district some 3–5 per cent of the land is used for this purpose.

FIBRE EXTRACTION

In the living plant the fibre bundles lie beneath the bark, surrounded by gummy materials; these encircling soft tissues must be softened, dissolved, and washed away so that the fibre can be obtained from the stem. This is done by steeping the stems in water and is known as 'retting'. The bundles of stalks are laid in ponds, ditches, or slow-moving streams, weighted down with stones, leaves, or clods of earth, and left for 5–15 days. A plentiful supply of water for retting is another of the reasons why jute can only be grown on a large scale in certain regions of the world (approximately 2,800 gal are needed to pond-ret 1 ton of green stalks which will yield some 112 lb of fibre). The optimum water temperature for retting is 80° F. Retting is caused by micro-organisms which soften the tissues and gums, starting at the cambium and extending outwards so that the outer cells of the cortex are the last to disintegrate. Retting is better if the stems are uniform in thickness since large differences in diameter mean that the thin stems will be retted before the thicker ones and by removing the stems at an average time poor quality arises from the thin stems being over-retted and the thick stems under-retted. Similarly at the root end of the stem the bark is stronger and more resistant to the micro-bacterial attack than the middle of the stem which, in turn, is more resistant than the top end. The type of water which is used for retting has an influence on the value of the fibre, for instance stagnant pools where the same water is used over and over again become loaded with iron salts and the fibre is discoloured to a metallic grey shade. The best place for retting is in slow-running streams which are as free from pollution as possible. Retting, therefore, is a critical stage in the production of jute where good cultivation can be completely undone by carelessness or inattention.

When the daily examination of the stems shows that the bark can be removed easily from the rest of the stem the fibre is taken from the water as soon as possible. This stage is called 'stripping'. A bunch

of stems is held in one hand and the root end tapped lightly with a mallet, this action frees the fibres at the foot of the stalk. The labourer then grasps the fibres and by jerking and lashing the stems about in the water, loosens the rest of the fibres, picks off odd pieces of bark, washes the fibre, and squeezes the excess water out. The fibre is then collected and laid out on bamboo racks to dry for 2–3 days. In some districts of East Pakistan each stem is stripped singly but although this method produces a better quality of fibre it is slow and laborious.

THE MARKETING OF JUTE

The movement of jute from the growers to the home mills or the exporters is one of collection, assembly, storage, and transportation at several different stages, each becoming a larger and more important link in the chain. The first link is the bi-weekly village market or *hat*. As the crop becomes ready in late June or early July, itinerant dealers travel round the homes of the growers buying their jute and then taking it to the *hats* where they and some of the growers who bring their own jute to the market sell to merchants. The jute at the *hat* is sold in an unassorted fashion, the only distinction being between white and Tossa jutes. The fibre is transported by country boat, pack animal, or cart to the larger secondary centres where jute buying and selling goes on daily during the season. Throughout East Pakistan there are about 250 of these secondary markets. There the fibre is graded into Tops, Middles, B-, C-, and X-Bottoms by the *kutcha* baler. A kutcha baler is one who grades the raw jute and packs it into kutcha bales weighing about 250 lb for use in the home trade. At some of the secondary markets there are *pucca* balers too but pucca baling is more commonly carried on at one of the larger terminal markets. A pucca baler grades the fibre for export, cuts off the hard root end, and presses the jute into pucca bales weighing 400 lb and measuring 49 in. × 18 in. × 20 in. This is done to save valuable cargo space for the material which is to be shipped overseas. In East Pakistan the main terminal markets are Narayanganj and Khulna and the jute is shipped through Chittagong and Calna. The home mills buy their jute either from the primary or secondary centres, the latter being the chief source.

JUTE QUALITY AND GRADING

As yet there are no objective tests made commercially on jute to assess its quality, although many experiments have been made both in India and the United Kingdom to try to relate measurable fibre characteristics such as fineness, strength, length, etc., to the properties of the yarn spun from each grade. While laboratory tests are encouraging, no commercial grading is done in this way. Quality standards have developed through the normal channels of commercial usage and though there are no rigid rules laid down by which to differentiate the various qualities there is good agreement in India, Pakistan, and overseas between experienced assessors as to fibre value. Those fibres which may be spun into fine yarns are considered to be the most valuable and those which can only be spun into coarse sacking yarns of least value.

The factors which are taken into account during grading are colour, length, fineness of fibre, lustre, strength, cleanness, freedom from defects, and the amount of root end which will have to be cut off. A strong fibre with good length, even colour, high lustre, no defects, and little root is considered good quality. Needless to say, each area produces different grades of fibre according to the prevailing soil, climatic and cultural conditions, and, particularly, the quality of the retting water available. In those parts where clean water is freely available the fibre is invariably superior to those that have only dirty muddy water. Besides retting, however, the choice of seed and the time of harvest also play their part in determining quality.

The much commoner *C. capsularis* or white jute varies in colour from pale cream to grey or yellowish-tan, the best grades having a high lustre. Tossa jute (*C. olitorius*) has a russet tinge varying from golden brown to reddish brown. Daisee jute (*C. olitorius* from the Calcutta region) is grey to black from the presence of iron salts in the retting water.

Some of the defects which may be seen in jute are as follows:

(1) Runners. Long strips of bark adhering to the stems for much of their lengths, caused by inadequate retting.
(2) Rootiness. Tough, hard, stiff pieces of bark sticking to the lower end of the fibre, caused by flood water toughening the epidermis, making it more resistant to retting.

(3) Croppy. Gummy harsh top ends to the fibre, often resulting from incomplete immersion during retting or harvesting at the wrong time.
(4) Specky. Small, black pieces of bark sticking to the fibres, due to pests or branching in the stem, both of which lead to the formation of harder bark which is difficult to ret.
(5) Dazed. Dull, weak fibre, usually limp and lifeless, caused by over-retting (or packing in damp bales).

Grading is done at two stages—one for the home trade and one for the export trade. The growers have little knowledge of jute grading and it is not until the fibre comes into the hands of the larger

TABLE I.I TYPES OF JUTE AND THEIR GROWING AREAS

Type	*District*	*Characteristics*
White jute (*C. capsularis*)		
Jat	Mymensingh, Dacca, Tippera	Best quality, strong, clean, lustrous, good length
District	Bogra, Pabna, Faridpur, Khulna	Medium quality, harder than Jat
Northern	Dinajpur, Pabna, Jalpaiguri	Soft fibre, medium to low quality with loose stick and speck
Western	Purnea	Soft, rather weak, discoloured
Assam	Goalpara, Nowgong, Sylhet	Variable quality
Orissa	Cuttack	Generally poor
Jungli	Murshidabad, Malda	Soft heavily rooted, poor quality
Tossa jute (*C. olitorius*)		
Jat	As for white Jat	Golden brown, strong, lustrous, clean, pliable, good length
District	Faridpur, Khulna, Nadia, Jessore	Medium quality
Northern	Murshidabad, Pabna, Bogra	Soft, lighter in colour with much loose stick and speck
Daisee jute (*C. olitorius*)		
Jat	Howrah, Hooghly, Burdwan	Long, lustrous, soft, grey
District	24 Parganas, Jessore, Khulna	Dark in colour, medium strength

merchants that it is assorted into different classes. The preliminary grading is done by kutcha balers.

The current tendency is for the growers to produce as much Tossa as possible. Some years ago the ratio of white to Tossa grown was of the order 3 : 1, but in 1962 the ratio had changed to approaching 2 : 1.

Table 1.1 gives a brief note on the characteristics of each type, and their growing areas are shown in Figure 1.2.

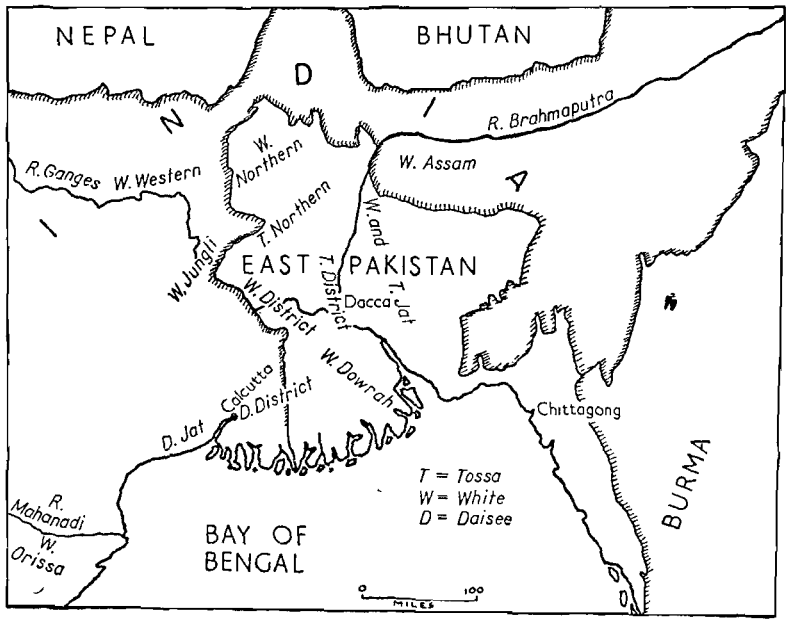

Figure 1.2. Jute growing districts of India and Pakistan

The bulk of Pakistan jute is broadly classified into three groups, Jat, District, and Northern, in descending order of merit. The kutcha baler carries out a further division of each type depending on the relative value of the fibre he has received. The criteria by which he judges the fibre are shown in Table 1.2. Nowadays, the top two gradings, i.e. Jat and District Tops, have largely vanished from the raw jute market.

Indian kutcha gradings follow the same pattern but the allowances for cuttings are about 5–10 per cent more in the top two grades and B- and C-Bottom are omitted.

TABLE 1.2. KUTCHA BALERS' GRADINGS OF RAW JUTE (1961)

Grade	*Characteristics*	*Root-end Cuttings not to exceed (per cent)*	
		White	*Tossa*
Tops	Very strong fibre, excellent colour and lustre, free from all defects	15	10
Middles	Strong, sound fibre, average colour for the district, free from speck, runners, and harsh crop end	25	15
Bottoms	Sound fibre, medium strength, free from hard-centred jute	30	20
B-Bottoms	Sound fibre, medium strength, not suitable for higher grades	30	20
C-Bottoms	Medium strength fibre, any colour, free from runners and croppiness	35	25
X-Bottoms (Cross Bottoms)	Weak, harsh jute, free from tangled jute and stick	40	30
Habijabi	Tangled, ravelled jute of any sort, free from dust and cuttings		

The other classification of raw jute is for the export trade and is done by the pucca baler. Each baler has his own house-signs or marks by which his jute may be known. Virtually all jute that is packed in pucca bales for export has the hard dark-coloured root end cut off to save the expense of root-cutting in Europe. These root ends are sold separately as cuttings.

White jute is assorted into three main classes: Crack (or Dundee), Mill, and Export (or Grade). The top class is sub-divided into Firsts, Lightnings, and Hearts; the Mill Class into Reds, Firsts, Lightnings, and Hearts; and the Export class into Firsts, Lightnings, and Hearts. Tossa jute is assorted into four classes: Dacca Tossa, Crack, Grade (or Dundee), and Outport (or Continental). Each class is sub-divided into 2/3s and 4s with 5s and 6s in the Dacca Tossa class only. Little Daisee jute appears on the export market, what there is being graded into Crack 2/3s and 4s and Grade 2/3 and 4s.

Naturally, between certain of the class divisions there is an overlap, but Table 1.3 shows the relative gradings in general terms. It must be emphasized, however, that as conditions vary from year to year the relative value of the various marks changes.

TABLE 1.3. GRADINGS OF RAW JUTE EXPORTED FROM PAKISTAN

White jute			*Tossa jute*				
Crack	*Mill*	*Export*	*Dacca Tossa*	*Crack*	*Grade*	*Outport*
Hearts			4			
	Firsts		5	4	2/3	
	Lightnings	Firsts	6		4	
	Hearts	Lightnings				2/3
		Hearts				4

The link between the kutcha assortment and that of the pucca baler is roughly as in Table 1.4.

TABLE 1.4. APPROXIMATE RELATION BETWEEN KUTCHA AND PUCCA GRADES

Kutcha grades	*Pucca grades*
White jute	
District middle and Northern top	Crack Hearts
Jat bottom and Northern middle	Mill Firsts
District bottom	Mill Lightnings
Jat X-Bottom and Northern bottom	Mill Hearts
All jute not in above classes	Grade Hearts
Tossa jute	
Jat middle	Dacca Tossa 4
Jat bottom	Dacca Tossa 5
Jat X-bottom	Dacca Tossa 6
Northern top	Grade Tossa 2/3
District middle	Crack Tossa 4
District bottom and Northern middle	Grade Tossa 4
Northern bottom	Outport Tossa 2/3
All jute not in above classes	Outport Tossa 4

RAW JUTE MOISTURE

In the normal course of events the fibre is saturated with water when it leaves the retting pits and must be dried off before it can be sold. In its passage from up-country to the baling centres it may become wet again and need to be dried before baling. There is no standard moisture content for baled jute but claims for damage due to excessive

moisture can be taken to arbitration. In Pakistan legislation now exists which prohibits the sale or purchase of damp jute.

The most serious effect of excessive quantities of moisture in baled jute is 'heart damage'. When a heart-damaged bale is opened it is found that fibre in the centre of the bale is brittle and powdery. This damage results from micro-biological activity and only occurs under certain conditions of temperature and moisture. This action is unlikely to begin if the moisture content of the bale is below 19–20 per cent no matter how high the ambient temperature becomes, but at moisture contents in excess of this level there is a danger that damage may occur. It will be appreciated that in passage *en route* to Europe through the Red Sea the temperatures in a ship's hold become very high. In bales susceptible to heart damage these temperatures can stimulate bacterial growth. In spite of recourse to arbitration, the loss to the buyer resulting from heart damage is a serious one.

TABLE I.5. MOISTURE CONTENT OF PUCCA BALES OPENED IN U.K.

Annual figures		*Monthly figures*	
Year	*Average moisture content (per cent)*	*Month of opening*	*Average for 1954–59 (per cent)*
1954	13·3	January	14·0
1955	13·5	February	14·0
1956	13·9	March	13·9
1957	13·8	April	13·6
1958	13·4	May	13·3
1959	13·2	June	13·1
		July	13·0
		August	13·1
		September	13·2
		October	13·4
		November	13·8
		December	14·0

Table 1.5 shows the results of tests carried out on raw jute imported into the United Kingdom over the years 1954–59. The points to be noted are that bales opened between November and March have a slightly higher moisture content than those opened during the rest of the year. This represents the arrival of a new crop. Taken on

average there is very little variation from year to year, but this is not to say that individual bales are equally uniform—moisture contents as high as 22 per cent and as low as 10 per cent are not unknown.

ALTERNATIVES TO JUTE

Many countries have tried to develop plants which could be used as a substitute for jute but at the present time only three plants can be considered as commercially successful in this respect. All belong to the same botanical family as jute and, in many respects, are very similar to jute itself.

Hibiscus cannibinus is grown widely in the Tropics and sub-Tropics where it is known by many names, e.g. Bimli jute, mestha, Deccan hemp, stockroos, or kenaf. It can stand lower temperatures than jute and is grown as far north as the Caspian Sea and as far south as the Transvaal in the Republic of South Africa. The most important growing region, however, is India, mainly Hyderabad and Madras in the south and Bihar in the north. In general, cultivation follows the same pattern as jute but there have been more attempts to harvest the crop mechanically and to extract the fibre by machine.

Hibiscus sabdariffa is being grown on a fairly large scale in Thailand and other parts of the world. The fibre is properly called 'roselle' but in Thailand it is known as kenaf and when the same fibre reaches Europe it becomes 'Siamese jute'—a clear demonstration of the confusion which exists in the nomenclature of the jute alternatives. Many breeding trials have been made with *H. sabdariffa* with the object of producing tall, disease-resistant strains. The properties of roselle are similar to jute and the fibre may be spun either alone or in a mixture with jute without any modifications to the machinery.

Urena lobata, Congo jute or aramina, is grown chiefly in the Congo and now supplies that country with much of its fibre for sack requirements. Cultivation is easy and the yield is high, retting being carried out in the same way as jute retting. At present little of this fibre comes on to the world market as most of it is used internally.