Bast, the Textile Fibers

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Bast, or stem, fibers are soft, pliable, and fine. Some of them are known to have been used in Europe and Egypt 5 thousand years ago.

The principal bast fibers, known as textile fibers, are in two general groups. Some, such as flax, ramie, and hemp, mainly are spun into yarn and woven into fabrics for clothing, household, and special industrial uses. The other group—jute, kenaf, sunn—mostly is woven into coarser fabrics for bagging and protective coverings.

Most bast fibers, however, are also used in threads, twines, and cordage, and each has important uses other than the principal ones. Each is used often with various other fibers or substituted for them.

Most bast fibers are in dicotyledonous plants that grow from seed and thrive in climates ranging from temperate to tropical.

The fiber lies between the outer bark and the woody central cylinder and gives the stem strength and flexibility. It is usually obtained by pulling the plants from the ground or cutting them near the base.

Some process of natural retting (or rotting) or chemical process is used to weaken the gums and connective substance that hold the parts of the plant stem together. This usually precedes but sometimes follows actual separation of the fiber. The fiber is separated, scraped, washed, straightened, and dried. It is then baled for marketing.

Jute (Corchorus capsularis and C. olitorius), of the Tiliaceae family of plants, is a soft, lustrous, textile fiber, ranging from grayish white to almost red and obtained from the stems of cultivated plants.

It is an ancient fiber, but it entered the commercial world later than most of the other most commonly used vegetable fibers. Jute fiber now is the most widely used of the long vegetable fibers and is second only to cotton among all the natural plant fibers.

The jute plant may have originated in the Mediterranean area, but early records of the Bengal area of India-Pakistan mention it as a well-established plant there as early as 800 B.C. India and Pakistan produce the bulk of the current world supply.

An English firm made the first yarn spun by machine in 1820. Firms in Dundee, Scotland, began experiments with jute on their established flax machinery in 1832. Whale oil was introduced soon afterward as a softening agent for the fiber. These developments started the industry on a long period of prosperity. The use of jute increased when new processes were discovered for bleaching and waterproofing it and mixing it with any of many other fibers for special purposes.

By 1855 jute had replaced flax on most of the spindles in Dundee, which became the world center for the import and manufacture of jute.

Calcutta, India, erected its first jute mill and introduced power looms in the 1850's. The Indian industry soon replaced Dundee as the jute manufacturing center. Thus India, almost the only producer of jute fiber, became an exporter mainly of manufactured goods rather than of the raw fiber.

World production of jute reached a peak of 5,545 million pounds in 1961 and was 4,855 million pounds in 1963. The peak was 27 percent more than the average annual crop in the preceding 5 years and 61 percent more
than the average in 1935–1939. Demand for jute continues to increase, even though competition has been strong from other fibers, materials, and methods of handling products.

Pakistan and India accounted for 96 percent of the world crop in 1963, when Pakistan produced 2,400 million pounds of jute and India produced 2,240 million pounds. Brazil ranked third, with 106 million pounds.

The leading jute-growing area was in the eastern part of India, especially in the hot, humid, valley lands of the Brahmaputra and Ganges River Basins. The jute mills have been centered in Calcutta, a port city.

When Pakistan and India were separated in 1947, at least two-thirds of the jute-growing area was in Pakistan, and all the mills were in India. Trade was negotiated between the two countries, and a new trend began in the industry. India encouraged an increase in production of raw fiber to supply its mills and thus save foreign exchange on imports. Pakistan built mills to manufacture its raw jute and reap the benefit of increased value of its exports.

Indian production of raw jute increased 113 percent from the 1947–1951 average to the 1961 level of production. Production in Pakistan increased 25 percent during the same period, but Pakistan sales of manufactured jute goods, which began in 1951, grew to a value of 21 million dollars a year by 1960.

Brazil began growing jute in commercial quantities in the Amazon Valley in 1937 and ranked third in 1963.

The fiber is 6 to 10 feet long, smooth, and pliable. It takes dyes readily. It is adaptable to machine manufacture. Bags and coverings of jute cloth are strong and resist tear in shipping. Wherever bulky, strong fabrics and twines are required, jute is almost universally accepted because of its relatively low unit price, although it is not so strong as flax or many other soft fibers. It deteriorates rapidly, especially when exposed to moisture.

Jute is used mainly for items that support or protect other goods—burlaps, sacking, bagging, other protective coverings, backings, support webbings, twines, and felts.

A growing use is in backing cloth for carpets, linoleum, and oilcloth and alone or mixed with other fibers in the manufacture of carpets, rugs, matting, tapestries, curtains, upholstery, and novelty fabrics for dresses, coats, and trimmings.

The oldest use of all, cordage, still exists in twines, small cordage, binding thread for carpets, rugs, certain types of shoes, and core material for various cables. The coarse butt ends of the fibers are manufactured into cheap sacking, cotton bale covering, and pulp for paper.

Jute plants are herbaceous. Their slender stems grow 5 to 15 feet tall. Branches at the top bear bright, green leaves, small yellow flowers, and distinctive seed pods. They grow best in a hot, moist climate.

Several varieties are grown to some extent in many countries, but the rich alluvial soils of the river deltas and other conditions in northeastern India and East Pakistan lend themselves best to extensive production. The low cost of labor in that area allows the crop to be processed and marketed at a price that discourages competition from fiber of other countries.

Jute is a small-farm crop centered in rice-growing areas. The two crops compete for land in proportion to the ratio of their prices. Jute occupies only 5 percent of the total cropland in East Pakistan but is the most valuable cash crop. A total of 94 percent of the jute in East Pakistan is on farms of 1 to 25 acres; 44 percent of all the farms raise some jute along with other crops.

About 2 million acres of jute are grown in each of the two main producing countries, India and Pakistan. About 85 thousand acres are grown in Brazil.

Cultivation methods are rather primitive in most Far Eastern countries. Most of the work is done by hand.
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The fields are plowed and harrowed, often with crude, oxen-drawn implements, and the clods are broken up with mallets. Seeds usually are broadcast, although sowing in rows has become accepted as a better method. The crop is thinned and weeded several times by hand.

The grower sells his small lot of jute to the local collector, who is usually a moneylender as well as middleman for the crop. He grades it and collects it into large bundles of about 80 pounds and sells it to the next middleman. After further grading and sales, it is finally baled into loose kutch bales of about 300 pounds each, for domestic consumption, or in pressed pucca bales of 400 pounds each, principally for export.

India, with more than half of the jute looms of the world, consumes its own large crop of fiber and is the largest manufacturer and exporter of jute goods. Jute manufactures are the country's largest earner of foreign exchange and represent 22 percent of the total of all exports.

The value of exports of jute manufactures was 319 million dollars in 1962–1963. Pakistan exports the major part of its jute as fiber. Brazil manufactures practically all of its jute for domestic use.

The Indian jute industry has been organized and controlled to a large extent for many years, but the growers and laborers had little organizational activity until recent years. Mills belonging to the Indian Jute Mills Association have 94 percent of the looms of India.

India had a virtual monopoly on jute for many years, and through the association had considerable influence in stabilizing prices of jute by sealing a designated percentage of looms on the basis of changes in the relationship of supply and demand for jute goods. Since the separation of India and Pakistan, however, the mill organization has lost some of its effectiveness on world prices. The association, alone and in cooperation with government agencies, engages in quota buying, controlling mill stock by designating how many months' supplies must be bought ahead, and fixing prices.

The Indian Central Jute Committee and Jute Buffer Stock Agency work in cooperation with the Indian Jute Mills Association. The Jute Buffer Stock Agency buys surplus stocks at a set price when supply exceeds demand and prices fall below a set level. The East India Jute and Hessian Exchange has power to regulate futures markets.

Modernization of Indian mills became necessary to compete with the new mills of Pakistan and the modern mills of Europe. Modernization, begun in 1955, has meant the replacement of many old spindles and looms. Indian manufactures of jute goods reached 1,074,000 tons, or 51 percent of the world total of 2,107,000 tons in 1959–1960. Consumption of raw jute by domestic mills that year was 1,243,000 tons, or 45 percent of the estimated world consumption.

Pakistan supplies almost all the jute used in mill consumption of nonproducing countries, and its exports have been increasing. Jute has accounted for more than half of the country's foreign exchange in some years.

The Government of East Bengal controlled jute acreage as a means of stabilizing prices during 1940–1960, and since then has advised farmers as to the advisable acreage to plant.

Most phases of jute cultivation and marketing in Pakistan are controlled somewhat by government ordinances and the Pakistan Central Jute Committee. The Pakistan Industrial Development Corporation has been instrumental in setting up new mills in Pakistan and, through special trade agreements, in some neighboring countries to use raw jute from Pakistan. In the first 10 years of industrialization, Pakistan acquired 14 mills with more than 8 thousand looms, and its consumption increased to 800 million pounds of raw jute fiber. The Second 5-Year Plan had a target of 12 thousand looms by 1965.
Exports of jute and manufactures from East Pakistan and India reach all major countries of the world either for domestic use or as containers or wrappings for imported commodities. Pakistan, the principal exporter of jute fiber, shipped 65 percent of its 1,734 million pounds of jute exports in 1962 to European countries, with 320 million pounds going to the United Kingdom, 203 million to Belgium, 146 million to France, 112 million to West Germany, and quantities of 85 million or less to each of the other European countries.

Only 101 million pounds were shipped to the United States, but small amounts went also to many of the other countries of the Americas, Asia, Africa, and Oceania. However, most countries with large agricultural trade, or with an industrial economy, import large quantities of manufactured jute goods.

The United States imports most of its jute needs in the form of manufactured or semimanufactured goods. The popularity of jute in most countries rests largely on its relative initial cheapness. When it is priced on a level with other industrial fibers, it loses its market to the stronger or more readily available fiber, to paper, or to the other methods of handling products, and the consumer often does not return to using jute.

Jute has had strong competition from cotton or paper in bags for such commodities as fertilizers, cement, and flour and in tying twines; from plastics and other manmade materials in bags for vegetables, and in tarpaulins or covers for such items as machinery, loads of commodities, and commodities in bulk. The bulk handling of many commodities, such as the grains, agricultural lime, commercial fertilizers, mineral ores, and coal, has made large inroads in that part of the market for jute.

*Kenaf* (*Hibiscus cannabinus*) and roselle (*H. sabdariffa*, var. *altissima*), similar jutelike bast fibers, are known also as mesta, Deccan hemp, Ambari hemp, Bimlipatam jute, and Bombay hemp. Together they are the chief competitor of jute and are adaptable to a wider variety of growing conditions, but they rarely compete with the best grades of jute because they are somewhat coarser.

Kenaf and roselle, or mesta, are grown extensively in India, where they are used along with jute in the hessian and bagging mills, and to varying extents in many other Asian, African, and American countries of the warm zone.

There are two kinds of roselle plants—one is grown for fiber and one for fruit.

World production of kenaf and roselle is hard to estimate because many countries do not report the amounts they produce. Production in India was reported at 640 million pounds in 1963. In Thailand it was 551 million pounds. It probably reached 535 to 540 million pounds by 1959 in mainland China.

Producing countries use nearly all their crop of fiber in domestic manufacture of bags, burlaps, and other coarse fabrics for protective coverings. The use of kenaf and roselle has been increasing, and many countries have experimented with the fiber, especially in years when the jute prices were exceptionally high.

*Flax* (*Linum usitatissimum*) is the first and most valuable of the long vegetable fibers to be spun and woven into cloth.

It is the long, soft, fine, and lustrous textile fiber that some believe was woven into the fine linens of the Pharaohs of Egypt 4 thousand years ago. Old Biblical records refer to it as a symbol of purity.

Some gossamer linens discovered in ancient tombs are far finer than any linen available in the modern world. Linen was used by the prehistoric Lake Dwellers of Switzerland.

The Egyptian art of weaving flax yarn into linen spread slowly to India,
where many of the castes wore linen before they began to wear cotton. It was carried to various parts of Europe, Turkey, and the Western Hemisphere. It came to the United States with the early colonists.

Flax was one of the two leading vegetable fibers during the Middle Ages. Hemp was the other. The spinning of flax and the weaving of linen have long been associated with feminine graces of noble women and humbler women, much of whose time was spent at the task in order to supply household fabrics and clothing for their families.

The widespread use of linen for household fabrics for so long gave us our misleading names of “bed linens” and “table linens” for articles made of cotton, ramie, rayon, and other man-made fibers, and even silk, but rarely of linen anymore, except in some flax-producing countries.

Flax lost its priority among textile fibers to cotton after invention of the cotton gin. Jute further displaced flax by being economical in coarse wrapping materials. Man-made fibers now compete seriously in materials for clothing and trimmings.

Flax, because of its length, strength, and beauty, has many uses. It is made into cloth—the finest and sheerest of handkerchief linen, ducks and drills, material for suits and dresses, bedding, napery, curtains, upholstery, drapery, cushion covers, wall coverings, hand towels, and decorative articles.

Flax threads are strong and are used for sewing threads, button threads, fish and seine lines, shoe threads, harness and sacking twines, and upholstery twines. Other uses are in parachute harness webbing, uppers for women’s shoes, paddings, and linings.

Large acreages are now grown for seed, and seed-flax straw is used in fine paper, such as cigarette paper.

World production of flax fiber, other than the Chinese output, was estimated at 1,357 million pounds in 1962. Flax will grow in many temperate regions, but the Soviet Union, the largest producer, is averaging 907 million pounds a year. Poland, Belgium, France, and the Netherlands, with 56 to 103 million pounds each, have been important producers for many years.

Belgium has been noted for a thousand years for the high quality of its retted fiber because of the peculiarly favorable characteristics of the water of the River Lys, which is used for retting the flax straw.

Canada produced flax fiber from 1940 to about 1955 and shipped much upholstery tow to the United States, Australia, and New Zealand. The northwestern United States and other countries produced fiber during the Second World War but later abandoned it as unprofitable in peacetime.

The flax plant for fiber is tall, slender, and branched at the top. Some varieties of flax are grown especially for fiber, some especially for seed, and some for either seed or fiber. Close planting is best for fiber production, because it discourages branching and causes the stem to grow longer and smoother and thus produce a longer fiber.

The flax fiber is obtained from the stem in somewhat the same manner as jute but with some important differences. Often stalks are pulled by hand, even though pulling machines began to be used about 1940. After rippling to remove the seeds, flax retting may be by any of several methods; namely, tank retting (usually with controlled temperature of the water), stream retting in sluggish running water, or dew retting on the grass. The first method is the commonest. All the processes require experience, skill, and judgment.

The flax straw must be dried after retting, and the fiber is separated by machines. The stalks may be dried in drying rooms or by air drying on the grass, either spread or sitting up in loose shocks until dry.

The dry stalks are put through breaking and scutching machines first to break and crush the woody parts of
the stems that have been loosened by dissolving of the connecting gummy substance during retting, and then to scutch or scrape away these nonfiber parts called shives. Combing (or hackling) is necessary on the long (line) fiber before it can be spun into yarn. The short fibers that are broken in the scutching process are kept separate and are known as scutching tow. Hackling or machine tow, sometimes called flax noils, is short fiber resulting from further combing and manufacturing processes and is cleaner and finer than scutching tow.

Tows are used in coarse fabrics, rope, and sometimes for upholstery stuffing. The long fiber is known as scutched flax, or line, and is sorted according to length and bundled and baled for shipment. Sometimes flax is scutched without retting, and the dried green fiber is made into straps or coarse cloth. It is coarser and stiffer than the retted fiber.

The Netherlands and France export much flax straw to Belgium for its specialized retting and import some of the scutched fiber in return, but France has been encouraging domestic processing of the straw.

Northern Ireland and the Irish Republic once had 260 thousand acres in flax but had only about 200 acres each in 1961. The famous Irish linens are now manufactured almost entirely from imported flax—much of it from Belgium. The United Kingdom, however, imports some flax fiber from the Netherlands, France, and the Soviet Union.

All the large producers of fiber flax export both fiber and tow in some form, and most of them manufacture flax goods, also for export. Both fiber and goods are imported by many countries.

The use of flax has declined because of the increase in production of cheaper natural fibers, especially cotton, and the manufacture of manmade fibers. The advance in fiber finishes to make cotton wrinkle resistant or waterproof and to change the characteristics of various fibers has furnished cheaper fabrics with many of the characteristics of linen. The trend among countries toward self-sufficiency in domestic fibers also has reduced the demand.

Hemp (Cannabis sativa) is nearly as old as flax and is nearer like flax than any of the other vegetable fibers. It is native to central Asia, and has been cultivated for thousands of years.

A Chinese emperor of the 28th century B.C. taught his people to cultivate for fiber a plant of two forms called ma. China still produces ma, its name for hemp.

This bast fiber is 40 to 80 inches long, lustrous, and pliable. It is stronger than flax but less fine. It may be creamy white or gray and sometimes brown. It suffers less damage from heat, moisture, and friction than any other soft fiber, except flax. Although it resembles flax, it is more adapted to cordage, and flax is better for clothing and fine linens.

Hemp was the first important cordage fiber. The name “hemp” is sometimes erroneously and confusingly applied to other fibers that are used for cordage. Consequently, we find the name applied to various agaves, sansevierias, Fourcroyas, yuccas, Sidas, and others, but never to flax, the fiber it most nearly resembles.

If a prefixed name is not used, such as in “sisal hemp,” “New Zealand hemp,” or “bowstring hemp,” and only the term “hemp” is used, statistics can become hopelessly confused. Even with the qualifying name, such as in “Swedish hemp” or in “Cuban hemp,” there can be considerable misunderstanding, because many fibers that carry the false name of “hemp” are hard fibers and are quite different from the soft true hemp.

Hemp grows throughout the Temperate Zones wherever the climate is warm and rainfall moderate. Unlike many other fibers, it has names in nearly every language. It is known as canamo in Spanish, canhamo in Portuguese, chanvre in French, canapa...
in Italian, hanf in German, hennup in Dutch, and kenevir in Turkish.

Hemp is still mainly a cordage fiber, but its specific uses have changed with changing conditions. It was once about the only cordage fiber of the civilized world and was the chief fiber for marine cordage until abaca came into use in the 19th century.

Sisal also began soon afterward to take over the duties of hemp in larger ropes, fishing lines, yacht cordage, marlines, rigging, and carpets. Other soft fibers came into use for homespuns and the so-called “linen” crash, which was formerly made of hemp rather than linen. The modern “hemp” ropes are almost never made of hemp or even a soft fiber, but of abaca, sisal, henequén, or possibly some other hard fiber.

Present uses of hemp are in small, usually tarred, ropes up to 1 inch in diameter, nets, canvas, warp of carpeting material, a substitute for flax in some yarn sizes, cores for wire cables, and many kinds of twines for tying, seines, sacking, mattresses, upholstery, hats, alpargata (sandal) soles, book-binding, and lashings.

The tow, or short fibers, goes into oakum, packing for pumps and calking for boats. It has competition in these uses from tow of hard fibers such as sisal and coir and from other soft fibers such as sunn. Short fibers are also spun into yarns, and machine waste is used as stuffing for upholstered goods.

The hemp plant also yields an oilseed. Various parts of the plant yield narcotic drugs, the major one being marihuana, derived from the flower.

The cordage industry was one of the first and largest industries in the colonial United States because of the large use of ropes in sailing vessels. A cordage factory was set up in Boston in 1642 with hemp as the raw material. Cordage factories are still an important industry in New England. Much of the work was hand done until the first quarter of the 19th century, when machines were invented for practically every process of combing and twisting the fiber into yarn, laying the strands, and winding the finished rope on large spools.

Abaca and other fibers have now largely replaced hemp in this country, however, and the crop is no longer grown for fiber in the United States.

Hemp was native to central Asia and has long been cultivated in Persia (now Iran), China, and India for both the fiber and a drug, and in many other warm countries principally for the fiber. Many countries prohibit or severely restrict cultivation of the plant because of the strong narcotic substances.

The Soviet Union, which ranks first in production, manufacture, and consumption, produces about 250 million pounds of scutched hemp fiber out of a world total of about 625 million pounds, and consumes most of it domestically. Yugoslavia, Turkey, and Italy also produce large quantities. Italian hemp is considered to be best in quality.

The chief exporting countries are Yugoslavia, with an average of 90 million pounds, the Soviet Union, and Italy. West Germany and the United Kingdom are the chief importing countries.

The hemp plant grows 6 to 8 feet tall. It is dioecious—male and female flowers are on separate plants. It, like flax, can be grown for either seed or fiber. It is planted in early spring.

Harvest for fiber comes in most countries about 4 months after planting, or when the staminate flowers begin to open and shed pollen.

Cutting is done by hand in some places, but reapers, or hemp harvesters, have become common.

The straw must be processed. The fiber is used without hackling or combing for coarse yarns, but mills hackle some of it to obtain finer, better, and more expensive yarns. These specially separated yarns are as fine as the coarser grades of flax and can be mixed with other fibers in fabrics for clothing.
The processed long, or line, fiber comprises about two-thirds of the total output. The rest is short-fibered tow.

Sunn or San "hemp" (*Crotalaria juncea*), also called San Pat, Indian hemp, Madras hemp, or Bombay hemp, is a soft fiber that grows abundantly in India and parts of Ceylon.

It has been used in southeastern Asia since prehistoric times as a cordage fiber and is used in the United Kingdom especially for paper but also in mixture with other fibers for ropes, cables, twines, and nets.

The chief use in the United States since 1940 has been in the manufacture of cigarette papers and other tissue papers, because of the high cellulose and low ash content.

Sunn can substitute for jute or true hemp. It is also made into carpets and fishing nets. Sunn makes cattle fodder.

Indian cultivation of sunn in 1962 included 482 thousand acres for fiber, 169 thousand acres for green manure, and 135 thousand acres for fodder—altogether, a total of 786 thousand acres. Fiber production was 172 million pounds.

Production fell in the second quarter of this century because of a big drop in exports to the United Kingdom, where other fibers were replacing sunn in cordage manufacture.

Sunn requires moderate rainfall and a light and moderately deep soil. Cultivation, harvesting, and processing methods for sunn are the same as for jute. The processed fiber is soft, ranging in color from gray to brown.

India is the chief exporter as well as producer of sunn fiber. Exports in 1962 amounted to 18 million pounds, worth 1.7 million dollars. Of this quantity, 46 percent was to the United Kingdom and 39 percent to other European countries. The remaining 15 percent went to the United States, Canada, Japan, and other countries.

Ramie, Rhea, or China grass (*Boehmeria nivea*) of the Urticaceae or nettle family, yields a lustrous, white, silky, textile fiber. It has been known since ancient times.

The white ramie was first recognized in fabrics exported from China to England as China grass cloth. This species is also common in Taiwan and India. The green ramie (*B. nivea*, var. *tenacissima*), often called rhea, is a more tropical and less hardy plant that grows mostly in Malaya, Africa, Mexico, and the East Indies. The white ramie fiber is finer but not so bright as the rhea.

The distinguishing names by color stem from the different colors of the undersides of leaves of the two species, but the fibers are similar.

Because the degummed ramie fiber has favorable characteristics, many attempts have been made to process it economically by machine.

Ramie is soft, lustrous, silky, nearly as fine as flax, and stronger than other natural textile fibers. It has excellent bleaching qualities and elasticity. It is resistant to rot in dampness and water. It can be processed to resemble wool or cotton.

The fibers are difficult to separate from the stem and from each other, however, and they are not obtained by water retting, like jute, flax, or hemp. Final degumming of the decorticated ribbons is usually a chemical process.

Ramie fiber is manufactured mostly into fabrics in mixture with cotton, wool, silk, manmade fiber, or other fiber and into napery and specialties.

Its possibilities are many. In China, where it is prepared almost entirely by hand as a home industry, it is made into grass cloth and other fabrics and yarns for clothing, mosquito nets, and fish nets. The Japanese make it into seine twines, mosquito nets, shirting, suiting, and manmade fibers, such as rayon. The uses in Germany range from shoe threads to tapestries, trimmings, and various woven fabrics.

Gas mantles once required large quantities of ramie. Ramie has also been used in banknote paper, cigarette paper, fish lines, and nets.

The ramie plant, native to the
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Orient, grows well in any hot, moist climate whose soil is rich, damp, and well drained. Commercial production is in China, the East Indies, Japan, Taiwan, India, and the Philippines. Small-scale or experimental production has spread to many countries.

The plant differs from most bast fiber plants in that it is a perennial and lasts 6 or 7 years. New stalks grow up as old ones are cut. A mature plant is 3 to 6 feet tall and has numerous straight stalks bearing heart-shaped leaves. Propagation is usually by rootstocks.

Establishment of a good stand requires about 2 years. Stalks are cut several times during the first 2 years to induce more branches. Then harvest for fiber begins. Cuttings several times a year can continue during the life of the plant. Harvest continues in China from late May until frost each year.

Rame plants are subject to a variety of hazards, including early or late frost, high winds, excess moisture or drought, lack of fertilizer or cultivation, root rot, insects, and diseases. The chief deterrent to expanded cultivation was the difficulty in obtaining the cleaned fiber by economic mechanical means without damaging it in the process. The fibers are arranged in bundles that extend the full length of the stalk, and they are held together with gums that must be subjected to a chemical degumming process.

The fiber at this stage dries harsh, wiry, and difficult to separate, so a final treatment with a special emulsion is added during drying to leave the fiber soft, pliable, strong, and gleamingly white.

Most of the commercial production of rame is in southern China, and about half of the production is exported. The Philippines and other Asian countries also produce commercial quantities.

Japan, the principal importer, sometimes imports the ribbons for processing and manufacture and then exports the finished goods back to the country of origin as well as to other countries.

MALVACEOUS FIBERS are obtained from the stems of many species of the hibiscus, sida, and other groups of plants. Most resemble jute in appearance, performance, and the methods of cultivation and preparation. Kenaf and roselle (discussed previously) are the most generally known.

Urena probably is second in importance. Other fibers are most commonly used in their countries of origin. Urena lobata, a plant of the Malvaceous family, is indigenous to China but is grown in exportable quantities in the Congo and has been carried to the Western Hemisphere, where in tropical areas it has developed into a native weed.

It is known by many names, and is the Congo jute in Africa and in the export trade from the Congo, paka in the Malagasy Republic, cadillo or cadilla in Venezuela, bolo-bolo in western Africa, grand mahot cousin in Martinique, and Caesar weed in Florida and some other parts of the Americas. Also it is the cadillo, guizazo, or malva blanca of Cuba, and the guaxima vermelha, carrapicho, or aramina (little wire) of Brazil.

Urena lobata grows wild in most of the countries where the fiber is collected and prepared as a cordage fiber or jute substitute.

The Republic of the Congo and Brazil produce the fiber in commercial quantities, but the former is the only exporter.

Brazil has had large-scale production from both wild and cultivated plants since 1900. Output was 29 million pounds in 1961, and peak production was 44 million pounds in 1956. Most of it is manufactured into coffee bags.

Congo (Léopoldville) produces 25 to 30 million pounds a year of Urena lobata and punga, (Cephalonema polyon-drum), a similar fiber, and exports 4 to 6 million pounds of urena and 2 to 3 million pounds of punga.

Urena is grown and retted as jute is. The fiber is 3 to 8 feet long. It is used locally in producing countries in cordage, bags, packing materials, sail-
cloth, and handmade twines. Importing countries (mostly Belgium, West Germany, and Angola) use it as they do jute.

Many other malvaceous fibers are used to a limited extent, especially in the countries where they are produced. They are generally most suited to cordage or bagging and coarse cloth. I name a few.

Common okra (Hibiscus esculentus) of India is used in crude twines and cordage. Indian mallow or Chinese jute (Abutilon avicennae) of China is white, glossy, and strong but has little economic value. Mexican Indians use the highly durable fiber from Abutilon incanum for hammocks, ropes, and nets. Indian hemp (Apocynum cannabinum) is a native fiber of the United States which resembles flax and was used by the Indians for all purposes, but has not been exploited commercially. The Brazilian native paco-paco (Pseudabutilon spicatum) is cultivated as a substitute for jute. Rama fibers (Hibiscus lunarifolius and Urena sinuata) of western Africa are jutelike fibers used domestically.

Sida fibers, also of the Malvaceous family, are used in many countries instead of jute. Sida acetosella is a Mexican fiber harvested from both wild and cultivated plants. It is light colored, even, and slightly harsh to the feel and has good tensile strength. The Sida rhombifolia is a good fiber common in most tropical countries. The Sida tiliacefolia is an excellent fiber cultivated in China. Other sida fibers are used in Brazil, the Philippines, Canary Islands, West Indies, parts of India, and in northern Vietnam and Laos.

Nettle fibers are malvaceous fibers, which include many besides ramie or China grass, but most of the others are derived from stinging nettles. The great nettle (Urtica dioica) is a perennial and yields the most fiber, but the fiber is of considerable thickness. It was used in “nesseltuch” or nettle cloth especially in Germany and France before cotton was introduced into Europe, and has been used some since during periods of cotton shortage. The small nettle (Urtica urena) is a smaller fiber that somewhat resembles flax.

Nettle fibers have been produced since ancient times in Germany, the Soviet Union, Hawaii, and Sweden. They were used in Italy and France during the Middle Ages. Nettle goods were a part of the trade of Germany, Sweden, and Picardy early in the 19th century, but cotton crowded out nettle fibers, except for some local use and a few specific uses.

The fibers are obtained by retting and scraping or decorticating by machines, such as are used for ramie.

Tree fibers include the paper mulberry fiber, an unusual bast fiber, which is extracted from the inner bark of a small tree Broussonetia papyrifera.

The South Sea Islanders make a fabric known variously as tapa, kapa, or masi from it without first spinning or weaving it. After the fiber has been extracted and cleaned, it is laid evenly in several layers while still wet and allowed to dry overnight. They adhere in one piece when dry. This piece of webbing is laid on a smooth plank and beaten with a wooden tool until it spreads and mats together into cloth as thin as muslin or thick like leather, according to the desire of the worker. Pieces can be joined in the same manner so as to make large pieces of this characteristic cloth. The fabric can be bleached white or dyed or printed.

The same type of fiber is used in Japan, where it is cut in strips, twisted into yam, and used with a warp of hemp or silk to make cloth. The Japanese also use it in papermaking.

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