FIBRE YIELDING PLANTS

Structure

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7.1 INTRODUCTION

Earlier units in this course have provided information about uses of various crop plants. Crop plants have been cultivated since ancient times for various uses such as food, wood and medicines. Plants have been cultivated in different parts of the world for getting cereals, pulses, spices, fibres, oils, beverages and timber. This present unit will provide you information about the important fibre yielding crops grown in different parts of the world with major emphasis on crops of commercial importance such as cotton. Cotton is one most important natural fibre. The fibre of the crop plants is used for the textile purposes.

Objectives

After studying this unit, you should be able to:

- enumerate the region of origin of fibre crops;
- discuss about the different type of fibres;
- describe the important fibre crops of the world;
- describe the morphology, cultivation, varieties and uses of major fibre crops.
7.2 GENERAL ACCOUNT

The use of fibre obtained from plants for clothing has been recorded since prehistoric times. Early humans obtained fibre from plants which later on was spun and weaved to get threads by interlocking strands. Fibre consists of long narrow cells having thick walls but narrow lumen. The cells are non-living but impart strength and rigidity to the plant body. They occur singly or in groups/bundles closely cemented to each other. Many plant species are rich source of vegetable fibre. Vegetable fibres are mainly composed of cellulose which forms its main structural component. This macromolecule is made up of many glucose units. Plant fibres have been classified into different types depending upon the morphological nature and structure. They are mainly classified into three types- 1) soft stem or bast fibres, 2) hard leaf or structural fibres and 3) surface fibres.

**Bast fibres** - These fibres are found associated with the phloem, pericycle and cortex. They are found mostly in dicotyledonous plants. They are durable and capable of resisting bleaching. Commercial bast fibres are produced by plants mainly- flax, jute, hemp, kenaf.

**Structural fibres** - They include strands of small, short lignified cells ensheathing xylem and phloem. They are mainly found in leaves of monocotyledonous plants. They are highly lignified and coarser.

**Surface fibres** - This type of fibres are produced on the surface of stems, leaves, fruits and seeds. The fibres arise as epidermal outgrowths of the seeds or inner wall of fruits. Cotton is the main plant in this category.

According to their use the fibres are classified as textile fibres, brush fibres, filling fibres, natural fibres and paper making fibres. The fibres that are used in the manufacture of fabrics are called textile fibres. For manufacture of fabrics, the fibres are twisted together into threads or yarn and woven. Cotton, along with some quantities of flax, ramie and hemp are used for this purpose. Some fibres are used in the manufacture of brushes. These include sisal and istle (hard fibres), broomcorn (inflorescence of *Sorghum vulgare*) and strong and stiff fibres of piassava (fibres from palm leaves and stem). Flat strands or strips are woven into hats, baskets and roof of houses. Some fibres are used for filling of cushions and mattresses. These include cotton, jute, hard fibres and several grasses. Various wood fibres, grasses and sedges are used for making paper.

7.3 IMPORTANT FIBRE CROPS

The major fibre yielding species include cotton, coconut, jute, hemp, flax, kenaf etc..

**7.3.1 Gossypium**

Family: Malvaceae

Vernacular name: cotton

n = 13, 26
The cotton has been cultivated in South East Asia and Central America since ancient times. India has been the most primitive center of cotton from where it was introduced to China and Egypt around 600 B.C. In the nineteenth century its cultivation spread in tropical, subtropical and warm temperate parts of the world. Its cultivation has been noted throughout India, Myanmar, Malaysia, China, Korea and Japan. India and Africa are the largest producers of cotton mainly of *C. arboreum*.

The four cultivated cotton species with large number of varieties and hybrid forms are classified into two types i.e. i) American or the new world cotton represented by *G. hirsutum* and *G. barbadense*, ii) the Asiatic or the old world cotton consisting of *G. arboreum* and *G. herbaceum*.

**G. arboreum** (Ceylon cotton)

The plants are annual or perennial shrubs with the height up to three meters. The leaves are five to seven lobed (Fig. 7.3). The fruits or bolls are tapering structures profusely pitted having prominent glands in the pits. The fruits open widely when ripe. They contain up to 17 seeds per loculus. The seeds are covered with grayish green or rust colored short hairs called fuzz.

![Fig. 7.1: A flowering branch of G. arboreum.](image)

**G. herbaceum** (Levant cotton)

*n=13*

The species is native to tropical Africa, Middle East and grown in China, Indonesia, India, Pakistan, Iran, Iraq, Turkey, Greece.

The plants are shrubby, reaching a height of 1 m. The leaves are three to five lobed. The incisions in the leaf extend to half the length of the lamina. The bracteoles are widely flaring and boll is three celled, rounded, beaked and
smooth surfaced (Fig. 7.2). The fruit opens at maturity with three to four loculi each having up to 11 seeds. The seeds bear two coats of hairs, long lint hairs and short fuzz hairs.

![Fig. 7.2: A flowering branch of G. herbaceum.](image)

**G. barbedense**

*n=26*

The plant is native of South America. It is known for its lint length and fineness of the lint. It has two varieties – Sea Island cotton and Egyptian cotton. Sea Island cotton is one of the finest varieties of cotton and largely grown in West Indies, Fiji and islands of the coast of Florida, Georgia and Southern Carolina. The fine spun yarn is used in the manufacture of laces, cambric and fine hosiery. Egyptian cotton is grown under irrigated conditions of Nile river valley of Egypt and Sudan. The fibre is durable and hence used in the manufacture of goods that require huge strength such as automobile tyre fabric and high quality hosiery.

The plants are tall, annual shrubs reaching a height up to three meters. The plant bears few ascending vegetative branches. The leaves are three to five lobed (Fig. 7.3). The corolla is bright yellow in color with red to purple spots near the base. The bolls are usually large, dark green and prominently pitted with oil glands. The bracteoles are large divided at the apex with 10-15 long acuminate teeth. The fruit is three to four valved each having five to eight seeds having fuzzy ends. In Sea Island cotton, the fibres are white, light/cream coloured, soft and lustrous.

![Fig. 7.3: A flowering branch of G. barbadense.](image)
**G. hirsutum** (upland cotton)

n=26

The cotton is native to Mexico and Central America. It is grown in most parts of the world. It constitutes 95 per cent of the world production. Besides United States it grows in Brazil, Uganda, Africa, Iraq, China, Turkey, Greece, India and Pakistan. Most of the world’s cotton comes from USA, China, India, Pakistan, Uzbekistan, Turkey, Brazil, Turkmenistan, Greece and Australia. India ranks third in the production of cotton. The major cotton producing states in India are Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Punjab, Haryana and Madhya Pradesh.

On the basis of length of staple its two varieties are recognized which include American upland short staple cotton with the length of about 16 to 27mm and American upland long staple cotton with the length of 28 to 38 mm.

**Morphology**

The plants are generally shrubs or trees with vegetative branches. The main stem of the plant is monopodial in growth and possesses spirally arranged leaves. The leaves bear two kinds of buds- axillary and extra axillary. The plant shows dimorphic branching. The vegetative branches are monopodial while the fruiting branches are sympodial. The vegetative branches develop from the axillary buds of the nodes of lower stem while the fruiting branches arise from the extra axillary buds of the upper nodes. Vegetative branches are morphologically similar to the main stem and do not bear flowers. The secondary (fruiting) branches bear a flower at the tip. From the axil of the subtending leaf, a branch develops that terminates into a fruiting point. The flowers are borne opposite to the leaf on the fruiting branch. The leaves are large, palmately lobed (three to five lobed) cordate, hairy. The flowers are large, showy, white or pale yellow and usually without purplish spot at the base. The flowers are surrounded by involucres of bracts that are generally persistent. The flowers turn pink or red on second day of blooming. The bolls are large, rounded, green and smooth leathery capsules. The fruit consist of three to five locules or chambers (Fig. 7.4). The seeds are covered all over with a long hairs or lint or short hairs or white fuzzy coating.

The capsule cracks at maturity along the sutures and contents expand into a white fluffy mass which is pushed outside the carpel. The cotton fibres represent epidermal elongations of the seed coat cells. The fibres attain maturity and full length during the first twenty five days of boll development. A mature fibre looks like a translucent, flattened twisted more or less tubular structure with broad base and an untwisted tapering apical end. A raw cotton fibre consists of 94percent cellulose, protein 1.3 per cent, pectic substances 0.9 per cent. The fibres are classified as long staple and short staple fibres. The long staple fibres are of American or Egyptian origin and have length of 1 to 2.5 inches, good texture and lusture. Short staple fibres are of Indian origin and have length of about 0.3-0.7 inches and are coarse and lustureless.

Cotton bolls are handpicked. The fibre is taken out and it is spun into yarn and woven into cloth. The fibre passes through various processes such as ginning, baling, carding, picking and combing. Because of its superior quality, cotton is widely used in textile industry.
Cotton is a tropical crop. The crop requires abundance of sunshine and a warm temperature of 21-43°C. The cultivation requires adequate soil moisture i.e. about 100 cm of rainfall during early stages of growth and a dry season during flowering and fruiting. Harvesting is done six months after sowing.

Uses
The fibre possesses high tensile strength and remarkable resistance. The fibre is used to make innumerable clothing and furnishing items. The absorbent cotton (prepared by removing waxy or oily coating) is used in bandage making and medical purposes.

**SAQ 1**

a) Which part of the cotton plant yield fibres?

b) Match the following:

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) finest varieties of cotton</td>
<td>1. Asiatic</td>
</tr>
<tr>
<td>ii) new world cotton</td>
<td>2. G. barbedense</td>
</tr>
<tr>
<td>iii) main stem of cotton</td>
<td>3. Egyptian</td>
</tr>
<tr>
<td>iv) old world cotton</td>
<td>4. G. hirsutum</td>
</tr>
<tr>
<td>v) native of South America</td>
<td>5. Sea Island</td>
</tr>
<tr>
<td>vi) dark colored and inferior quality of cotton</td>
<td>6. monopodial</td>
</tr>
</tbody>
</table>
7.3.2 *Cocos nucifera*

Vernacular name: Coconut

Family: Arecaceae

n = 16

Commercial coir is obtained from the fibrous husk of the fruits of coconut palm. The fibre is light with high elasticity and high resistance. India is the largest producer of coir and its products. About 40 per cent of the nuts produced are used for production of fibre. The fibre is used in the manufacture of mats, rugs, carpets and bags. The fruits are harvested when still green to obtain coir. The fruit is dehusked. The husk is then subjected to retting to remove tough interstitial mass. After retting the husks are taken out of water and thoroughly and repeatedly washed to remove dust.

Fibre obtained from coconut has resilience, durability and resistance to water and used in the manufacture of cordage, cables, coir fibres are used in the manufacture of mats, cushion seating, packing material and boards.

Distribution, morphology, cultivation and uses of coconut has already been discussed in Unit 6 Oils and fats.

7.3.3 *Crotolaria juncea*

Vernacular name: sunhemp

Family: Fabaceae

n = 8

It is a species of Asian origin and grown since prehistoric times. It is used as a source of bast fibre in India. It has spread to other countries and grown for fodder or green manure. It is grown as a commercial fibre crop in India, Bangladesh and Pakistan. In India, Orissa, Madhya Pradesh, Uttar Pradesh, Bihar, Maharashtra and West Bengal are the major sun hemp producing states.

**Morphology**

The plant is a tall, erect annual about 1-3 m tall with strong tap root system penetrating the soil. The roots produce nodules which are branched and lobed (Fig. 7.5). All vegetative parts of the plant are covered with hairs. The leaves are small, lanceolate and subsessile. Flowers are small, yellow and borne in axillary racemes. The fruit is a long pod with pointed beak and contain kidney shaped seeds. Out of the three varieties, green, white and Dewghuddy, white variety produces nearly 60 per cent of the fibre.

**Cultivation**

The crop is well adapted to tropical and subtropical climate with light loamy well drained soils. Sunhemp is widely cultivated in tropical and subtropical areas of the world. It is grown at a large scale in India, Bangladesh and Brazil. The plant grows well at temperature of 18-27°C and areas that receive rainfall below 200 mm.
Uses

The bast fibre produced by the plant consists of ribbon shaped strands which are light in grey to yellow in color. The fibres possess great tensile strength and durability. The fibre strands are lustrous and resistant to moisture. The fibre is used in the manufacture of ropes, twines, cords, canvas, matting and soles for shoes.

7.3.4 *Corchorus* spp.

Vernacular name: Jute

Family: Tiliaceae

n = 7

It is one of the most important source of bast fibres. It is widely cultivated along with cotton among all the natural fibres. The fibre is obtained from stem. The two most cultivated species are *C. capsularis* and *C. olitorius*. It is believed that the plant derived its name from “Korkorus” which was used by Greeks. In India this fibre has been used as a sack-cloth since ancient times. In earlier times India produced about 99 per cent of the total jute but today about 80 per cent of the total production comes from India and Bangladesh. It has been also cultivated in China, Thailand, Russian Federation, Vietnam and Myanmar. In India, it is mainly produced in the states of West Bengal, Bihar, Assam and Andhra Pradesh.

Morphology

The plants are woody branched annuals which can grow up to 3.5 m in height having simple ovate, serrate margined leaves. Flowers are solitary, or arranged in cymes. *C. capsularis* is tall branched annual with ovate glabrous leaves containing a glycoside ‘corchorin’. Flowers are yellow, small and produce globular, wrinkled capsules flattened at the top. The plants of *C. olitorius* are also tall bearing shining upper and a rough undersurface. The flowers are yellow, large and produce long, cylindrical ridged capsule with elongated beak (Fig. 7.6).
Cultivation

*C. capsularis* is grown as a rainy season crop which grows well on warm, humid, rich loamy soil with annual rainfall ranging from 150-250 cm, temperature of 17-38 °C and humidity around 70-90 per cent. The plants are harvested at the stage when 50 per cent of fruiting is there because both yield and quality of fibre is good. The fibres are separated by retting. The process usually takes 10-30 days and time of the process depends upon the maturity of the crop, water, temperature and depth of immersion. Generally the bundles of fibres are stacked upright in about 0.6 m of water for two to three days. The retting removes the bark.

Uses

The fibres are yellow in colour and possess silk like lustre. They are stiff, brittle and possess low stretch ability and durability. The fibres contain about 63 per cent cellulose. The major use of jute is in the manufacture of sacks, bags, rugs, ropes, blankets, carpets, curtains, upholstery etc.

![Flowering branch of *Corchorus*.](image)

**7.3.5 *Hibiscus cannabinus***

Vernacular name: Kenaf, Java, jute

Family: Malvaceae

\[ n = 18 \]

The plant is used for fibre which is a substitute of jute. Kenaf is also known as Deccan hemp or Java Jute. The plant is grown in many countries of tropics and subtropics such as India, Thailand, Brazil, China, Cuba and Mexico. The fibre is extracted from the lower portion of the stem.
Morphology

The plant possesses a long, slender, unbranched stem about 2-3 m in height. The leaves are usually cordate or palmately divided. The flowers are large, showy and arise in the axil of leaves (Fig. 7.7). The fruit is globose capsule with a pointed tip. The fruit produces brown seeds at maturity. The major variety is *H. sabdariffa*. The fibre strands are long (1-3 m), coarser, tougher and stronger.

Cultivation

The plant is cultivated mainly in tropics and subtropics at temperature above 20° C. The plant prefers well-drained humus rich fertile soil. The plant requires rainfall of about 57 to 400 cm and annual temperature of 11 to 28° C for its growth.

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7.3.6 *Cannabis sativa* (Hemp)

Vernacular name: hemp

Family: Cannabinaceae

*n* = 10

It is one of the oldest fibres known to mankind. It originated in central and western Asia. Later on it spread to China and Europe. The major hemp producing countries are Romania, Hungary, Poland, Yugoslavia, India, China, Japan, Chile, Peru, Iran and Turkey.

Morphology

The plant is a hollow stemmed annual bearing dark green palmately compound leaves (Fig. 7.8). The plants are dioecious. The female plants are shorter, robust while the male plants are taller and slender. Male flowers are
borne in axillary and terminal panicles. Female flowers are sessile and arranged dense in a spike. The fruits are smooth, shining achene enclosed by a calyx and large bract.

The fibre is obtained mainly from the male plants. The harvesting is done at the time of pollination. The premature harvesting can result in lower yield and weak, soft fibre. The delayed harvesting results in harsh and brittle fibre. The plant is chopped 2 to 3 cm above ground with the help of knife and the cut stems are spread on ground for drying followed by retting. The fibre strands are yellowish, grey or green and possess strength and durability.

**Cultivation**

The plant is grown in nearly all temperate regions of the world with temperatures ranging from 17 to 27°C and rainfall of about 75 cm per annum.

**Uses**

The fibre is used in the preparation of canvas, cables, webbing, twine, rope and artificial sponges.

**Uses**

Hemp is used in the manufacture of carpet, warp, canvas, webbing sacking, rape, cables. Hemp oil is used in making paint, varnish, soaps.

7.3.7 *Linum usitatissimum* (Flax)

Vernacular name: flax or linseed

Family: Linaceae
The plant has been cultivated since prehistoric times. The presence of flax has been noted since old European and Egyptian civilizations. Nowadays it is cultivated in temperate parts of Europe. The leading producers are France, Russian Federation, Ukraine, Czech Republic and Egypt.

**Morphology**

The plant is an annual herb with slender stem bearing alternately placed small ovate, or lanceolate leaves. The flowers are white or blue present in loose, terminal leafy racemes or open cymes (Fig. 7.9). The fruit an indehiscent globular capsule enclosed in a persistent calyx.

Flax fibre is essentially a crop of temperate climate. The fibres occur in discrete groups or aggregates of many of cells in the pericycle (bast or stem fibres). The number of fibrous bundles is about 30 with each bundle consisting of ten to forty individual fibres. The fibres after extraction are dried in sun and subjected to the process of rippling, steeping, retting and hackling. The fibres obtained from leaves and stem are subjected to rippling while the fibres obtained from small branches are subjected to retting by immersing them in water tank for several days.

**Cultivation**

The plant grown well in sandy, loam soil and cool temperate climate.

**Uses**

The fibres are fine, durable and flexible. The fibres are used in the preparation of cambrics, damasks, sheetings, laces for apparels and household furnishings. The coarser grades are used in the manufacture of canvas, ducks, toweling, twine, bagging and industrial sewing threads.

![Diagram showing flowering branch of Linux, an opened flower and fruit.](image-url)
SAQ 2

a) Fill in the blanks:
   i) Fibres are mainly composed of ………………. .
   ii) Soft fibres obtained from plant stem are called as ………………… .
   iii) For manufacture of …………………., the fibres are twisted together into threads or yarn and woven.
   iv) Commercial coir is obtained from the fibrous husk of the fruits of ………………… .
   v) The botanical name of sunhemp is ………………… .
   vi) …………………. plant derived its name from the word ‘Korkorus” used by Greeks.

b) Write the botanical names of the following plants:
   i) jute
   ii) flax
   iii) hemp
   iv) kenaf

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7.4 SUMMARY

In this unit you have studied that:

- Many plant species are rich source of fibres. Depending upon the morphological nature and structure, plant fibres have been classified into different types mainly soft stem or bast fibres, hard leaf or structural fibres and surface fibres.

- The major fibre yielding species include cotton, jute, hemp, coconut and kenaf. Cotton is one of the most important commercial fibre crop. It has been cultivated in South East Asia and Central America since ancient times. The four cultivated cotton species include American or the new world cotton $G. hisutum$ and $G. barbadense$ and the Asiatic or the old world cotton $G. arboreum$ and $G. herbaceum$.

- Sunhemp, jute, coconut and flax are the other fiber producing plants that are cultivated on a large scale. Most of these varieties produce bast fibres which possess high tensile strength and durability.

- Commercial coir is obtained from the fibrous husk of the fruits of coconut palm. The fibre is light with high elasticity, high resistance. India is the largest producer of coir and its products.

- The bast fibre produced by the sunhemp plant possesses great tensile strength and durability. The fibre strands are lustrous and resistant to moisture. $Corchorus$ is another important source of bast fibres.
7.5 TERMINAL QUESTIONS

1. Differentiate between bast and surface fibres.
2. Enlist the major uses of jute.
3. Describe the morphological features of the cotton plant.
4. Give brief description of morphology and uses of sunhemp.
5. Write short notes on:
   a) kenaf
   b) coconut
   c) flax

7.6 ANSWERS

Self-Assessment Questions

1. a) The fibres arise as outgrowths from the seeds or inner wall of fruits.
   b) i) Sea Island; ii) *G. hisutum*; iii) monopodial;
      iv) Asiatic; v) *G. barbedense*; vi) Egyptian

2. a) i) cellulose
      ii) bast fibres
      iii) fabrics
      iv) coconut palm
      v) *Crotolaria juncea*
      vi) Jute
   b) i) *Corchorus spp.*
      ii) *Linum usitatissimum*
      iii) *Cannabis sativa*
      iv) *Hibiscus cannabinus*

Terminal Questions

1. Refer to Section 7.2.
2. Refer to Subsection 7.3.4.
3. Refer to Subsection 7.3.1.
4. Refer to Subsection 7.3.3.
5. Refer to Section 7.3.