

## Unit 3 LINEN

### NATURAL CELLULOSIC FIBER

#### Can you tell?

- *Have you ever seen linen fiber*
  - *Are you aware from which tree linen fibers are obtained?*
  - *Have you ever used linen garments? How different they are from Cotton garments?*
- Let's learn & find out more information about linen in this chapter.*

### 3.1 INTRODUCTION

Linen yarn is made from fibers removed from the stem of a slender flax plant. Since it is obtained from the stem of the plant it is termed as **Bast** fibers. These fibers, held together under the stem's bark by a gummy substance, pectin, which forms the body of the flax plant.



**Fig. No. 3.1 : Flax Plant & Linen Fiber**

The word flax is derived the old English Fleax. Linen is term applied to the yarn spun from the flax fibers and to the cloth or fabric woven from this yarn.

The flax fiber is basically composed of the woody substance, cellulose.

Linen is considered to be the oldest fiber used in the Western World, which dates back to about 10,000 BC. There are references in the Bible regarding the use of Linen. It was used in Egypt from 3000 to 2500 B.C. These early fabrics were very fine and delicate and were considered the fabric of luxury. This was fashionable and regal fabric of Middle Ages. From Egypt, it was introduced in Great Britain around 1000 B.C. When cotton gin was developed, linen lost much of its importance.

- **Flax Producing Regions :**

Flax of various grades is mainly produced in Australia, Austria, Belgium, Czechoslovakia, France, Germany, Ireland, The Netherlands, New Zealand, Italy and U.S.S.R.

- **Cultivation of Flax :**

The flax plant requires a temperate climate with cloudy skies and adequate moisture. It grows well in deep, rich, well plowed soil. To obtain best quality of fibers the

crop should be carefully rotated. Crop-rotation program of five years yields good harvest.

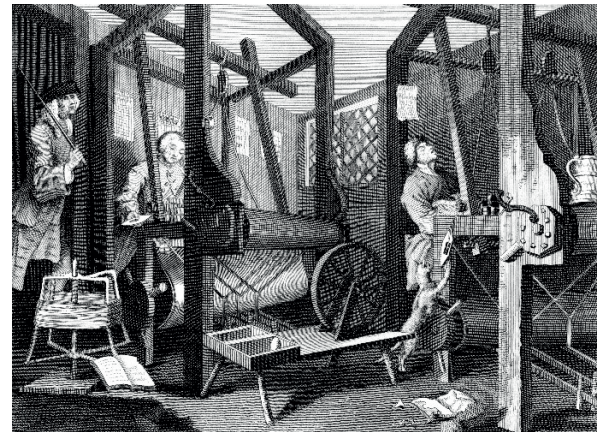
Flax seed is planted by hand in April or May. The seeds are sown close together, so that the plant will grow dense but fine. The flax plant reaches a height of 2-4 feet. Its blossoms are delicate pale blue, white or pink. Plants are pulled before the seeds are ripe when it is to be used for fibers.



**Pic. No. 3.3 : Flax Plant**



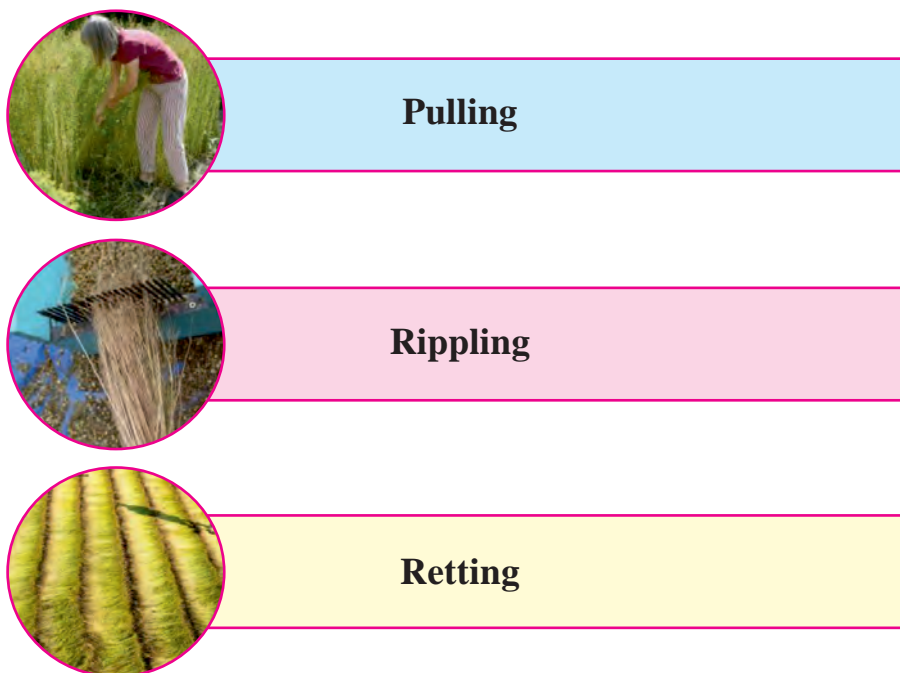
**Pic. No. 3.2 : Cultivation of Flax**



**Pic. No. 3.4 : Processing of Linen in Olden Times**

### 3.2 MANUFACTURING PROCESS OF LINEN

**Chart no. : 3.1 Manufacturing Process of Linen Fiber**





**Breaking**



**Scutching**



**Hackling**



**Spinning**

● **Pulling :**

By the end of August flax turns brownish in colour. It indicates that it is ready for pulling. At this stage if it is delayed, the fibers lose its prized luster and soft texture. Flax for fibers is pulled by hand or mechanical pullers, to keep the roots and stalk intact for the fibers extend below ground surface. The stalks are tied in bundles called beets.



**Pic. No. 3.5 : Pulling**



**Pic. No. 3.6 : Drying Linen Stalk**

**chart no. : 3.2 Types of retting**



**Dew Retting**

- flax straw is spread on open field.
- uneven retting but gives strongest linen.



	<p><b>Pool Retting</b></p> <ul style="list-style-type: none"> <li>● flax straw is immersed under water.</li> <li>● takes less time but over retting can happen.</li> </ul>
	<p><b>Tank Retting</b></p> <ul style="list-style-type: none"> <li>● huge concrete tanks filled with river water.</li> <li>● best grade Belgium Flax is made by this method.</li> </ul>
	<p><b>Wooden vat Retting</b></p> <ul style="list-style-type: none"> <li>● flax is immersed in warm water.</li> <li>● faster method.</li> </ul>
	<p><b>Chemical Retting</b></p> <ul style="list-style-type: none"> <li>● Chemicals are added in water.</li> <li>● very fast but fibre can get damaged.</li> </ul>

- **Rippling :**

After drying the plants, the seeds and leaves are removed from the stem of the flax plant by passing the stalks through coarse combs. This process is called rippling. Bundles of flax are then piled in the fields to dry.

- **Retting :**

To obtain the fibers from the stalk, the outer woody portion must be removed. The bundles of plant are then steeped in water. This allows the tissue or woody bark surrounding the fiber to decompose and loosen the gum that binds the fiber to the stem. This decomposing and fermentation is called **retting**. It is done by the following methods.

### Types of Retting :

- 1) **Dew Retting :** The flax straw is spread on the grass to expose it to the atmosphere for three to four weeks. This method gives uneven results but produces flax which is strong and dark gray in colour.



**Pic. No. 3.7 : Dew Retting**

- 2) **Pool retting :** It requires less time than dew retting from ten to fifteen days. This method some times causes over retting as stagnant water is used and it may result in brittle and weak flax fibers. The fibers obtained are bluish gray in colour.
- 3) **Tank retting :** Bundles of flax are placed in huge concrete tanks with river water. Its temperature of the water is 75° F and increased to 90° F. It requires 24 to 25 days and produces strong, lustrous, highest quality flax fibers. The best grades of Belgium flax are retted in water from the **rivers Lys**.



**Pic. No. 3.8 : Tank retting**

### Internet is my friend!

Collect more information from internet about Retting carried out in various European countries. Also observe the various photographs. Discuss this information in your class.

#### 4) **Wooden vat or mechanical retting:**

The flax is immersed in wooden vats containing warm water at temperature ranging from 75° F to 90° F. This method shortens the retting process. The flax is removed from the vats and passed between the rollers to crush the decomposed bark as clean water flushes away the pectin or gum and other impurities. Linen produced by this method is more susceptible to mildew.

#### 5) **Chemical retting :** The flax is stacked in tanks containing water and chemicals such as Sodium Hydroxide or Sodium Carbonate. Flax is sometimes boiled in dilute solution of Sulfuric acid. It can shorten the process considerably but it may affect the strength of the fibers if it is not carefully controlled.

#### ● **Breaking :**

After retting is complete, the stalk is bundled together and passed between fluted rollers. It breaks outer woody covering into small particles. These are called shives.

#### ● **Scutching :**

Scutching process separates the outer covering or shives from the usable fibers. The flax fibers are thus released from the stalk. This process is done by hand or by machines.



**Pic. No. 3.9 : Scutching**

#### ● **Hackling :**

Hackling or combing process corresponds to the carding and combing process of cotton. This process straightens the flax fibers and separates short fibers called 'tow' from the long fibers known as 'lines'. It arranges longer fibers in parallel formation. For very fine linen, the process is done by hand and is repeated. Coarse linen is hackled by machine. The fibers are then drawn into a sliver.



**Pic. No. 3.10 : Hackling**

#### ● **Spinning :**

The flax fibers are drawn out into yarn and twist is imparted. Although the flax is one of the strongest fibers, it is unelastic and requires carefully controlled, warm, moist atmosphere while spinning. Flax fibers are spun by either dry or wet spinning methods. Wet spinning gives best quality yarn.



**Pic. No. 3.11 : Flax Seed to Linen Fabric**

### 3.3 PROPERTIES OF LINEN (Flax) FIBER

#### A) MICROSCOPIC PROPERTIES :

Under the microscope longitudinal view of linen appears to be composed of a number of small fibers cemented together. It looks much like a bamboo pole with crosswise markings called nodes & inter nodes. Flax has a large central canal. (For Diagram of Linen Fiber refer to practical No. 8)

**Table No. 3.2**

#### Microscopic Characteristic of Linen

- **Bamboo pole like appearance**
- **Crosswise markings (Nodes)**
- **Large central canal**

#### B) PHYSICAL PROPERTIES :

##### 1. Length :

Linen fibers vary in length from few inches to 22 inches or more. Linen fibers (Long linen fibers) are usually more than 12 inches and frequently

from 18-22 inches, Average length of fibers after processing is 10-15 inches. Tow fibers (short linen fibers) are less than 12 inches in length and can be as short as a fraction of an inch.

##### 2. Luster :

Flax possesses a high natural luster. Flax is almost silky in appearance and produces attractive yarns and fabrics.

##### 3. Strength :

Among the natural fibers, it is second in strength to silk. It is much stronger than cotton and it gets stronger when wet. Tenacity of flax is 5.5 – 6.5 grams / denier.

##### 4. Elastic recovery and elongation :

Linen (flax) fiber has no significant elasticity. It is, infact, the least elastic of natural fibers. Fibers are naturally stiff and resists bending. It has elastic recovery of 65 % at 2 % extension. It has low elongation of 1.8 – 2 %, may extend as much as 3.3 %.

##### 5. Resiliency :

Linen fiber has little resiliency. Thus fabrics are prone to crease and wrinkle badly. Finishes can be applied to improve this property.

##### 6. Moisture regains :

Linen fiber has good moisture regain. It's moisture regain is 10-12 % at 65 % relative humidity and 70° F temperature. When absorbency is the main consideration, linen is preferable to cotton. It absorbs moisture and dries more quickly. It is therefore excellent for handkerchiefs and towels. Water causes the fiber to swell slightly. This can cause shrinkage. Fabrics can be stabilized in the finishing process.



### 7. Density :

Linen is a high - density fibre. Its density is 1.5 gms/cc. This makes the fabric heavy in weight.

### C) BIOLOGICAL PROPERTIES :

#### 1. Resistance to Mildew :

Being a cellulosic fiber like cotton linen is vulnerable to mildew. Mildew will grow on and damage fiber particularly in humid atmosphere.

#### 2. Resistance to Moth :

Like cotton linen is resistant to moths & insects.

### D) THERMAL PROPERTIES :

#### 1. Effect of Heat :

Linen fiber burns much the same way as cotton. Fibers burn readily and quickly with a smell similar to that of burning paper. It leaves a small amount of gray ash.

#### 2. Heat Conductivity :

It is a good conductor of heat and hence is more suitable for summer wear.

Table . No. 3.3

Properties of Linen Fibers

Properties	Linen fiber	Can you tell?
Microscopic	bamboo pole like with crosswise marking (Nodes)	Why term Linen is used for household textiles such as bedsheets, napkins, table cloth, towels etc ?
Length	Staple length. Vary from few inches to 22" or more	
Strength	5.5 – 6.5 gm / denier. High wet strength	Why linen towels are used for dish & glassware ?
Elasticity	Low	Why linen is used primarily for high fashion fabrics ?
Resiliency	Low	
Moisture absorption	Very good.	Why linen it more suitable in summer as compared to cotton ?
Density	More 1.5 gm/cc	
Effect of mildew	Easily affected	
Effect of moth	Not easily affected	<b>Hint :</b> The Answers lie in the properties of the fiber.
Effect of heat	can withstand high temperatures. Burns readily swells like burning paper.	
Heat Conductivity	Good	

### 3.4 USES OF LINEN

Flax has many advantages. It has a high natural luster, strength, good moisture regain, and drape. Flax is used primarily for fashion fabrics in both apparel and home furnishings due to its high price. Linen can be made into sheer lightweight fabrics. Linen absorb moisture more readily and dries more quickly than cotton. Because of this property linen fabrics are cool and comfortable to wear. Linen is most suitable for summer apparel due to it's heat conductivity. It allows the heat of the body to escape.

Linen launders well and gives up stains readily, its softness is enhanced by repeated washing, because of these special qualities linen has long been used for a wide variety of home furnishings. In fact the often used term of 'linen' which refers to home furnishings now usually made of cotton and cotton blends stems from their original composition of linen because flax fibers are strong, they do not break off in use as quickly as other fibers; as a result, they do not form lint and frequently are used for drying towels for dishes especially glassware.

Linen fibers are also blended with cotton and rayon. In a blend linen fiber will contribute certain of its desirable properties that other fibers may lack.

**Following are the main uses of Linen :**

#### 1. Apparel uses :

Shirts, Pants, Skirts, Kids wear, Sarees, Formal gents wear, Jackets, Scarf, Handkerchief.



**Pic. No. 3.12 : Apparel uses of Linen**



**Pic No. 3.13 : Apparel uses of Linen**

#### 2. Household Uses :

Bed sheets, Pillow covers, Curtains, Table Cloth, Table mats, Dish cloth towels, Napkins.

#### 3. Miscellaneous Uses :

Handkerchiefs, Scarves.





**Pic. No. 3.14 : Household & Miscellaneous uses of Linen**

**TABLE NO. 3.5 PROPERTIES COMMON TO ALL CELLULOSE FIBER**

No.	Properties	Importance to consumer
1.	Good absorbency	Comfortable for summer wear Good for towels, diapers, bandages, handkerchiefs and active sportswear.
2.	Good conductor of heat	Fabrics suitable for summer.
3.	Ability to withstand high temperature	Suitable for varying medical uses Fabrics can be boiled or autoclaved to make relatively germ free. No special precautions in ironing.
4.	Low resiliency	Fabrics wrinkle badly unless finished for recovery.
5.	Good conductor of electricity	Does not build up static.
6.	High density (1.5 ±)	Fabrics are heavier
7.	Harmed by mineral acids, but little affected by organic acids	Fruit stains (acidic in nature) should be removed immediately from garments to prevent setting.
8.	Attacked by mildew	Store clean items under dry conditions.
9.	Resistant to moth	Can be stored safely for season without any damage.
10.	Flammability	Less harmful in fire accidents.
11.	Moderate resistant to sunlight	Draperies should be lined.

## EXERCISE

### Objective Type Questions

#### I) Match the Pairs

A	B
1. Retting	a) Separating Linen fiber from outer covering
2. Scutching	b) removing linen plant from ground
3. Pulling	c) Decomposition of linen bark
4. Hackling	d) Seeds leaves separated from flax stem
5. Rippling	e) Straightening of linen fibers
	f) Burning of vegetable matter.

#### II. State Whether the following sentences are true or false :

1. Linen is a seed hair fiber.
2. Linen is a natural cellulosic fiber.
3. Dew retting is carried out by using chemicals.
4. Rippling is decomposition of outer woody bark of linen fibers.
5. Best quality of linen is produced by retting in river lys of Belgium.

### Multiple Type Questions

#### III. State and Write the most appropriate answer from the given alternatives :

1. Resiliency of linen is  
a) Poor    b) Good    c) Best

2. Burning linen fiber smells like burning  
a) Paper    b) Plastic    c) Hair
3. Long linen fiber is  
a) Tow    b) Line    c) Lint
4. Linen belongs to the category of  
a) Mineral fiber    b) Animal fiber  
c) Vegetable fiber
5. Density of linen is  
a) Medium    b) High    c) Poor
6. Short linen fiber is  
a) Linters    b) Tops    c) Tow

#### IV Complete the flow chart using correct word.

1) **Retting** →  →

**Scutching**

→  →

### Short Answer Type Questions

#### I. Give Reasons :

1. Linen is suitable for towels & napkins.
2. Linen is termed as best fiber.
3. Retting is essential for linen.
4. Linen towels are suitable for dishes & glassware.
5. Linen is useful as summer ware fabric.

#### II. List the following :

1. List the steps in manufacturing process of linen.

2. List the various types of retting processes.
3. List the flax producing countries.

**III. Answer in Short :**

1. What is Pulling ?
2. What is Retting ?
3. What is Dew Retting ?
4. What is Pool Retting ?
5. What is Tank Retting ?

**IV. Answer the following :**

1. Explain microscopic properties of linen.
2. Explain uses of linen
3. Write any three properties common to cellulose fibers.

**Long Answer Type Questions**

1. Explain types of retting.
2. Explain hackling & spinning of linen.

**Project / Self Study**

1. Visit nearby textile market & study various textile products made up of linen.
2. Make a list of textile products made up of linen for Household purposes.

