important, or when a more casual fabric is acceptable. Cotton blended with polyester in wrinkle-resistant fabrics is widely marketed. These blends retain cotton’s pleasant appearance, have the same or increased durability, are less comfortable in conditions of extreme heat and humidity or high physical activity, and have better appearance retention as compared with 100 percent cotton fabrics. However, removal of oily soil is a greater problem with blends.

Cotton is a very important interior fabric because of its versatility, natural comfort, and ease of finishing and dyeing. Towels are mostly cotton—softness, absorbency, wide range of colors, and washability are important in this end use. Durability can be increased in the base fabric, as well as in the selvages and hems, by blending polyester with the cotton. However, the loops of terry towels are 100 percent cotton so that maximum absorbency is retained.

Sheets and pillowcases of all-cotton or cotton/polyester blends are available in percale, flannel, dobby and jacquard weaves, jersey, and muslin. A range of blend levels and counts are available. Cotton blankets and bedspreads can be found in a variety of weights and fabric types.

Draperies, curtains, upholstery fabrics, slipcovers, rugs, and wall coverings are made of cotton. Cotton upholstery fabrics are attractive and durable, comfortable, easy to spot-clean, and retain their appearance well. Resiliency is not a problem with the heavyweight fabrics that are stretched over the furniture frame. Cotton is susceptible to abrasion, waterborne stains, and shrinkage if cleaning is too vigorous or incorrect. Small accent rugs made from cotton can be machine-washed.

Medical, surgical, and sanitary supplies are frequently made of cotton. Since cotton can be autoclaved (heated to a high temperature to sanitize it), it is widely used in hospitals. Absorbency, washability, and low static buildup are also important properties in these uses.

Technical uses include abrasives, book bindings, luggage and handbags, shoes and slippers, tobacco cloth, and woven wiping cloths. Recycled denim scraps are used to create paper currency.

Cotton Incorporated is an organization that promotes the use of cotton by consumers. It also promotes the use of all-cotton and NATURAL BLEND™ fabrics with at least 60 percent cotton (Figure 12). The National Cotton Council is an organization of producers, processors, and manufacturers.

Other Seed Fibers

Coir

Coir is obtained from the fibrous mass between the outer shell and the husk of the coconut (Cocos nucifera). It is sometimes sold as coco fiber. The long, curly fibers are removed by soaking the husk in saline water. Coir, which is very stiff, is naturally cinnamon-brown. It can be bleached and dyed. It has good resistance to abrasion, water, and weather. Available from Sri Lanka, coir is used for indoor and outdoor mats, rugs, floor tiles, and brushes. Its stiff, wiry texture and coarse size produce fabrics whose weave, pattern, or design is clearly visible. These floor textiles are extremely durable and blend with interiors of many styles.

Learning Activity 6

Select three technical end uses for cotton and explain its performance characteristics that make it appropriate for those end uses.
natural cellulosic fibers

Kapok

Kapok is obtained from the seed of the Java kapok (silk cotton) tree (Enicodendron anfractuosum) or the Indian kapok tree (Bombax malabarica). The fiber is lightweight, soft, hollow, and very buoyant, but it quickly breaks down. The fiber is difficult to spin into yarns, so it is used primarily as fiberfill in some imported items from Java, South America, and India. Researchers in India are studying ways of blending kapok with cotton for apparel uses.

Milkweed

Milkweed (Asclepias incarnata and A. syriaca) produces a soft, lustrous, hollow-floss seed hair fiber resembling kapok. Milkweed has been used for fiberfill in comforters, personal flotation devices, and upholstery. It is very difficult to spin into yarns because it is so weak, smooth, and straight. Milkweed is also known as silkweed fiber and asclepias cotton.

Bast Fibers

Bast fibers come from the stem of the plant, near the outer edge (Figure 13). Hand labor may be used to process bast fibers, and production has flourished in countries where labor is cheap. Since the fiber extends into the root, harvesting is done by pulling up the plant with mechanical pullers or cutting it close to the ground to keep the fiber as long as possible. Cut fibers are approximately 10 percent shorter than pulled fibers. After harvesting, the seeds are removed by pulling the plant through a machine in a process called rippling.

Bast fibers lie in bundles in the stem of the plant, just under the outer covering or bark. They are sealed together by a substance composed of pectins, waxes, and gums. To loosen the fibers so that they can be removed from the stalk, the pectin must be decomposed by a bacterial rotting process called retting. The process differs for individual fibers, but the major steps are the same. Fiber quality can be greatly affected by the retting process. Retting can be done in the fields (dew retting) or in stagnant ponds, pools, or tanks (water retting), where the temperature and bacterial count can be carefully controlled with special enzymes or with chemicals such as sodium hydroxide. Chemical retting is much faster than any other method. However, extra care must be taken if the fiber can be irreversibly damaged. Retting can create problems with water quality if the retting water is released directly into streams or lakes. Dew retting is done in many areas because of its minimal environmental impact.

After the stems have been rinsed and dried, the woody portion is removed by scutching, a process that breaks or crushes the outer covering when the stalks are passed between fluted metal rollers. Most of the fibers are separated from one another, and the short and irregular fibers are removed by hacking, or combing. This final step removes any remaining woody portion and arranges the fibers in a parallel fashion. Figure 14 shows the plant or fiber at each step in processing.

Bast fibers characteristically have thick-and-thin variations in their appearance when processed into yarns and fabrics. This occurs because fiber bundles are never completely separated into individual or primary fibers.

Because the processing of bast fibers is time-consuming and requires specialized machinery, researchers have developed ways of speeding up the process and minimizing the need for
special equipment. Cottonizing reduces a bast fiber to a length similar to that of cotton. These cottonized fibers can be processed on equipment designed for cotton but may lack some of their more traditional characteristics related to hand, luster, and durability. Flax, ramie, and hemp are bast fibers that are frequently cottonized.

Flax

Flax is one of the oldest documented textile fibers. Fragments of linen fabric have been found in prehistoric lake dwellings in Switzerland; linen mummy wraps more than 3,000 years old have been found in Egyptian tombs. The linen industry flourished in Europe until the 18th century. With the invention of power spinning, cotton replaced flax as the most important and widely used fiber.

Today, flax is a prestige fiber as a result of its limited production and relatively high cost. The term linen refers to fabric made from flax, but that term may be misused when it refers to fabrics of other fibers made of thick-and-thin yarns with a heavy body and crisp hand. Irish linen always refers to fabrics made from flax. (Because of its historic wide use in sheets, tablecloths, and towels, the word linen is used to refer to table, bed, and bath textiles.)

The unique and desirable characteristics of flax are its body, strength, durability, low pilling and linting tendencies, pleasant hand, and thick-and-thin texture. The main limitations of flax are low resiliency and lack of elasticity.

Most flax is produced in Western Europe, in Belgium, France, Italy, Ireland, the United Kingdom, Germany, the Netherlands, and Switzerland. Flax is also produced in Russia, Belarus, and New Zealand.

Structure of Flax Individual fiber cells, called ultimates, are spindle-shaped with pointed ends and a center lumen. The primary fiber of flax averages 5.0 to 21.5 inches in length and 12 to 16 micrometers in diameter. Flax fibers (Linum usitatissimum) can be identified microscopically by crosswise markings called nodes or joints that contribute to its flexibility (Figure 15). The nodes may appear to be slightly swollen and resemble the joints in a stalk of corn or bamboo. The fibers have a small central canal similar to the lumen in cotton. The cross section (Figure 15) is many-sided or polygonal with rounded edges. Immature fibers are more oval in cross-section with a larger lumen.

Flax fibers are slightly grayish when dew retted and more yellow when water retted. Because flax has a more highly oriented molecular structure than cotton, it is stronger than cotton.

Flax is similar to cotton in its chemical composition (71 percent cellulose). Compared to cotton, flax has a longer polymer (a higher degree of polymerization) and greater orientation and crystallinity.

Short flax fibers are called tow; the long, combed, better-quality fibers are called line. Line fibers are ready for wet spinning into yarn. The tow fibers must be carded before dry spinning into yarns for heavier fabrics for interior textiles.

Aesthetics Flax has a high natural luster that is softened by its irregular fiber bundles. Its luster can be increased by flattening yarns with pressure during finishing.

Because flax has a higher degree of orientation and crystallinity and a larger fiber diameter than cotton, linen fabrics are stiffer in drape and harsher in hand. Finishes that wash and air blow the fabric produce softer and more drapeable fabrics.

Figure 15 Photomicrographs of flax: cross-sectional view (left), longitudinal view (right).
SOURCE: Courtesy of the British Textile Technology Group.
Durability  Flax is strong for a natural fiber. It has a breaking tenacity of 3.5 to 5.0 g/d when dry that increases to 6.5 g/d when wet. Flax has a very low elongation of approximately 7 percent. Elasticity is poor, with a 65 percent recovery at only 2 percent elongation. Flax is also a stiff fiber. With poor elongation, elasticity, and stiffness, repeatedly folding a linen item in the same place will cause the fabric to break. The nodes contribute greatly to flexibility, but they are also the weakest part of the fiber. Flax has good flat abrasion resistance for a natural fiber because of its high orientation and crystallinity.

Comfort  Flax has a high moisture regain of 12 percent, and it is a good conductor of electricity with no static buildup. Flax is also a good conductor of heat, so it makes an excellent fabric for warm-weather wear. Flax has the same high specific gravity (1.52) as cotton.

Care  Flax is resistant to alkalis, organic solvents, and high temperatures. Linen fabrics can be dry-cleaned or machine-washed and bleached with chlorine bleaches. For upholstery and wall coverings, careful steam cleaning is recommended to avoid shrinkage. Linen fabrics have low resiliency and often require pressing. They are more sunlight-resistant than cotton.

Crease-resistant finishes are used on linen, but the resins may decrease fiber strength and abrasion resistance. The wrinkling characteristics of linen make it easy to recognize. Linen fabrics must be stored dry; otherwise mildew will become a problem.

Table 4 summarizes flax's performance when used in apparel or interior textiles.

Environmental Concerns and Sustainability of Flax  Flax has less of an environmental impact than does cotton. The production of flax requires fewer agricultural chemicals like fertilizer and pesticides, and irrigation is seldom required. But the practice of pulling the plants

| Table 4 Summary of the Performance of Flax in Apparel and Interior Textiles. |
|--------------------------------------|------------------|
| Aesthetics                          | Excellent        |
| Luster                              | High             |
| Texture                             | Thick-and-thin   |
| Hand                                | Stiff            |
| Durability                          | Good             |
| Abrasion resistance                 | Good             |
| Tenacity                            | Good             |
| Elongation                          | Poor             |
| Comfort                             | High             |
| Absorbiency                         | High             |
| Thermal retention                   | Good             |
| Appearance Retention                | Poor             |
| Resiliency                          | Poor             |
| Dimensional stability               | Moderate         |
| Elastic recovery                    | Poor             |
| Recommended Care                    | Dry-clean or machine-wash (apparel) |
|                                     | Steam- or dry-clean (interior textiles) |
natural cellulosic fibers

during harvest in order to get longer fibers contributes to soil erosion. Removing the fiber from the stem requires significant amounts of water, but recycling is often used. Depending on the type of retting used, disposal of chemicals and contaminated water are other areas of concern. Changes in retting practices have occurred because of environmental issues. Dew and enzyme retting are more sustainable practices than water retting. Hand labor used in some areas where flax is produced needs to be monitored to avoid exploitation of workers.

Identification Tests Flax burns readily in a manner very similar to that of cotton. Fiber length is an easy way to differentiate between these two cellulosic fibers. Cotton is seldom more than 2.5 inches in length; flax is almost always longer than that. However, cottonized flax will be more difficult to identify. Flax is also soluble in strong acids.

Uses of Linen The Masters of Linen, an organization that promotes the use of linen, has developed a trademark to identify linen (Figure 16). Linen is used in bed, table, and bath items, in other interior items for home and commercial use, in apparel, and in technical products. Linen fabrics are ideal for wallpaper and wall coverings up to 120 inches wide because their irregular texture adds interest, hides nail holes or wall damage, and muffles noise. Linen fabrics are used in upholstery and window treatments because of their durability, interesting and soil-hiding textures, and versatility in fabrication and design.

Linen apparel includes items for warm-weather use, high fashion, casual, and professional wear. Technical products include luggage, bags, purses, and sewing thread.

In 1998, The Center for American Flax Fiber (CAFF) was established in South Carolina. Its goal is to establish a U.S. flax industry that emphasizes short-staple or cottonized flax.

Learning Activity 7

Use a small portion of the fiber from the small self-sealing bag labeled Flax or a yarn from Fabric #1 from your swatch kit. Examine the fibers using the microscope to see the nodes and variations among the flax fibers. Describe the differences in surface contour and structure between flax and cotton.

Learning Activity 8

Use a small portion of the fiber from the bag labeled Flax or three to four yarns from Fabric #1 from your swatch kit. Conduct a burn test. Describe the ease of ignition, the color of the smoke, the color and texture of the ash, and the smell of the smoke. Compare your results with the chart on the sheet with the fiber bags in your swatch kit. Describe the similarities and differences between your results with cotton and linen.

Learning Activity 9

Select an end use for flax other than apparel. Explain its performance characteristics that make it appropriate for that end use.

Figure 16 Linen symbol of quality.
SOURCE: Courtesy of Masters of Linen/USA.
Other Bast Fibers

Ramie

Ramie is also known as rhea, grasscloth, China grass, and Army/Navy cloth. It has been used for several thousand years in China. The ramie plant (Boehmeria nivea) is a tall perennial shrub from the nettle family that requires a hot, humid climate. Ramie is fast-growing and can be harvested as frequently as every 60 days. Thus, several crops can be harvested each year. Because it is a perennial, it is cut, not pulled. It has been grown in the Everglades and Gulf Coast regions of the United States, but it is not currently produced in those areas.

Ramie fibers must be separated from the plant stalk by decortication, in which the bark and woody portion of the plant stem are separated from the fiber (83 percent cellulose). Because this process required a lot of hand labor, ramie did not become commercially important until less expensive mechanized ways of decorticating ramie were developed. Because ramie is a relatively inexpensive fiber that can be cottonized and blends well with many other fibers, ramie or ramie blend items are common in the United States. Ramie is produced in China, Brazil, the Philippines, South Korea, Taiwan, Thailand, and India. Ramie must be degummed by boiling in a weak alkaline solution to remove the wax and pectin along the cell walls and separate the fiber bundles.

Properties of Ramie

Ramie is a white, long, fine fiber with a silklike luster. It is similar to flax in absorbency, density, and microscopic appearance (Figure 17). Because of its high molecular crystallinity and orientation, ramie is stiff and brittle. Like flax, it will break if folded repeatedly in the same place. Consequently, it lacks resiliency and is low in elasticity and elongation potential. Ramie can be treated to be wrinkle-resistant.

Ramie is one of the strongest natural fibers known; its strength increases when it is wet. It is resistant to insects, rotting, mildew, and shrinkage. Its absorbency is good, but it does not dye as well as cotton. Ramie can be mercerized to enhance dye absorbency. Ramie does not retain color well unless it is dry-cleaned.

Uses

Ramie is used in many imported apparel items, including sweaters, shirts, blouses, and suits. Ramie is important in interiors for window treatments, pillows, and table linens. It is often blended with other natural fibers in levels greater than 50 percent ramie for many apparel and interior uses. It is used in ropes, twines, nets, banknotes, cigarette paper, and geotextiles for ground-cover fabrics for erosion control.

Table 5 summarizes ramie's performance in apparel and interior textiles.

Hemp

The history of hemp is as old as that of flax. Hemp resembles flax in macroscopic and microscopic appearance; some varieties of hemp are very difficult to distinguish from flax. Although hemp is coarser and stiffer than flax, processing and cottonizing can minimize these differences. Hemp fibers can be very long—3 to 15 feet. It is processed in a manner similar to flax with similar environmental issues. Alternatives to regular retting are enzyme retting and steam explosion. In steam explosion, steam is used to break apart the fiber and the woody stem. While the process shortens the staple length and reduces its strength, hemp processed in this manner is easier to process on cotton spinning equipment.

Depending on the processing used to remove the fiber from the plant stem, it may be naturally creamy white, brown, gray, almost black, or green. It is 78 percent cellulose and can be
machine-washed and dried. The plant produces three types of fibers. The bast fibers from the outer region of the stalk are the longest and finest. These are the fibers most often used in 100 percent hemp and blend fabrics with linen, cotton, or silk for apparel and interiors. The inner two fibers are shorter and most often used in nonwovens and other technical applications. The innermost woody core fibers are used for mulch and pet and animal bedding. Hemp is resistant to ultraviolet light and mold. It has only 5 percent elongation, the lowest of the natural fibers.

The high strength of hemp makes it particularly suitable for twine, cordage, and thread. Hemp is resistant to rotting when exposed to water. Although hemp had been an important technical fiber for centuries, its importance began to decline in the late 1940s because of competition from synthetic fibers and regulations controlling the production of drugs—hemp (Cannabis sativa) is a close relative of marijuana. New varieties of hemp grown for fiber have less than 1 percent of the compound tetrahydrocannabinol (THC, the hallucinatory agent in marijuana) and are of no value as a source of the drug. Hemp activists and promoters are working to lift the ban on producing hemp for fiber in several countries.

Because of its comfort and good absorbency (8 percent), hemp is used for some apparel and interiors. Hemp is environmentally friendly and does not require the use of pesticides during its production. It grows so quickly that it smothers weeds. Its root system minimizes soil erosion. Approximately 20 to 30 percent of the hemp plant is fiber. Hemp produces 250 percent more fiber than cotton and 600 percent more fiber than flax on the same land. Most hemp fiber is imported from China and the Philippines, but it is also grown in cooler climates in Italy, France, Chile, Russia, Poland, India, and Canada. Commercial production of hemp is not allowed in several countries, including the United States. Hemp is found in hats, shirts, shoes, backpacks, T-shirts, and jeans. Hemp also is used as a paper fiber and as litter and bedding for animals. In some areas, it is being grown on land to extract such pollutants as zinc and mercury from the soil. Oil from hemp seeds is used to make cooking oil, cosmetics, and plastic.
natural cellulosic fibers

Jute

Jute was used as a fiber in Biblical times and probably was the fiber used in sackcloth. Jute, which is 81 percent cellulose, is one of the cheapest natural textile fibers. It is grown throughout Asia, chiefly in India and Bangladesh. The primary fibers in the fiber bundle are short and brittle, making jute one of the weakest of the cellulosic fibers.

Jute is creamy white to brown in color. While soft, lustrous, and pliable when first removed from the stalk, it quickly turns brown, weak, and brittle. Jute has poor elasticity and elongation.

Jute is used to produce sugar and coffee bagging, carpet backing, rope, cordage, and twine, but it is facing strong competition from olefin for these end uses. Because jute is losing its market, it is being investigated as a reinforcing fiber in resins to create preformed low-cost housing and in geotextiles.

Burlap or hessian is used for window treatments, area rugs, and wall coverings. Jute has low sunlight resistance and poor colorfastness, although some direct, vat, and acid dyes produce fast colors. It is brittle and subject to splitting and snagging. It also deteriorates quickly when exposed to water. Jute is occasionally used in casual apparel like walking shorts.

Kenaf

Kenaf is a soft bast fiber from the kenaf plant. The fiber is long, light yellow to gray, and harder and more lustrous than jute. Like jute, it is used for twine, cordage, and other technical purposes. Kenaf is produced in Central Asia, India, Africa, and some Central American countries. Kenaf is being investigated by researchers as a source of paper fiber and in blends with cotton.

Hibiscus

Hibiscus is from the same general botanical family as cotton—the Malvaceae family. The plant (Hibiscus ficulneus) grows as a tall shrub in tropical and subtropical regions. While it is commercially grown and used for clarifying sugarcane juice, the waste material has been studied for its fiber potential. As with other bast fibers, retting is required to extract the fiber from the plant stem. Hibiscus fiber can be bleached and has good fastness when dyed with direct dyes. The fiber is stronger than jute and has a potential for use in bags, rugs, and some apparel items when used in blends.

Nettle

Nettle fiber known as aloo or allo is removed from the plant stem of the Himalayan giant nettle plant (Girardinia diversifolia). The fiber is stripped from the stem, boiled for several hours, air dried, and handspun into yarns. The hollow fiber looks and feels similar to raw flax. The nettle plant is a perennial that grows without the use of fertilizers or pesticides. The fiber is used for technical products like bags and ropes as well as for apparel and interior textiles. Because the fiber is hollow, it has good insulating characteristics.

Another nettle fiber from the stinging nettle (Urtica cannabina L.) plant stems was widely used in Europe until the 15th century when cotton began to replace it because of easier processing. Stinging nettle is being investigated in Europe as a potentially sustainable fiber. The plant can be grown in areas where the soil or climate is not conducive for the production of
natural cellulosic fibers

cotton. Nettle must be pond retted for a few weeks and mechanically separated from the plant stem. Degumming in an acidic water bath is required. Nettle is 48 percent cellulose. It is similar in shape to ramie, coarser than jute, and stronger than ramie. Current plant breeding programs are attempting to improve fiber characteristics.

Bamboo

There are two types of bamboo fiber on the market. The type that is removed from the bamboo culms (above-ground stems of the plant) will be discussed here. The other bamboo fiber is regenerated from bamboo pulp. The natural bamboo fiber (as opposed to the regenerated bamboo rayon fiber) maintains its natural resistant to microbes. The fiber is also absorbent, but has a somewhat coarse hand. This type of bamboo is not usually found in the apparel or interiors market. Bamboo is a type of grass that grows quickly without the use of pesticides or fertilizer. Most bamboo is harvested on a regular basis from managed farms where the land is not tilled and irrigation is not needed. Natural bamboo does not threaten wild bamboo forests or natural habitats. Most bamboo is processed in China.

Leaf Fibers

Leaf fibers are those obtained from the leaf of a plant. Most leaf fibers are long and fairly stiff. In processing, the leaf is cut from the plant and fiber is split or pulled from the leaf. Most leaf fibers have limited dye affinity and may be used in their natural color. Several leaf fibers are being used in composites in the European automotive industry.

Piña

Piña is obtained from the leaves of the pineapple plant. The fiber is soft, lustrous, and white or ivory. Since piña is highly susceptible to acids and enzymes, rinse out acid stains immediately and avoid detergents or enzyme presoaks. Hand washing is recommended for piña. The fiber produces lightweight, sheer, stiff fabrics. These fabrics are often embroidered and used for formal and wedding wear in the Philippines. Piña is also used to make mats, bags, table linens, and other apparel (Figure 18). Current research is aimed at producing a commercially competitive piña fiber that can be blended with other fibers.

Abaca

Abaca is obtained from a member of the banana tree family (Musa textilis). Abaca fibers are coarse and very long; some may reach a length of 15 feet. Abaca is off-white to brown in color. The fiber is strong, durable, and flexible. It is used for ropes, cordage, floor mats, table linens, some wicker furniture, and apparel. It is produced in Central America and the Philippines. Abaca is sometimes referred to as Manila hemp, even though it is not a true hemp.

Sisal and Henequen

Sisal and henequen are closely related plants. They are grown in Africa, Central America, and the West Indies. Both fibers are smooth, straight, and yellow. They are used for better grades of rope, twine, and brush bristles. However, since both fibers are degraded by salt water, they are not used in maritime ropes.

Figure 18 Piña place mat.
natural cellulosic fibers

Sisal is used for upholstery, carpet, and custom rugs that can be hand painted for a custom look. Sisal provides a complementary texture and background for many interior styles. Sisal may be used by itself or in blends with wool and acrylic for a softer hand. The dry extraction cleaning method is recommended. Sisal is used in wall coverings, especially in heavy-duty commercial applications, because of its durability and ease of application to a variety of surfaces. Unfortunately, sisal has a tendency to shed and fade out and it absorbs waterborne stains.

Other Cellulosic Materials

Other cellulosic materials are important in interiors. Rush (stems of a marsh plant), sea grass from China and Vietnam, and maize or cornhusks are used in accent rugs because of their resistance to dry heat and soil. Rush and palm fiber seats are often used on wooden frame chairs for a natural look. Yarns made from paper (wood pulp) add interest and texture to wall coverings for interiors. Wooden slats and grasses are found in window treatments. Grasses are especially appealing for wall coverings; the variable weights, thicknesses, and textures add a natural look to interiors. They can be applied to any type of wall surface, treated to be flame retardant, and colored to match the decor.

Wicker furniture is commonly made from tightly twisted paper yarns, rattan, and other such natural materials as sea grass, abaca (banana leaf), and raffia. Wall panels and wall coverings are being produced from shredded straw, bark, and old telephone books because of the interesting texture and shading produced by these materials.

Bacteria produce cellulose with an extremely uniform structure, high water-holding capacity, and multidimensional strength. At present, bacterial cellulose is used in medicine as a covering for severe burns and other skin injuries.

Learning Activity 10

Select one of the minor bast or leaf fibers. Identify an end use for this fiber and explain its performance characteristics that make it appropriate for that end use.

Learning Activity 11

Use Fabrics #1, 3, 41, and 53 from your swatch kit. Check the key for the swatch kit and determine the fiber content of each swatch. Identify an end use for each fabric and describe the serviceability of that product based on fiber content. Examine Figure 1 and locate one or more countries where each of these fibers might have been produced.

Learning Activity 12

Identify a cellulosic fiber that could be promoted as a more sustainable replacement for cotton for many end uses. Explain why it is more sustainable. What are the roadblocks preventing this fiber from taking over more of cotton’s market share? What are the properties in which this fiber is better than cotton? What are the properties in which this fiber is not as good as cotton? How would you market this fiber to convince consumers that this is a sustainable alternate to cotton?