



Naturally Good

By Maria C. Thiry

People have used natural fibers—fibers directly obtained from animal, vegetable, or mineral sources—since before the dawn of history. Scientists estimate that people first started wearing clothing more than 100,000 years ago (when the body louse became distinguishable from the head louse).¹ For most of history, natural fibers were the *only* textile fibers. Synthetics became big business in the 20th century, but naturals aren't a thing of the past.



Robin moth



Mitun Chakrabarti, founder and CEO of Rajboori Fine Silk Items, says that natural fibers are gaining in popularity because eco-conscious consumers “look for natural products for their homes.” Renewable and biodegradable fibers have a natural head-start in the sustainability race.

Besides sustainability, Mark Messura, senior vice-president of global supply chain marketing for Cotton Incorporated, says that natural fibers also offer fashion and performance functionality. He says the popularity of natural fibers is a reflection of what people focus on: the benefits of the fabric.

In addition, consumers all over the world equate natural fibers with luxury and value, says Crisan Popescu, researcher at DWI an der RWTH Aachen University. “Prince Charles’ campaign for wool made a big impact on the younger generation,” he notes.

Natural Performance

“Nature makes the most efficient things.” says Gregor McCluskey, founder of Bräeval brand sporting apparel. “If we look at the technical aspects of natural fibers and apply the ingenuity and technology that we do to synthetics, then a lot more is possible.” In addition to the performance properties inherent in the fibers themselves, mechanical or chemical treatments can impart further functionality to natural fibers. Today’s natural fiber fabrics can offer surprising performance.

Comfortable Cotton

The three greatest natural attributes of cotton are its breathability, comfort, and versatility, says Vikki Martin, director of quality research and product evaluation for Cotton Incorporated.

Cotton’s ability to retain fiber strength when wet allows consumers to care for cotton garments at home instead of at professional cleaners, making cotton apparel very popular. However, cotton’s tendency to crease and wrinkle meant that consumers had to engage in more maintenance for their garments than they preferred. “In the 1960s and 70s, man-made fibers had an edge over natural fibers in that they required less home maintenance, but they lacked the comfort and breathability so inherent in cotton,” says Martin. “However textile chemistries like wrinkle- and stain-resistant finishes soon helped to level the playing field.”



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More recently, says Martin, synthetic and man-made fibers had a competitive advantage over cotton in the outdoor and performance apparel categories because of their hydrophobic properties. In response, Cotton Incorporated developed the TransDry and Wicking Windows technologies to add enhanced moisture-management to cotton apparel. “It is a simple solution that varies the hydrophilic properties of cotton with a hydrophobic treatment that not only transfers moisture from the inside to the outside of the garment, but also leads to improved drying time,” says Martin. “Unlike synthetic apparel offering a comparable benefit, these technologies are not hampered by home drying, but are actually reactivated by it.”

Enhanced moisture management of another kind is the basis for Cotton Incorporated’s Storm technologies. The Storm technology can be applied to any cotton garment to make it rain repellent so that it doesn’t retain water against the body, but at the same time “allows for the breathability that consumers appreciate in cotton apparel,” says Martin.

Warm as Wool

The performance qualities of wool are “without equal,” says Karl Spilhaus, president of the Cashmere and Camel Hair Manufacturers Institute. “No other fabric [fiber] comes close for formal wear.” Stewart Collie, team leader for textiles at AgResearch Ltd., says that, from the apparel perspective, the main performance features of wool are its moisture man-



agement properties. “The inside of the fiber is very hydrophilic, while the outside of the fiber is somewhat hydrophobic,” he says. These properties help wool to transfer moisture away from the body.

“Wool has the highest capacity to absorb moisture of conventional fibers,” says Collie. “It can absorb up to one third of its own weight in moisture before it feels wet.” This property is important to wool’s moisture-buffering effect. “The moisture vapor coming off a wearer’s body is absorbed by the wool,” says Collie. The wool fabric doesn’t get clammy, clingy, or damp from mild perspiration. Because of its capacity to absorb moisture, wool is also resistant to static electricity, and therefore less likely to cause static shocks.

Other fiber properties make wool useful for interior and technical fabrics as well. “Wool is a good odor absorber,” notes Collie. “The chemical structure absorbs and holds volatile chemicals.” He says wool works well in passive filtering environments. Wool’s powers of absorption are not just confined to odors. Margot Buick, commercial manager for AgResearch Ltd., says wool is sometimes used to absorb oil from roadways, oil spills, and even to absorb heavy metals.

Wool is naturally flame retardant—it ignites at a higher temperature than cotton and some synthetic fibers, has a lower rate of flame spread, low heat release, low heat of combustion, and does not melt or drip like some synthetics. It forms an insulating and self-extinguishing char. “Wool has the lowest flammability of conventional fibers,” says Collie.

Learn which fibers produce the *most* harmful byproducts of burning. Read “Thermal Decomposition of Selected Flame Resistant Clothing Materials” on page 34.

Collie says that the main challenge with wool is the lack of consumer awareness. “We have lots of myths

to overcome,” he says. “Garment-grade wool is not scratchy, and a wool garment can be a relatively easy care product nowadays.”

Conventional wisdom has it that wool can feel scratchy because of the scales on its surface. But Collie says it’s not so much the scales on wool that make it scratchy. “It’s the proportion of fibers in the yarn that are coarse (more than 30 microns in diameter). The coarser fibers tend to stick out more and prickle,” he says. “If the proportion of coarse fibers is really low, then you don’t get the scratchiness. The easiest way to get that average lower has so far been to get the total micron average lower. But another way would be to select for sheep with a narrower micron distribution.”

The average fiber diameter for a sample could be 18 microns, with a range of 15-30 microns, or a range of 15-20 microns. “The idea is to get a narrower range,” says Collie. Buick says that research is underway to breed animals bearing wool with a narrower range of mean fiber diameter.

In addition to wool’s natural properties, Spilhaus says that chemical treatments to prevent felting make wool home washable. “This has helped in the promotion of wool for sports and outdoor garments,” he says. Johann Mittermayr, sport/outdoor manager for Australian Wool Innovation (AWI) in Europe, says that he’s seeing excellent wool fabrics for sports and outdoor wear. “Mercerization makes Merino wool softer, washable, and gives it a very nice, luxurious hand, with a beautiful sheen.”

McCluskey’s Bräeval features a fabric made of an intimate ring-spun blend of Merino wool and long staple cotton. McCluskey says that wool and cotton are “performance fibers that fit everyday lifestyles. People buy our clothing for the first time for the color and style, but buy it again for the performance. The wool retains color well, is odor resistant, helps



with micro-climate maintenance, provides moisture wicking, and is flame retardant. The cotton brings comfort, enhances the fabric hand, and provides easy care.” He says today’s wool garments are typically machine washable and dryable.

Strong as Silk

Silk is famous for its beauty, luxury, and strength. The incredible strength of silk fibers enable fabric manufacturers to make very fine, lightweight fabrics that are still strong and durable. “Silk is a very durable, long lasting fabric that is luxurious yet provides comfort all year round, as it’s cool in the summer and warm in the winter,” says Chakrabarti. “If properly cared for, silk garments can last a lifetime. This allows the consumer to make a good investment that lasts over a longer period of time.”

Sericulturist Michael Cook says that a lot of the new developments in silk come from the use of varietal silkworms from different regions of the world. “There are wild silks being used for textiles from all over the world, particularly in Africa and India; some of them had been known from prior ethnic tradition, but are being put to new uses and introduced to new markets,” says Cook. “Several of the wild silks, including Tasar in India, and Mopani and Anaphe in Africa, are being used in poverty-alleviation programs; their aversion to indoor bulk rearing makes them a perfect crop for many tribal areas. Muga silk (from the moth *Antheraea assamensis*), from the northeast of India, has just received geographic designation, meaning that in order to be labeled as ‘Muga silk’ it has to come from a small region near Assam, much like how sparkling wine labeled ‘Champagne’ has to come from certain regions in France.”

Jane Deane, silk spinner, textile designer, and sericulturist, says that new advances are being made in silk coloration. “*Boxbyx mori* (common silkworm) silk is white, but the Japanese have developed a process that produces vibrantly colored cocoons, cutting out the need for dyeing.”

Sustainability

With the increasing focus on sustainability in the textile industry, fibers are often the first consideration in the quest to make fabrics more “eco-friendly.” Natural fibers have the advantage of being renewable and biodegradable. However, warns Messura, “every fiber has a footprint, and an impact on the environment. What’s key is how you manage it and how you reduce it over time.”



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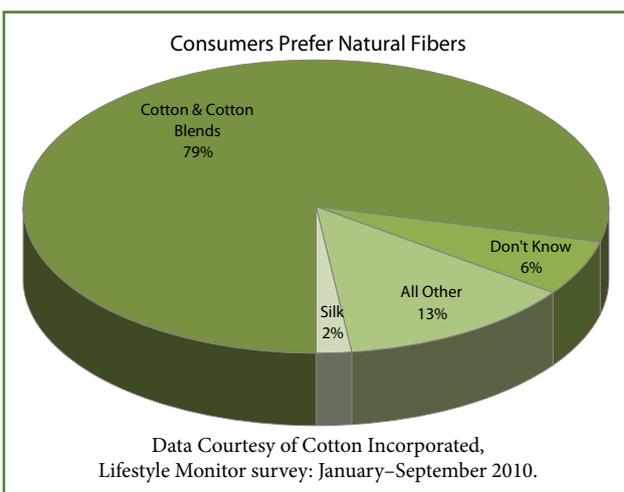
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Cultivating Cotton

“At the outset it should be acknowledged that with the population set to increase to nine billion by 2050, it is going to take a lot of fiber supply to meet apparel demand 40 years from now. Balancing the environmental and economic sustainability to meet projected demand is key to any discussion or definition of sustainability across the apparel supply chain,” notes Martin.



Dyed in the Wool

Collie says that improved sustainability for wool can come from improved processing. One processing step that can be improved is wool dyeing. Popular dark shades for wool are often achieved with chrome-based dyes. The European REACH legislation put chrome dyes on the list of substances of very high concern. Many European brands are concerned, and asking their suppliers if they still use chrome dyes.

Franz Gruener, global technical wool specialist in the Business Development division of Huntsman Textile Effects, says that Huntsman has developed a range of chrome-free black, navy, and other dark shades very popular on wool. "Chrome dyes expose workers to dangerous chemicals, and are a serious health issue," he says. Huntsman's Lanazol range of dyes "give better environmental performance and better overall performance," says Gruener.

Gruener explains that the chemical reaction with amino chains in the wool lets the Lanazol dyes develop high fastness. "These dyes can also be applied at lower temperatures, giving both an environmental benefit, plus less damage to wool fibers from high heat," he says. Gruener notes that most wool is still dyed at the fiber stage before spinning. "If a fiber is damaged during dyeing, it will have more yarn breaks and cause serious problems during spinning," he says.

The environmental sins usually leveled against cotton include the use of chemical pesticides and defoliants, as well as water use, and the use of land that could be used to raise food crops. "Through the use of modern agricultural practices and scientific advances such as biotech crops, cotton producers in the United States have significantly reduced the need for natural resources like water and chemical inputs such as chemical pesticides. This has resulted in increased cotton yields without increased land use, and a decrease in environmental impact," says Messura. It's in the farmer's best interests to use less land, water, and chemicals to grow his cotton crop, says Messura, because doing so will save money.

As for the tradeoff between acreage used to plant fiber and food, Messura says that cottonseed is already used for animal feed and refined cottonseed oil is used in many human foods. "We're researching lowering the levels of gossypol (a toxic substance to humans) in cottonseed so that in the future, it will be possible to use cottonseed as a protein source for humans," says Messura. "We should see it on the market in a decade or so."

Some of the advances in cotton production that allow the crop to have a lower environmental impact

are due to the genetic engineering of the cotton plant. Some people have philosophical issues with the use of genetically modified organisms (GMOs). "On a scientific level, however, fiber from a genetically-engineered cotton plant is not structurally different than that of a non-genetically-engineered plant," says Martin. "Part of the controversy stems from a fundamental misunderstanding of GM agriculture and its goal of efficiency. GM cotton varieties enhance the natural ability of the plant to defend itself from damaging pests, which helps reduce pesticide applications and their associated costs. Productivity is also a facet of GM, in which increased fiber volumes can meet demand without encroaching on land that can be used to grow food crops." Messura says genetic engineering is just a tool, and likens genetic engineering to building a house using power tools instead of hand tools—both get the job done, the power tools are just quicker.

Shearing Sheep

"Sheep eat grass, then grow wool. That's very environmentally friendly!" says Buick. She says that in New Zealand, sheep are "free range"—not housed in crowded conditions, so there is no overgrazing. "Sustainable grazing practices prevent soil erosion, and conserve water and grass cover," says Peter Vandeleur of New Merino.

Wool is also recyclable, although there's not as much wool recycling as there used to be, according to Collie. "The whole 'shoddy' industry was based on reprocessing wool," he says. "The worsted process used first grade, longer fibers, and the woollen process used shorter fibers, including recycled wool. As the value of wool fiber increases, reprocessed wool may come back into use." Collie says that recycled wool can also be made into insulation and all kinds of products, not just fabrics and carpets. Buick says that recycled wool can also be a source of biomaterial, such as protein used in personal care items like shampoos.

Popescu says there are claims that wool is less environmentally friendly than polyester (PET), for example, if the overall CO₂ balance for processing





the fibers is considered. In addition, wool processing, particularly scouring the raw greasy wool, uses and pollutes a large amount of water. However, he notes that in making those comparisons, the measurement of the environmental impact for wool goes from the shorn sheep to the end product, while the measurement for PET goes from the fiber to the end product. Buick feels that wool comes out much better when the entire life cycle of the fiber, from source to end of life, is considered. The end of life story for wool is especially good, she says, because it's readily biodegradable.

Another issue plaguing wool, specifically Australian Merino wool, is mulesing. Mulesing is a surgical procedure that removes folds of wrinkly skin from the sheep's buttocks. It is intended to prevent a slow and agonizing death from fly strike—in regions where the blowfly is prevalent. However, because of the number of sheep involved, the surgery is commonly done without the use of anesthetic, which earns the protest of animal rights and welfare advocates. AWI is researching non-surgical methods of controlling fly strike. Since fly strike is much more prevalent in Merino sheep with wrinkly skin folds, Vandeleur says that "plain-bodied" sheep are now being bred.

Vandeleur says that the industry needs a more transparent supply chain and a processing "chain of custody," including documented certifications for organic wool and for sheep raised under an animal welfare code of conduct. "We need traceability from farm to topmaker," he says.

Saving Silkworms

"*Bombyx mori*, the mulberry or cultivated silkworm, has been raised for thousands of years and is now completely dependent on its human carers," says Deane. "The moths have lost the ability to fly and to see, and those who have kept them have seen more than one caterpillar that is starving, or even dead, because it is not willing, or able, to walk a couple of inches to a new bit of mulberry leaf"

Chakrabarti says that the silkworms cocoons are collected and thrown into boiling water to kill the worm inside so that the yarn can be spun from the cocoons. "About 15 silkworms are killed to produce a gram of silk and 1,500 silk worms are killed to get a meter of woven silk material," she says.

Chakrabarti says there is a new movement in silk called "eco-silk," Ahimsa silk, or Peace silk.



Silk worm.

Unlike regular silk, in Ahimsa silk, the silkworm pupa is allowed to mature and escape from its cocoon. "The cocoons are collected at this point and the silk is spun, mostly at village level production houses," says Chakrabarti. "Peace silk is not readily available like commercial silk and is more difficult to access, making it more of a sought after and exclusive silk."

"There are two main types of Ahimsa silk, cultivated and 'wild' (semi-domesticated)," notes Cook.² "Most cultivated Ahimsa silk is *Bombyx mori*. It is raised just like conventional cultivated silk, right up to the point where the cocoons would be stifled, or processed with heat, in order to kill the pupa and keep it from breaking through the cocoon. The Ahimsa cocoons are all allowed to hatch and breed, and the silk is processed from the hatched cocoons."²

Cook feels that the term "Ahimsa" is a misnomer, because although the moths are allowed to hatch and are not killed, "the process require[s] the destruction of approximately 200-300 embryos or hatchling silkworm per moth, for any amount that exceeds what is required for the next crop. Instead of killing one pupa for the silk of the cocoon, it kills hundreds of caterpillars. While it may be true that the individual caterpillar that spun the cocoon didn't die inside it, its offspring will have to be ruthlessly culled," says Cook.²

Since gathering and processing Ahimsa cocoons is more labor-intensive, Peace silk is more expensive than regular silk. However, because the moths are allowed to hatch, Ahimsa silks have shorter fibers, not the long single strand harvested from traditional (reeled) silk cocoons.

Other moth species used for Ahimsa silk include *Samia ricini*, the Eri silk moth, *Antheraea pernyi*, the Chinese Tussah moth, *Antheraea mylitta*, the Indian Tasar moth, and *Antheraea assamenisis*, the Muga moth.² While Eri silk moths are fully domesticated, and raised similarly to *Bombyx mori*, according to Cook, the Tussah and Tasar moths are “traditionally raised outdoors on plantations of food trees, which are watched carefully to protect the caterpillars from predation and damage.”²

Deane considers these “wild” moth species to be the source of eco-silk. “They are, of course, farmed, but in a manner that allows the caterpillars to live on the trees as they would in the wild,” she says. Dean says these moths have not traditionally been reared in “industrial quantities and have therefore kept their natural behavior...and are less subject to disease than their cultivated cousins.”

“Wild” moth cocoons typically are gathered after the moth has emerged. “Most of these caterpillars produce silk that is colored by the tannin from the leaves on which they feed. They may also produce a cocoon that is broken thread, unlike *Bombyx mori*, whose cocoons are spun in one single thread and which commercial silk reeling machines have been designed to exploit,” says Deane.

Cook feels that calling these moths “wild” is also a misnomer. “Wildcrafting has a specific meaning—harvesting from an untended wild environment,” he says. “If you plant something and then pick it, it’s agriculture. ‘Wild’ Tasar and Tussah silks are not wildcrafted, they are farmed...their reproduction is controlled, the caterpillars are taken to their food plants, and the cocoons are picked like fruit once the worms are done spinning. They are watched over, similar to how sheep or goats are reared in open pasture.”²

Price

“Natural fibers usually require more artisanal hands to develop into fabrics and are more expensive as the extraction process is more labor intensive. Synthetic fibers are generally machine-made and efficiency of production is much higher, making them a low cost product choice,” notes Chakrabarti.

Because natural fibers are harvested from plant, animal, or insect sources, they are also subject to the vagaries of Nature. Floods, droughts, and other natural disasters can affect the fiber supply. The current situation with high raw cotton prices is

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Degummed versus raw silk.

57% of consumers are willing to pay more for natural fibers.

—Data Courtesy of Cotton Incorporated, Lifestyle Monitor survey: January–September 2010.

due to a decreased supply because of poor harvests, combined with higher than usual demand. “Currently, higher cotton prices are leading growers to plant more cotton and less alternative crops like soy

or corn. Once the harvest from these additions to world cotton acreage become available next fall, it could be expected that there will be some weakening in prices,” explains Cotton Incorporated economist, Jon

Devine. “In the immediate future, manufacturers and retailers can expect some lingering pricing volatility, at least until the cotton crop year has ended and analyses of ending stocks and projected plantings for the next crop year can be made with more authority.”

Wool is also at a very high price. Popescu says that the price will stay high because of increasing demand and “not enough wool in the pipeline.” The wool supply is at its lowest level since 1925, says Vandeleur, and production is still declining. “Wool is only 2% of the world’s fiber market,” he says. “Australia dominates the Merino market, and, with 73 million sheep, produces 230 million clean kilos of wool per year.” Collie says the New Zealand sheep farming industry has also been in decline. “New Zealand raised 70 million sheep in the 1980s, down to 30-35 million today,” he says.



COTTON INCORPORATED

Silk was never inexpensive, but this luxurious fiber is rising in price as well. “Silk production in the Far East is coming under pressure, as many other natural products are, from increasing industrialization that leads to loss of habitat. Silk farmers are moving from their traditional lifestyles to work in factories, sometimes as a matter of choice, sometimes because their mulberry plantations are removed to make way for modern industrial complexes,” says Deane. “It has been predicted that silk prices will rise by approx 25% in 2011.”

“Cotton is getting a lot of attention because of the rapid price rise,” says Messura. “However, over the long term, polyester, cotton, and rayon prices are all strongly positively correlated—the prices all move up together.”

“Based on consumer survey data from the fourth quarter of 2010, the top five drivers for any apparel purchase are fit, comfort, price, quality, color, and style,” says Martin. “Quality is likely to move higher up the ladder for consumers, as a range of economic factors such as 15 years of deflationary apparel pricing, and rising fuel, raw fiber, and labor costs conspire to increase the cost of clothing at retail.”

The volatile natural fiber prices highlight the fact that the entire textile industry depends on its basic element—the fiber. Natural fibers are wonderful, but they don’t—they cannot—meet all the world’s fiber needs. “Currently the demand is 9 kilos of fiber per person per year,” says Popescu. “But, looking forward, we anticipate a demand of 17 kilos of fibers per person per year.” The production of natural fibers is *declining*, not rising. Over the long run, the market will require the use of many different kinds of fibers, says Messura. “No one can produce only one fiber type to meet all needs.” 

What about the *other* natural fibers? See the May 17 edition of *AATCC News* for more information about natural fibers. For a free subscription, visit www.aatcc.org/media/subscribe/newsletter.

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