In recent decades, the textile industry has begun to face up to its responsibility to the environment and to evaluate the impact of its products and processes. If the environment is important, what is the best approach to preserving it? Where should our industry start? For some, the logical place to begin is where the fabric starts—with the fiber.

Depending on its intended function and end-use, a fabric can be made from natural, synthetic, or man-made fibers. Natural fibers, including cotton, wool, silk, and flax, usually come from plants or animals. Synthetic fibers are often petroleum based—for example, polyester, acrylic, or nylon. Man-made fibers may use natural raw materials, like corn sugars or wood cellulose, to manufacture fibers like viscose and lyocell. All fibers, however, are not the same, environmentally speaking.

Natural versus synthetic? Renewable versus recyclable? Debate in the textile community over which kind of fiber is more “green” can go on forever. The reality is that consumers pay the bills, and they are unlikely to give up entire classes of textile fibers. The real issue is how to minimize the environmental “footprint” of each kind of fiber, while retaining the performance, comfort, and aesthetics that consumers demand.

**Chlorophyll—it’s naturally green**

Organic or Not?
The big question in natural fibers is—organic, or not organic? Producing natural fibers can have significant environmental repercussions. Theoretically, any natural fiber can be grown organically.

The most common natural organic fibers are wool and cotton. Holly Givens, public affairs advisor for the U.S. Organic Trade Association (OTA), says that for organic wool, “Farmers follow organic livestock production standards. The sheep receive organic feed, no growth hormones, and have access to outdoors, with living conditions appropriate to their species.”

For cotton, organic cultivation means the crop is grown according to organic farming principles originally developed for food production. “Fibers grown to organic principles are better for the environment. Organic farming eliminates the use of chemical fertilizers, pesticides, and genetically modified organisms (GMOs), which improves human health, and also the fauna and flora within the farm environment,” says Environmental Manager Tracy Mak, of Instyle Contract Textiles Pty. Martin Guerena, program specialist for the U.S. National Center for Appropriate Technology (NCAT), which manages ATTRA, the National Sustainable Agriculture Information Service, says that organic farming introduces crop rotation and improves the quality of the land.

**Organic versus Conventional Cotton**

Currently, the organic fiber with the most interest from brands and retailers—and also with the most controversy—is organic cotton. According to Roy Cantrell, vice-president of agricultural research for Cotton Incorporated, organic certification refers to the process of growing the fiber. Physically, organically-grown and conventionally-grown cotton fibers are identical. “When you analyze the fiber there’s no difference,” notes Cantrell. “No performance difference, no difference in strength.”
Since there is no direct test of the fiber that can prove it's organic, the onus is on the source to provide correct certification to prove a cotton's pedigree. Because of large retailers' demands for organic cotton, Mark Messura, Cotton Incorporated's executive vice-president of global product supply chain, is concerned that organic growers' product will be counterfeited. "The total volume of organic cotton produced is approximately one tenth of a percent of total cotton, yet the organic fiber can bring 50%-100% more in price. Since there is no physical difference to distinguish these fibers, the situation is ripe for fraud."

Is organic cotton, indeed, better for the environment? Messura says that in some situations, yes—but not always. "Organic cotton may not be sustainable in large-scale production situations since it requires more arable land for the same volume of crop production," says Messura. "And it's not just production efficiency," Cantrell explains. "Conservation tillage practices that prevent soil erosion are difficult to implement in an organic system because tillage is often needed to control weeds."

Phil Wakelyn, consultant to the U.S. National Cotton Council, says that both organic and traditional cotton can be sustainable. "For example, if you can say that certain chemicals aren't used on the crop, you're entitled to use the EU Eco-label. Many conventionally-grown cotton crops are entitled to use the Eco-label." Wakelyn says that cotton has such high insect and weed pressures that there are only a few places in the world where it can be grown without synthetic pesticides. "Producing an agricultural commodity like cotton is very high-tech today," he says. "Growers use global positioning systems (GPS) to track how much water their crops need, and integrated pest management (IPM), including biotechnology." Cantrell notes that GMO seed varieties have dramatically reduced pesticide use—by more than 50% in the last 15 years, in the U.S.

**BASIC Cotton**

If organic cotton is not feasible for large-scale production, but the synthetic pesticides and GMOs of conventional cotton production do not seem environmentally friendly enough, is there a third option? Experts on both sides of the issue mention the BASIC cotton program.

Lynda Grose, designer, educator, and consultant to the U.S. State of California's Sustainable Cotton Project, says Sustainable Cotton's BASIC Cotton program works with conventional farmers to reduce chemical use on their cotton fields. "The BASIC Cotton program draws from biological agricultural systems, thus reducing chemical inputs," says Grose. BASIC is also non-GMO. "We don't want to close organic markets to the farmers."

On the other hand, BASIC cotton is not the same as certified organic cotton, although some farmers use it as a stepping-stone to organic production. "The cost of production to grow organic cotton in California is high," says Grose. "Furthermore, the yields are 50% that of conventional cotton. Per pound of cotton, organic is a thirstier crop than conventional. BASIC yields the same as conventional cotton and is a less thirsty crop than organic."

There were 100 acres of organic cotton grown in California in 2006 and they reduced chemical use by 850 pounds, according to California Environmental Protection Agency (EPA) Department of Pesticide Regulation (DPR) data, says Grose. In contrast, there were 1200 acres of BASIC cotton grown, reducing chemical use by 12,500 pounds. "We're finding BASIC is a much more effective vehicle than organic for achieving environmental gains," she says.

**Sustainability**

Many people feel that organic cotton is substantially better for the environment. However, the production of the fiber is only one aspect of the final textile product's environmental friendliness.

Sustainability is an approach to environmental stewardship that looks at the full environmental impact of the systems and processes over the lifetime of a product, not just at one aspect. Owen Hammond, vice-president of operations for sock manufacturer Teko, says "you need to look further than organic to be sustainable. Just because a fiber is organic doesn't mean the processing is sustainable."

The key point in the organic cotton debate, according to Phil Patterson, dyeing, printing, finishing, and colour manager for retailer Marks & Spencer, is that there isn't sufficient land available to produce everything organically. However, he feels that the debate about organic cotton is "useful in terms of highlighting important issues in conventional cotton production."
Olive Green—standards make organic palatable

"Something is only organic because someone says it is," notes Geoff Collins, marketing and sales manager for Lenzing Fibers. Graham Burden, sustainable textiles & cotton specialist at Marks & Spencer, says retailers and brands have to be careful choosing their supply chain partners. "Labeling and tracing are [big] issues," says Burden. "You're relying on a lot of paper documents and trust."

"All organic standards originated with local demand," notes William Lana, chair of the U.K. Soil Association's textile standards committee. Therefore, most countries have at least one organic standards association, if not several, as well as some private and international organizations. Most legitimate organic standards associations are accredited through the International Federation of Organic Agriculture Movements (IFOAM). "If the organic fibers are certified through a recognized organic certifying body—IFOAM accredited—then the claims are likely to be real," says Mak.

Grace Gershuny, OTA's representative on the Global Organic Textile Standards (GOTS) technical committee, says no matter where it's grown, a fiber needs to meet the regulations of the importing country to be labeled organic. Lana reminds us, however, that "Textiles, more than food, move across boundaries. The textile industry is global." There is widespread support in the industry for a global organic textile standard.

Even with the variety of organic standards organizations, all issues may not be addressed. Collins notes that Lenzing tried to have its lyocell fibers certified as organic, "but there isn't yet an organic standard for trees," he says. Instead, Lenzing uses raw materials (wood) from Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification Systems (PEFC) certified sources.

For some retailers, the social justice aspect is as important as the environmental stewardship aspect of fiber production. "Marks & Spencer is pushing for more fair trade cotton than organic cotton," says Burden. "We think this is something our customers understand at this point." Says Collins, "organic [certification] doesn't necessarily mean it's grown in a fair or ethical way."

Even if customers are happy with 100% certified organic fibers, they may still have questions about the processing those fibers undergo. Guerena notes that organic fiber can go through the same processing as conventional fiber. One problem is the lack of availability of gins for organic cotton. "The gin must be cleaned out for organic or run exclusively organic," he says. "If gins run mixed organic and non-organic at the same time, the fiber can't be certified organic."

After a natural fiber leaves the farm, organic certification ends. Just because the fiber is grown organically, doesn't mean the final textile product is environmentally friendly, whether that product is a T-shirt or a ball of knitting yarn. Certifying environmentally friendly finished textile products is what the Global Organic Textile Standard (GOTS) has been formed to accomplish. While the standard is under revision, Gershuny says that it offers the possibility of a certified organic garment with a verifiable label. GOTS is an international standard with sponsors from the U.K.'s Soil Association (SA), the U.S. Organic Trade Association (OTA), the Japanese Organic Cotton Association (JOCA), and Germany's International Association Natural Textile Industry (IVN). According to Givens, GOTS will address all aspects of processing, dyeing, and finishing.

Sap Green—man-made fibers grow renewable

If natural fibers are not an option because of performance requirements, environmentally friendly option exists in renewable man-made fibers. "A renewable fiber...can be replaced within ten years or less...by natural ecological cycles," says Mak. Unlike synthetics, these fibers start with bio-based raw materials that are then processed into fibers. The resulting textile fibers may be bio-degradable, renewable, and sustainable.

Fiber From Trees

Viscose, a traditional man-made fiber, starts with wood cellulose but processing it into textile fibers involves the use of chemicals that can be significant sources of pollution, says American Fiber Manufacturers Association (AFMA) Vice-President Bob

Photo courtesy of Unifi. Used with permission.

The organic movement is consumer-driven. Designers and manufacturers are moving towards it because their customers want it. —Martin Guerena, NCAT

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Barker. "On the other hand, lyocell also uses wood cellulose, but the solvent is completely recoverable and reusable, and so much more friendly to the environment."

Because the "demand for cellulosic fibers will grow at a rate that cotton won't be able to fulfill," says Collins, lyocell is a very environmentally friendly option. "Fiber made from trees is CO₂ neutral," notes Collins. "It uses land in an efficient way, because you can grow trees where cotton can't grow. Trees also use less water to provide more cellulose per kilo of raw material [than cotton]."

Fiber From Corn

A more rapidly-renewable manmade fiber, polyactic acid (PLA), requires only a large scale sugar (dextrose) source as a raw material. Currently, manufactured PLA takes this sugar source from corn. Steve Davies, global marketing director of Natureworks LLC, says that PLA fibers have the best of both worlds. "It [has] the pedigree of a natural fiber but the performance of a synthetic fiber."

Theoretically, since PLA comes from corn stock, it could be organic as well. However, according to Davies, "The amount of organic corn out there isn't enough to meet our manufacturing needs." Natureworks will work with customers who have particular ecological concerns—European markets often don't accept GMO-sourced materials. Although most of the corn Natureworks now sources is GMO corn, "we will source certified non-GMO corn if our customer demands it," says Davies. "If necessary, we can provide third-party certification that there are no genetically modified materials in our polymer."

Hybrid Fibers

There are two man-made fibers available as environmentally friendly alternatives to polyester (PET): polytrimethylene terephthalate (PTT) and 3 glycol terephthalate (3GT). They are hybrids, containing both synthetic and bio-based components on a molecular level. "One component of these may be bioderived but the second monomer is petroleum derived," says Bob Peoples, director of sustainability for the Carpet & Rug Institute. The bio-based portion is from corn-sugars.

Dawson Winch, global product manager of fiber producer DuPont, says that their 3GT is 40% renewably sourced by weight. "It can be recycled by breaking it down to its original components and simply making more fiber," she says. Winch says the DuPont fiber takes 40% less energy to produce than a petrochemical polymer such as nylon, with 55% lower CO₂ emissions.

Emerald Green—recycling digs up synthetic treasures

Although often derided because they do not come from renewable bio-based raw materials, synthetic fibers can offer an environmentally friendly choice. "Just because something is bio-derived does not make it inherently better," says Peoples. "Likewise, with the development of more sophisticated forms of reuse and recycling, petroleum-derived materials may, in fact, have a smaller environmental footprint [than natural fibers]. Synthetic fibers came onto the scene for two basic reasons: reliable supply at a better price and functionality."

Dan Vandenvoort, research and development director for Fox River Mills Inc., says that recycled synthetic fibers are often a good environmental choice. "Recycled synthetic fibers send less waste to the landfill, and use less energy to produce than virgin [synthetic fibers]." Mak explains that, "any 100% synthetic fabric is theoretically recyclable. A recycled fiber or fabric is one that contains either post-industrial (pre-consumer) or post-consumer recycled content. Post-industrial refers to the proportion of a product made from industrial scrap from other production processes. Post-consumer refers to the proportion of a product that is produced from materials that have already been used by domestic or other commercial consumers."

Jean Pierre Simard, marketing director and director of sustainable strategy for contract fabric manufacturer Victor Innovatex, says that recycling products makes them "technical nutrients" in McDonough Braungart Design Chemistry's (MBDC) "cradle to cradle" design protocol—in which products are designed with environmental friendliness in mind right from the start. "A technical nutrient is a
material that remains in a closed-loop system of manufacture, reuse, and recovery, maintaining its value through many product life cycles,” explains Simard.

One of the most commonly recycled synthetic fibers is polyester. “Production of recycled polyester yarns is now mainstream and the yarn manufacturers are continuously improving the process,” notes Christopher Gibbs, marketing director of fabric producer Consoltext.

**Making Technical Nutrients Possible**

Recycling isn’t a magical solution. There are several issues still to be resolved. What if the material you intend to recycle is already dyed? “This obviously limits the applications for those recycled materials to those of a dark color or where color and finish may not be important,” notes Peoples. “An example is the recycling of nylon carpet face fibers and plastics into black automotive parts for under hood applications. The next form is to process these materials in such a way as to remove color—which opens up basically all outlets the virgin material would be used for.”

An important issue for recycling is the purity of the source material, or, as Gibbs explains: “Just because a fabric has recyclable content in its construction does not necessarily mean that the fabric is recyclable. To be considered recyclable, fabric (and the garments made from them) need to contain 100% of the same recyclable materials. Fabric (garments) employing a blend of materials cannot be recycled unless the recycled components are extracted first—a process that in some instances is impossible or too costly. From an economic point of view, 100% polyester is the most popular choice for recyclable materials on the market today.”

The homogeneity of the source material is necessary for a uniform, high-quality final product. Bett Anderson, marketing manager for yarn manufacturer Unifi, says that it is possible to make a first quality recycled product that can be incorporated into current dyeing and finishing processes. “Many people remember recycled products of the past that were considered sub-standard,” she says. “We have developed a product that adheres to first quality standards and can be processed the same as standard polyester.”

Then there’s reliability. “Manufacturers need to be assured of a safe, secure, and reliable source of supply,” notes Gibbs. “It is important to forge partnerships with suppliers that can guarantee consistency in quality over time.” Some manufacturers are trying to ensure a constant source of raw materials through “take-back” programs, where they accept the return of recyclable products. “For a take-back program to work, you need a critical mass of fabric,” explains Simard. There are complex logistics to figure out to ensure that the take-back program is economically viable to implement, or that it doesn’t use so many resources that using virgin material would be a more environmentally friendly choice in comparison. However, carefully planned take-back programs are possible. “The more we increase demand for post-consumer materials, the more take-back systems will grow,” predicts Simard.

Market expectations will always drive the demand for recycling. Currently, says Simard, the market expectation for recycling is “up-cycling.” Up-cycling refers to material that, after the recycling process, has an equal or higher value than the original material. Recycling a shirt into another shirt, rather than a carpet pad, for example. The ability to recycle a product into the same or a similar product, over and over again, would be ideal, but is not always feasible. “We strive for products made with increasingly sustainable manufacturing processes for closed loop, zero waste production systems,” explains Mark LaCroix, vice-president global sustainability for contract fabric producer Interface Fabric.

Finally, it is vital to ensure that the recycling process itself is environmentally friendly. It’s important not to focus so exclusively on recycling as to become unaware of the bigger environmental picture. “Some recycling processes are energy intensive, so may be environmentally negative,” says Barker. “If you’re talking post-consumer waste, the energy used to transport the recyclable waste can be a significant issue. You may end up using more energy recycling than by using virgin product.”
Jade Green—manufacturing makes it beautiful

Turning an organic, renewable, or recycled fiber into an environmentally friendly fabric is a challenging proposition. So much of the textile manufacturing process is environmentally unfriendly. The chemicals or processes used to perform many common textile manufacturing tasks must be modified. Sometimes only more expensive chemicals enable manufacturers to produce a more environmentally friendly fabric.

Dyeing is one focus of environmental concern. The common assumption is that natural dyes must be more environmentally friendly than synthetic dyes. Ironically, "natural" does not automatically mean "environmentally friendly." The environmental impact of natural dyes can be worse than that of their synthetic equivalents. (For more details, see our sidebar, "What Dye Would You Like with Your Organic Cotton?")

John Easton, marketing & innovation textile services—ecology solutions manager of dye manufacturer DyStar, notes that his company works with organic textile standards organizations to list the synthetic dyes that can be approved within their criteria. He feels that "the people who set these standards are knowledgeable about growing things, but don't know as much about textiles." A number of dyes containing more than one percent AOX were ruled out for the list. "They don't make any distinctions between pigment colors that stay on the fabric or vat-dyes where fixation is 100% and reactive dyes where there could be some impact on wastewater," says Easton. "Many vat dyes have chlorine or bromine in their chemical structure, but those chemicals fix completely on the fabric and don’t go into the effluent."

Additionally, in the zeal to achieve a more environmentally friendly fabric, both standards organizations and consumer brands should consider the complete lifecycle of a fabric and the basic tenant of sustainability—a product is not sustainable if it won’t perform its intended function, or if nobody will buy it. "Consumers want organic [i.e., environmentally friendly] but don’t want to sacrifice appearance, performance, or cost," notes Easton. A drab, wrinkly garment may be left unsold on the store shelf, and waste all the resources that were invested in its creation. "GOTS do not permit the use of optical brighteners," notes Patterson. "That closes off 30% of the market. The GOTS standard doesn’t allow the use of easy-care finishes or performance finishes."

While that may make an initially more environmentally friendly fabric, it doesn’t take into account the preferences of consumers.

Electric Green—marketing makes environmental efforts stand out

A concern for environmental responsibility often arises from companies genuinely concerned with social responsibility, notes Messura. "But some companies are just jumping on the marketing bandwagon."

In the rush to market their environmentally friendly fibers and fabrics, some companies stray into "greenwash" (making unsubstantiated claims). "Greenwash is rampant," says Mike Italiano, CEO of Market Transformation to Sustainability (MTS). "There is a big demand for sustainable products. Manufacturers want to provide that and the competition is fierce."

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**APEXICAL**

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Developing products to the Triple Bottom Line is good for the environment and human health, and is economically viable. —Jean Pierre Simard, Victor Innovatex

There is a responsibility to educate the customer in marketing environmentally friendly products. However, there is a fine line between education and over-promotion. "As with any new trend, there will be exaggerated claims regarding derivation, features, and benefits. The marketing challenge is to not over-promise and under-deliver," says Jonathan Erb, marketing director of natural fiber producer TrapTek LLC.

Pricing is also challenging. "Organic fibers are sold at a higher price than non-organic fibers," says Mak. "It's a challenge to develop an eco-friendly textile at a certain price point because the market is generally unwilling to pay more for an eco-friendly product." Charging a premium for environmental friendliness is a problem because consumers won't pay a premium for it, although they may prefer it. Messura says that in 2003 Cotton Incorporated conducted a joint market research study with the OTA of people [in the USA] who bought organic cotton clothing. They found that only 4% of consumers bought it because it was organic.

Viridian Green—the future of environmental responsibility

"The whole process of achieving sustainability is a journey," notes Peoples. The textile industry has already begun to meet consumers' demands for good environmental stewardship. However, mistakes and missteps are bound to happen along the way—like focusing on one aspect instead of the whole problem. Peoples feels that focusing on a single environmental attribute—such as fibers—may not be the most effective approach to achieving sustainability. "There is not a 'one size fits all' answer to sustainability. We need to shift our thinking from prescriptive approaches or standards to functional performance standards," he says. Patterson has seen a fundamental focus shift from single-attribute concerns like pollution or health and safety to overall sustainability, which he sees as a more well-rounded strategy. "The use of lifecycle analysis and impact assessments is now becoming sophisticated enough to be used to guide our development process. The goal is products that have a smaller and smaller footprint on our environment," says Peoples.

LaCroix says his company focuses on the triple bottom line as described in the book Cannibals with Forks by John Elkington: the economic bottom line, human capital, and environmental capital. "Our industrial systems are wholly-owned subsidiaries of the
environment," says LaCroix. "Managing a business to the triple bottom line means measuring the benefits or costs to these three bottom lines—everything impacts these three systems. We have to redesign commerce so that every product has no externalized costs—because every time a company pollutes, somebody else picks up the tab."

Patterson makes the analogy of "graphing the amount of good that you are doing." Focusing on one eco-friendly element, like organic fibers, "creates spikes of goodness, verging on perfection, but at very low volume." Such spikes of goodness can’t be perpetuated on a large scale by the rest of the world—they serve a purpose by drawing attention to the issue, but they don’t resolve the overall problem. On the other hand, another approach is to "increase the overall level of goodness incrementally, which gives general improvement, at a very high volume." Collins says when large retailers like Marks & Spencer, Wal-Mart, or Ikea, or brands like Nike, get involved in environmental concerns, "it moves the baseline up" and makes more of a global impact. "It’s important to do the right thing, but also to do it in a way that is commercial and profitable," he says. Because that’s the way to ensure that it keeps being done. "Make a choice for the better, even if it’s not perfect," says Collins.

"There is no one company who has this figured out," adds LaCroix. "We point to our accomplishments but look at our challenges. Sustainability is a competitive strategy for us. This is our key differentiator in the marketplace; it’s how we supply more than just a yard of fabric."

Concern for the environmental has led to a growing interest in organic cotton. If you are thinking of buying and using organic cotton, you may also want to consider the nature of the dyes you will use to color it.

Natural Dyes
The plant dyes discovered centuries ago are a "natural" option, but natural does not always mean "good!" You may already know that there are several types of berries and other "natural" products that can kill you or make you ill. With natural dyes, you will need to consider that additional chemicals are required to make the dyes work, or stay where you put them. Mordants are used to fix the dye into or onto fibers. Most of these mordants contain metals that adversely affect the environment and human health. (There are more environmentally-friendly mordants you can use, such as cream of tartar and alum.) The most toxic of the metallic mordants is chrome, others include iron, tin, and copper.

Another consideration with natural dyes is the amount of dye actually needed to color a fabric. In many cases, it requires equal-weight ratios of dye to fiber—much higher than the ratios used for synthetic dyes. It would take a substantial amount of land and machinery to cultivate the vast numbers of plants required to produce sufficient quantities of natural dyes and large amounts of petroleum to operate the machinery. On a commercial scale, this is neither an ecologically or economically sound option.

Synthetic Dyes
Synthetic dyes pose some of the same challenges as the natural dyes but may actually cause less harm to the environment. Some contain toxic metals that are discharged into the waste stream along with large amounts of salt and other additives.

Currently, fiber reactive dyes are the preferred synthetic dyes for organic cotton because some are considered to have a low impact on the environment. These low-impact dyes generally do not contain heavy metals, do have a fixation rate of at least 70%, and are applied at lower liquor ratios and at lower temperatures. These dye features mean the dyeing process requires less water, less energy to heat the water, and smaller amounts of auxiliary chemicals. Such synthetic dyes provide a wide range of bright colors that can not typically be achieved with natural dyes.

Even low impact dyes are not without environmental impact. Fiber reactive dyes are produced from petrochemicals and the water discharge still contains salt, additives, and unfixed dye. Fiber reactive dyes are more expensive than some other cotton dyes, but reduced energy consumption helps balance the cost.

Clearly, there is no completely environmentally-friendly dye currently available for commercial use. Natural dyes, while conceptually pleasing, are not environmentally-friendly or practical on a large scale. Both natural and synthetic dyes pose environmental concerns. Low impact fiber reactive dyes are probably the best compromise for the present.

References