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A Focus on Cotton Sustainability

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Introduction

Sustainability is a concept that is misunderstood and misused by many. Concern for the environment is legitimate and must be viewed from the perspective of sustainability. There is great diversity among farms and farmers within the U.S. and around the world. Growing environments and the biological challenges to cotton production can differ dramatically. There is not a single package of "guidelines" to implement for sustainability. The retail trade and brands have brought considerable attention recently to sustainability, often associated with discussion of organic cotton. The challenge of sustainability in cotton production is quite unique compared to other crops since there clearly is a competing product or textile fiber manufactured chemically from synthetic compounds, often from petroleum based products. If an affordable global supply of cotton is not reliably grown, it will be displaced by synthetic manmade chemical fiber. That is not the challenge for any other major agronomic crop. Sustainable production must supply global demand for natural fiber and food today and in the future, the environment and natural resource base upon which the agricultural economy depends must be maintained, and finally it must sustain the economic viability of farm operations.

The Importance of Sustainability

A focus on sustainability should be welcomed, since this is an opportunity for cotton to be truly recognized as a natural, biodegradable, and renewable fiber compared to synthetic man-made fibers. Figure 1 illustrates a growing demand for all textile fiber. This includes man-made synthetic fiber, cotton, wool, and other types of fiber. It's projected out through the year 2014 to show an annual growth rate, very conservatively, of approximately 3-4% per year. In 2006 and beyond, world income and population growth will stimulate a 4.5 billion pound increase in global fiber demand each year. That increase equates to enough fiber for approximately 8.6 billion t-shirts or 2.3 billion pairs of denim jeans.

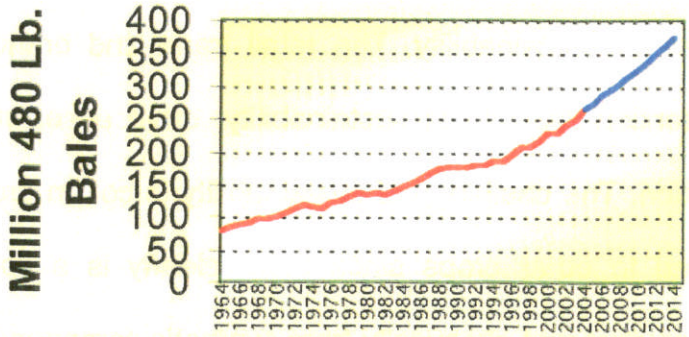

Figure 1. Global demand projection for all textile fibers.

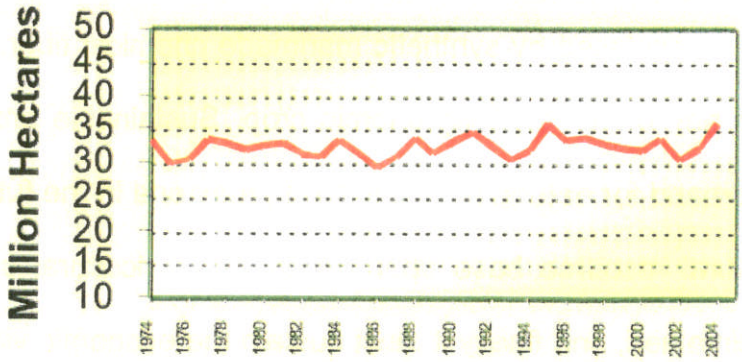

Figure 2. Global land area devoted to cotton production.

Supplying this growing demand in a competitive market with synthetic fiber will not be met by increasing the global area grown to cotton (Figure 2). From 1974 to 2004, the number of hectares in cotton production globally has been in the range of 30 to 35 million hectares. Area of cotton cultivation may shift and vary globally, but will likely never get significantly higher than 35 million hectares. Modern technology has allowed cotton to supply the market an affordable natural fiber with virtually no increase in land. In 2004, the world production of cotton was about 22 million metric tons, compared to about 38 million metric tons of synthetic fibers that were manufactured (chemical fibers). The trend in cotton vs. synthetic fiber production globally is shown in Figure 3 from 2000 – 2004, and it illustrates the dramatic increase in the manufacture of chemical synthetic fiber and the slight increase in productivity of cotton. The key message here is that the alternative to efficient and sustainable production of cotton globally, using all modern technology, is man-made chemical fiber. If you don't use the most modern technology to grow cotton on the 30-35 million hectares, then the alternative is a supply of man-made chemical fiber.

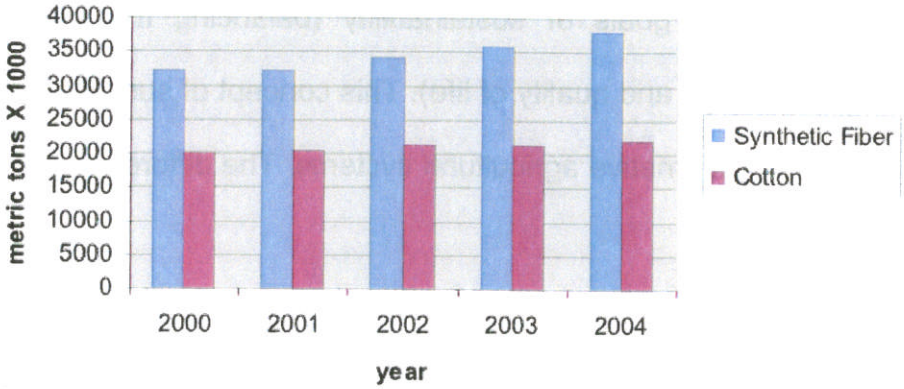

Figure 3. World production trends of synthetic fiber compared to cotton production (Source: Fiber Organon, published by the Fiber Economic Bureau).

Can the demand be met by organic cotton? The organic label is being used to differentiate textile products in the retail marketplace. Data provided by the Organic Exchange and the International Cotton Advisory Committee (ICAC) for 2005 states that world production of organic cotton was 115,000 bales. This is less than 0.1% of the world's cotton production devoted to organic cotton. All global organic cotton production in 2005 would fit on a single modest sized cargo ship! Organic cotton is likely to remain in very small niche markets due to the lower production capacity of organic cotton compared to conventionally grown cotton in similar environments. Typically, there is greater than a 30 percent yield penalty with organic cotton that is seldom offset by price premiums (Wakelyn and Chaudhry, 2006).

Sustainable agriculture – sustainable cotton production – tries to achieve three goals: to effect the environment in a positive way, to be economical and profitable, and to enhance the quality of life (Figure 4). The point where these goals intersect, in any given production system, is where the net effect comes the closest to meeting the goals of sustainability (balancing the effect on the environment, profitability, and quality of life). This concept of sustainability is very useful for comparing alternative agricultural systems. The differences are relative and not absolute.

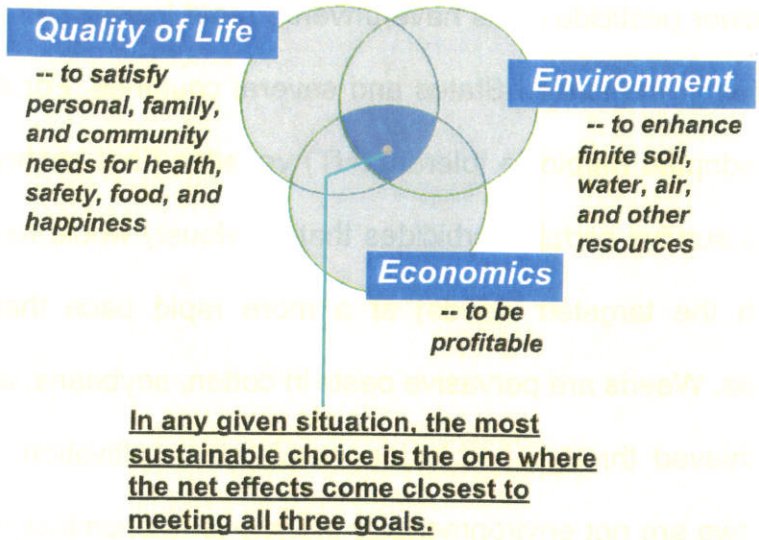

Figure 4. Graphical representation of sustainable production system.

Production systems that require significantly more land to maintain the same level of production, i.e. organic cotton, are seldom sustainable due to the adverse environmental effect on a finite land resource globally. Production systems that require significantly more labor to maintain the same level of production, i.e. organic cotton, are seldom sustainable due to the adverse social impacts on the quality of life.

Positive Environmental Trends Impacting Cotton Sustainability

Farmers are more likely to adopt new practices and technologies if they expect to benefit from them. Benefits are usually thought of in monetary terms, but can also involve ease of operation, time savings, lower exposure to chemicals, and other factors. Farmers choose technologies and practices they expect to yield the greatest benefit based on their own preferences, farm characteristics, demand for their product, and costs. Farmers' expectation of higher yields, savings in

management, and lower pesticide costs have driven a rapid increase in adoption of GMO crop varieties in the United States and several countries. For the most part, farmers have adopted herbicide tolerant (HT) varieties (that control weeds by enabling crops to survive certain herbicides that previously would have killed the crop along with the targeted weeds) at a more rapid pace than insect resistant (IR) varieties. Weeds are pervasive pests in cotton, soybeans, and corn. Weed control is achieved through herbicides, mechanical cultivation, or hand weeding. The latter two are not environmentally friendly or economical, with high fuel and equipment prices and availability of hand farm labor. IR crops contain a gene from the soil bacterium *Bacillus thuringiensis* (BT) that produce a protein toxic to cotton pests, such as tobacco budworm, bollworm, and pink bollworm. Cotton farmers planted BT cotton on 52% of the U.S. acreage in 2005. They have adopted HT cotton on approximately 58% percent of U.S. acreage (Figure 5).

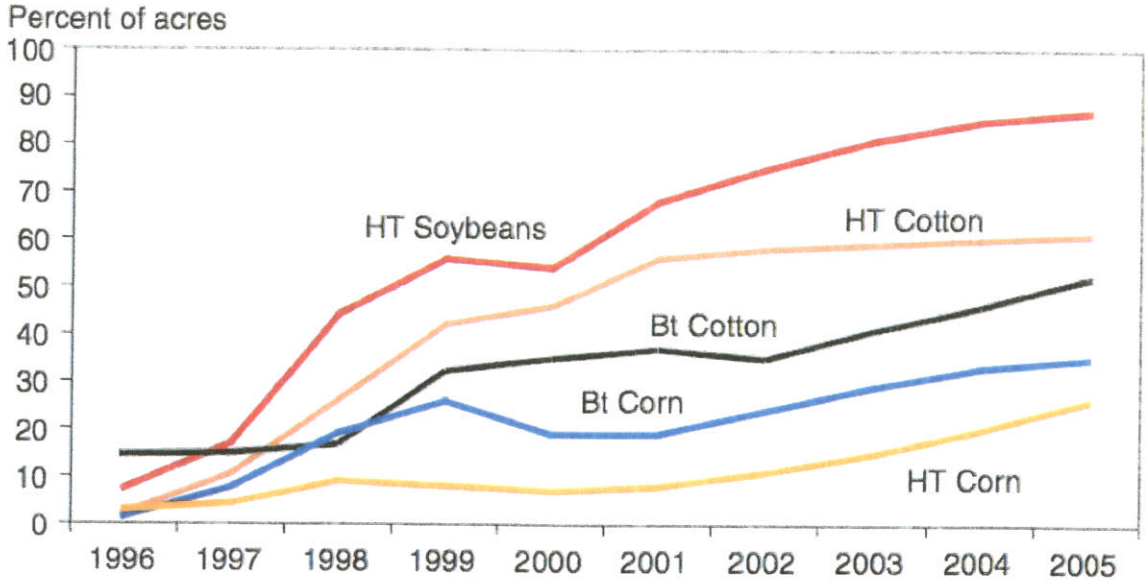

Figure 5. Trends in biotech crop adoption in the U.S. (Fernandez-Cornejo, 2005).

Positive environmental benefits are related to adoption of modern technology (Fernandez-Cornejo and Caswell, 2006). A 2-yr farm-scale evaluation of 81 commercial fields in Arizona shows that the use of transgenic BT cotton (GMO) significantly reduces insecticide use (Cattaneo and et al., 2006). Another critical finding was that BT cotton improved biodiversity in the cotton fields. This means that beneficial and non-target insects can flourish in BT cotton fields (Figure 6).

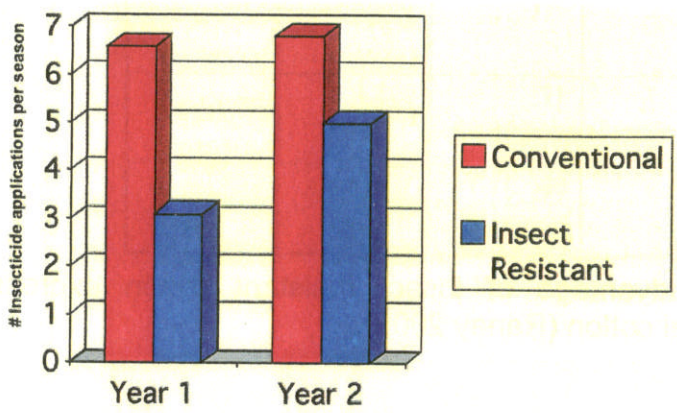

Figure 6. Positive Farm-scale Effects of Insect Resistant Cotton on Pesticide Use, and Biodiversity.

Table 1 summarizes the results from the most comprehensive economic studies of the farm-level impacts of Insect Resistant (IR) biotech cotton in developing countries (Raney 2006). Each of the studies was based on data from 2-3 seasons of commercial production. This data reflects the average percentage difference between IR and conventional cotton for all farmers over all seasons covered in the study. Although the averages conceal a high degree of temporal and spatial variability, they clearly indicate positive overall results. Farmers who adopted the transgenic varieties experienced higher effective yields (owing to less pest damage), higher revenue, and lower pesticide costs. These factors more than compensated for higher prices paid for IR seeds so that net profit increased for adopters.

	Argentina	China	India	Mexico	South Africa
Yield	33	19	34	11	65
Revenue	34	23	33	9	65
Pesticide Costs	-47	-67	-41	-77	-58
Seed Costs	530	95	17	165	89
Profit	31	340	69	12	299

Table 1. Performance advantage of insect resistant cotton expressed as percentage of conventional cotton (Raney 2006).

Consumers benefit from modern technology as well as farmers, seed suppliers, and technology providers. Biotech developers and seed companies benefit by

charging technology fees and seed premiums to adopters of modern varieties. U.S. and foreign consumers may benefit indirectly from biotech crops through lower commodity prices that result from increased supplies. USDA-ERS estimated the total market benefit arising from BT cotton and herbicide tolerant (HT) cotton (Price et. al., 2003). Total estimated benefit for HT cotton was $230M in 1997. This estimate includes the change in total welfare in both the seed input and commodity output markets. Surprisingly, adoption of HT cotton primarily benefits the consumer (Figure 7).

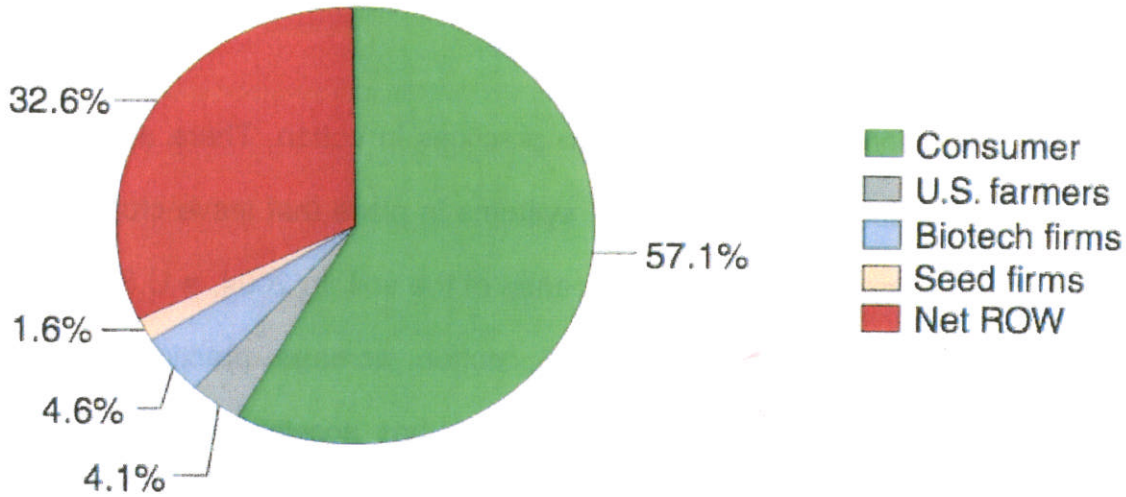

Figure 7. Stakeholder's share of the estimated total world benefit from adopting herbicide-tolerant (HT) cotton in 1997 (Price et.al. 2003).

Cotton producers are at the forefront of adopting modern technology for integrated pest management (IPM). Technologies in the U.S. and globally are being integrated, whether it be cultural practices, computer-aided management systems, biological control, precision agriculture, biotechnology, and genetics, before synthetic pesticides are used. IPM is defined by FAO (2002) as the careful consideration of all available pest control techniques and subsequent integration

of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. According to a USDA survey in May 2001, IPM was being practiced in over 60% of U.S. cotton acreage. Many of these technologies are being adopted in many regions of the world. IPM practices are incompatible with many organic cotton production systems because transgenic and synthetic pesticide technologies are excluded.

A revolution is ongoing in tillage practices in cotton. There are many forms of conservation, reduced or no-till systems in place that leave crop residue on the soil and limit mechanical disturbance of the soil. In 2004, a U.S. survey showed that approximately 60% of U.S. cotton acreage practices some form of conservation tillage. Modern technology has accelerated adoption of reduced and no-till cotton production. This is clearly demonstrated by the exponential increase in U.S. cotton no-till acres since 1996 (an increase of over 350 percent). Obviously, if you have less mechanical cultivation, that saves fuel and prevents soil erosion. The estimate is that about 306 million gallons of tractor fuel are saved per year due to conservation tillage in cotton (Average savings of $20 fuel & labor per acre). Another important aspect of conservation tillage is that it helps with greenhouse gases, CO_2, and global warming. With conservation tillage, plants take CO_2, which is a greenhouse gas, and through photosynthesis that

CO_2 is sequestered in plant material. Conservation tillage is great example of producers adopting a modern technology practice for profitability; it also has an accompanying positive environmental benefit.

Summary and Conclusions

Many have greatly distorted conventional and organic cotton production practices, particularly in the U.S., with outdated or false data. This is especially dangerous if presented in a context of organic being equivalent to or the only avenue to sustainability. In reality, sustainability has nothing to do with organic or conventional production; either may be sustainable. Rather than a narrow focus on niche markets of organic cotton, retail and brands need to recognize that cotton is a natural, sustainable, and renewable resource, and encourage its use over synthetic chemical fibers. The alternative to conventional cotton will not be organic, but will be synthetic chemical fibers. Globally, inputs remain a significant component of the variable costs of cotton production. As input costs are reduced, they often have a positive environmental benefit. Examples include: conservation tillage, biotechnology adoption for pest control, integrated pest management, and supplemental irrigation technology. Modern technology is essential for sustainable production of cotton. Conventional and organic cotton production can co-exist. Profitability will drive products in the supply chain and decisions by producers. In the U.S., data on production practices are routinely collected by numerous federal agencies. The production system in the U.S. is thus very transparent. An examination of U.S. production data and trends gives a glimpse

into the future for the rest of the world. Modern technology common in the U.S. is rapidly being adopted worldwide. So, many of the trends discussed in this paper will likely be mirrored in the future in other countries as they adopt this or similar technology.

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