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Perspectives on Traceability and BSE Testing in the U.S. Beef Industry

by DeeVon Bailey, James Robb, and Logan Checketts

The discoveries of a dairy cow in the state of Washington in December 2003 and a beef cow in Texas in June 2005, both infected with BSE, essentially removed any doubt that a better tracking method for animals and meat needs to be implemented in the United States. These tracking methods are often referred to as traceability. However, an important consideration evolving out of the pressure placed on the United States to develop some type of animal and meat traceability system is how to address consumer concerns about food safety related to BSE effectively without drastically disrupting the current domestic meat production and processing system. This article describes why farm-to-fork traceability is a difficult and costly task in modern, high-volume beef packing plants and also provides some insights based on survey data about consumer preferences for different tracking and testing methods to address food safety concerns relative to BSE.

The Emergence of a Two-Step Traceability Process in the United States

The dominant existing model for traceability is in the European Union (EU) and calls for farm-to-fork (linear) traceability systems for meat and other food items; a system many in the American food business currently consider either too costly to implement in the U.S. system or not justified by "sound science." For example, USDA estimates that implementing just farm-to-slaughter traceability for all program species would cost approximately $500 million over six years. Sparks Companies Inc. estimated that the initial capital investment required to implement a farm-to-fork system just for cattle in the United States would be approximately $140 million with an additional annual variable cost of about $108 million. Farm Foundation (2004) reports that American food firms would prefer a market rather than a regulated (such as in the EU) solution for traceability. Consequently, concerns about costs and flexibility appear to indicate that a model different than the EU's needs to be developed in the United States to address consumer concerns about food safety related to BSE while being cost effective.

The U.S. animal and meat tracking system is currently developing as a two-step process. The first step of this process is the eventual implementation of an animal identification system from farm to slaughter called the National Animal Identification System (NAIS). NAIS may be phased in as a mandatory system and full implementation is scheduled for 2009. The second step of the process would then have meat being tracked after it leaves the packing plant. This two-step approach creates a "break" in traceability at the processing plant.

Technical Challenges Associated with Linear Traceability for Beef

Robb and Rosa (2004) explain why a break in a two-step process would exist and also discuss some of the technical difficulties associated with a farm-to-fork beef traceability system in the United States. When beef packing moved from selling whole carcasses to selling cuts derived from primal cuts, the link between the identity of the animal(s) and beef cuts was broken. Transforming cattle into beef is a disassembly process. That is, rather than assembling inputs into a final product as is done in most manufacturing processes, an animal entering a processing plant is broken down into many parts or cuts and these parts are then reassembled with the same or similar cuts from other animals and then typically placed in a box for shipment.

Modern packing plants are complex incorporating skilled labor, mechanization, and government oversight at all production stages. The major stages involved in beef processing at a packing plant are illustrated in Figure 1. Cattle ready for slaughter typically are purchased from feedlot operators and then shipped to the processing plant.

Stage 1 at the processing plant involves slaughtering the animal as it enters the plant (Figure 1). The internal organs and hide are then removed from the animal and the carcass is split in two. These two halves are left hanging on hooks that are part of a trolley system that moves through the plant. In Stage 2, the carcass temperature is reduced and the carcass is stored in the plant's cooler. This is also the stage in which carcass grading typically takes place (Figure 1). In many cases, sorting in the cooler (Stage 2) results in batches of like carcasses (e.g., size and grade) to be subsequently processed as a group or "batch." As a result of BSE- induced regulations in the U.S., segregation of carcass groups may also be done based on animal age.

Stage 3 of the processing operation is the fabrication stage. The representation of Stage 3 in Figure 1 is a simplification, but understanding Stage 3 is important because it is essentially a "batch process." This means that groups of inputs such as carcasses or parts of carcasses enter the process separately but similar parts of the different carcasses leave in groups at the end of the stage. In Stage 3, the carcass leaves the cooler and is reduced into large primals (typically quarters of the carcass). During fabrication, parts of the carcass move in different directions in the plant while being further cut, trimmed, and sized. Many different butchers work on the different cuts and parts of the carcass as it moves through the fabrication stage of the production process. At each cutting stage of the fabrication process trim is collected from different carcasses. The fabrication process involves preparing the meat to meet customer specifications such as cut, size, grade, and other special requirements. USDA's Institutional Meat Purchase Specification (commonly called the IMPS code) indicates that there are approximately 30 beef products just from the loin, each with four standard weight ranges and 20 "portion cuts." This describes how many different cuts and specifications might be dealt with in the fabrication stage. The final stage in a typical U.S. packing plant (Stage 4 in Figure 1) involves moving boxes of cuts to coolers to await transportation to customers.

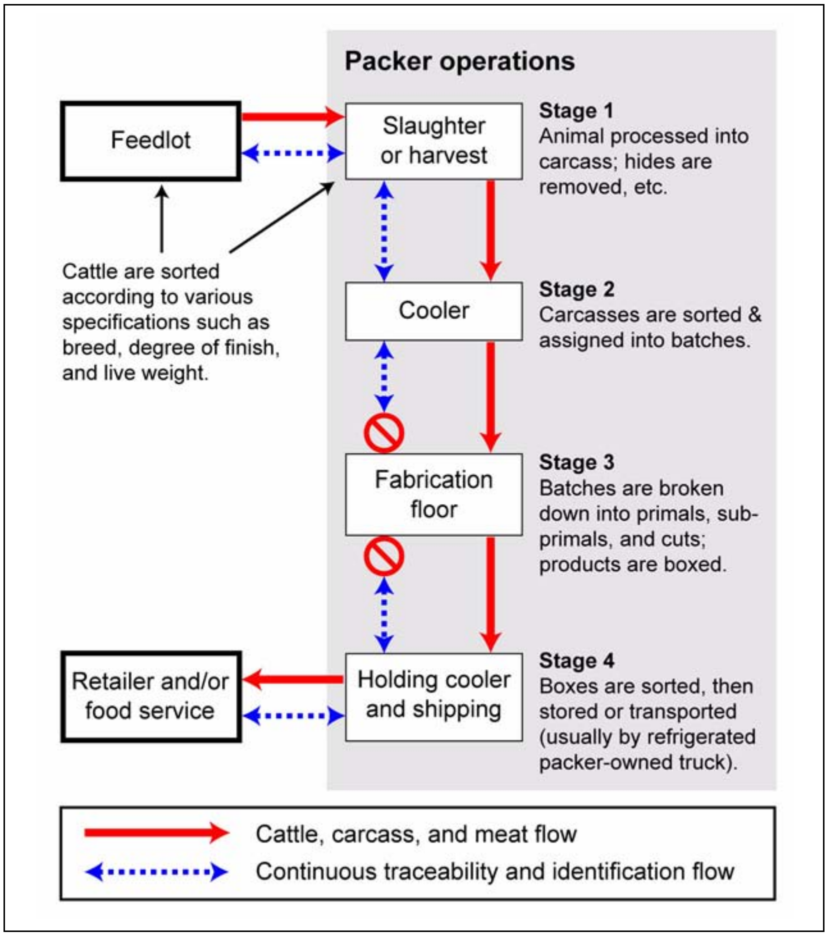

Figure 1. Schematic of wholesale (packer) sector stages and linkages.

Figure 1 illustrates that the breakdown in linear traceability between the animal's carcass and the beef exiting the processing plant is in the fabrication stage. Tracking within processing plants can be accomplished to the carcass cooling stage relatively easily if technology is invested in to connect animal ID information to a microchip embedded in the hook carrying the carcass through the plant on its trolley system. Tracking meat once it is in the box, to the end user is also relatively easy using bar coding on boxes or some other type of identification method.

Farm-to-fork traceability assumes that information flows forward with the product through the production stages and can also be followed back through the production stages. The speed and volume of meat moving through large U.S. packing plants makes tying individual cuts moving through the fabrication floor and into boxes back to animals entering the plant virtually impossible with current commercial scale technology. With effort and investment, fabrication stage tracking on a batch or time basis can occur. This is most easily done for whole muscle meat cuts (e.g., steak), but further processed items like mixed and ground trim components (hamburger) present even more traceability problems.

Testing and Traceability

Obviously, significant technical issues need to be addressed if farm-to-fork traceability were to be implemented in the U.S. beef system. In the meantime, testing protocols designed to ensure safety against BSE and other food-borne diseases are used to justify the break in traceability that exists in high-volume beef packing plants. The theory is that if protocols based on biological and statistical probabilities are in place to establish food safety for meat before it leaves the packing plant and the meat is deemed safe, then there is essentially no need from the perspective of food safety to maintain the link between the animal entering the plant and the meat leaving the plant.

Testing in the beef processing system is a standard statistical practice for monitoring procedures (e.g., testing for *E. coli*). The World Organization for Animal Health (OIE) recommends standards intended to help countries manage human and animal health risks related to BSE. Recently, the OIE recommended that "deboned skeletal muscle meat [excluding mechanically separated meat] from cattle 30 months of age or less . . ." should not require any BSE-related conditions (e.g., tests) for trade (see http://www.oie.int/downld/SC/2005/bse_2005.pdf). This standard also assumes that all specified risk materials (mostly related to the animal's central nervous system) have been removed and that no contamination of the meat by specified risk materials occurred. This suggests that a two-step system with a break in traceability at the processing plant can be justified especially for animals less than 30 months of age by OIE standards.

However, BSE testing protocols are often discussed as providing an enhanced consumer assurance attribute even if OIE standards indicate that BSE testing is not required. An example would be the recent trade negotiations with the Japanese to resume importing beef from the United States. Currently, the Japanese test 100% of the animals entering domestic beef production for BSE and other countries, such as in the EU, practice random BSE testing within the general slaughter population.

The testing program for BSE in the United States is undertaken by the USDA, Animal Plant Health Inspection Service (APHIS), which conducts non-random testing for BSE with cattle considered to be in the "high-risk" population. The high-risk population is defined as those animals exhibiting clinical signs involving the central nervous system that could be consistent with BSE and also dead and non-ambulatory cattle where such clinical signs can not be evaluated (see http://www.aphis.usda.gov/lpa/issues/bse_testing/faq.html#highrisk). As indicated, the APHIS testing program is in contrast to systems in other countries. However, APHIS states that their testing program would be able to detect one animal with BSE out of 10 million with a 95% level of confidence.

Consumer Acceptance of Different Traceability and Testing Protocols

Consumer acceptance of a two-step tracking system and the effectiveness of BSE testing are central questions to the appropriate development of animal and meat tracking systems in the United States. This stems from the implicit assumption within a two-step system that consumers will accept current "science-based" testing protocols. An additional assumption of the two-step system is that any further efforts to establish farm-to-fork traceability or expanded testing should be left to the private sector's ability to exploit any existing market opportunities. The private sector may also have non-price incentives for establishing farm-to-fork traceability or expanded testing such as developing or maintaining brand image or equity, identifying production efficiencies, and/or limiting product liability.

Missed Market Opportunities?

Research and anecdotal evidence suggest that marketing opportunities may exist for meat products with assurances beyond those offered by the two-step system; including farm-to-fork traceability (Dickinson & Bailey, 2002, 2005). Also, some American meat companies have considered differentiating meat products based on expanded BSE testing protocols. However, USDA has resisted efforts by private U.S. firms to establish and market products based on BSE testing protocols that exceed the APHIS and OIE standards, thus creating a seeming dichotomy between government-conducted scientific testing and what might be the preference of a significant number of consumers. From a marketing perspective, this raises the question of whether or not consumers are equally as happy with a two-stage process as they would be with farm-to-fork traceability. It also raises the question of whether or not consumers are equally willing to accept current government BSE testing protocols as they would be with either farm-to-fork traceability or expanded BSE testing.

Willingness to Pay for Traceability and Enhanced BSE Testing

A survey recently completed by Utah State University asked participants their hypothetical preferences for farm-to-fork traceability compared to a two-step tracking process with either the possibility that BSE tests were performed on the animal producing the beef (the system being implemented in the United States) or the guarantee that a BSE test was performed. The survey was conducted with consumers near supermarket meat counters in December 2004 and February 2005 in a small city (Preston, Idaho), a small to mid-sized city (Logan, Utah), and a larger city (Salt Lake City, Utah).

Each survey participant was asked for his/her hypothetical preferences if given a choice between a baseline USDA-inspected beef steak that might have been tested for BSE (i.e., the possibility that USDA testing for BSE might have been performed on the animal producing the steak) and three other steaks with enhanced characteristics offered at the same price as the baseline steak. If the enhanced steak was preferred, the respondent was then asked to indicate how much more he/she would be willing to pay, if anything, for the enhanced steak compared to the baseline steak. Each respondent was told that they should consider their responses based on the baseline steak being part of a two-stage tracking system. The choices were done in a pairwise fashion, with each of the three enhanced steaks being compared one at a time with the baseline steak. One of the enhanced steaks was traceable to the farm level and, just like the baseline steak, the animal producing the steak also might have been tested for BSE (Steak 1), another was traceable to the farm level with a guarantee that the animal had been tested for BSE (Steak 2), and the final steak was not traceable to the farm level, but was guaranteed that the animal had been tested for BSE (Steak 3).

Table 1. Utah/Idaho Survey responses to questions relating to two-step traceability, traceability, and BSE testing.

Category Vs. Baseline Steak	Percent Preferring Enhanced Characteristic	At Least Percent Willing to Pay 5% More
Steak 1: Traceable/Maybe Tested (N=103)	82%	57%
Steak 2: Traceable/Tested (N=104)	90%	76%
Steak 3: Non-Traceable/Tested (N=105)	87%	72%

Based on OIE standards, muscle products like steak from an animal under 30 months of age do not require BSE testing protocols as a safeguard for human health. But, there is no USDA rule that specifically excludes animals in the high-risk group, other than non-ambulatory or "downer" cattle, that have had a negative test for BSE from entering the food supply. Consequently, it was technically correct to tell participants that a BSE test might have been performed for the baseline steak or Steak 1. However, given that animals in the high-risk population have a relatively small likelihood of producing the baseline steak, the "possibility" of the animal having been tested for BSE was extremely remote (i.e., was a stronger statement than the actual USDA protocol). However, the purpose of the comparison was to determine how the possibility rather than the probability of testing compared to both the guarantee of testing and farm-to-fork traceability.

Table 1 demonstrates a stated preference by the survey respondents for traceability and/or guaranteed testing over two-stage tracking, with well over 80% of respondents preferring one or both to just two-stage tracking at the same price. A more general willingness to pay (WTP) appears to exist for guaranteed testing compared to traceability (higher percent willing to pay a 5% premium or more for Steaks 2 and 3 than for Steak 1) and traceability and guaranteed testing (Steak 2) had a slightly more general WTP than only guaranteed testing (Steak 3).

This was a non-probability survey conducted without providing the participants with full information about OIE standards as they relate to USDA BSE testing protocols. However, the survey results suggest that given the choice many of the survey participants deemed a two-stage tracking process as less preferable than farm-to-fork traceability and/or guaranteed testing for BSE. At the least this suggests that the survey participants could benefit from better education about the risks posed by BSE. But, it may also indicate that market opportunities exist if firms were allowed to provide enhanced assurances about farm-to-fork traceability and/or BSE testing, especially if cost-effective technologies can be developed that will allow these assurances to be made.

What technologies are candidates for providing farm-to-fork traceability in the U.S. meat system? Some have discussed taking DNA samples or even using a spray-on "smart dust" (see http://chem-faculty.ucsd.edu/sailor/research/smart-dust.html) to connect food products back to animals. More conventional solutions within packing plants might require plant and line redesigns, new types of line equipment, or having fewer people and locations within the plant involved in breaking down individual carcasses. The initial solution may be to simply run groups of animals from the same origin through plants in batches at the same time. All of these solutions run counter to maintaining the status quo in the American meat industry, and when suggested will likely lead to continued pronouncements that farm-to-fork U.S. traceability systems or expanded BSE testing are either too costly or unnecessary in the United States. However, if economic incentives exist, innovative firms will find cost-effective ways to provide these characteristics.

Conclusions

Given that incentives may exist to develop farm-to-fork traceability in trade and in domestic markets, one can ask if a two-step process represents the future of the U.S. meat industry. One of the contributions of this article is to point out the technological difficulties associated with farm-to-fork traceability in high-volume beef packing plants in the United States. The results presented in this article suggest that different cost effective technologies will likely be needed to facilitate a farm-to-fork meat system on a large scale in the United States, especially for beef. In the meantime, smaller meat processors will likely have an advantage over large processors in providing traceable or "source verified" meat products because the scale of their operations fits lot sizes from individual farms and feedlots better than high volume plants. This assertion appears to be supported by the fact that most firms participating in source verification are small to mid-sized.

Beef processing is moving at a slower rate to implement tracking systems than are swine and poultry; perhaps not surprisingly because the industry structures for these meats are different. However, regardless of whether pressure for better tracking comes from consumers, suppliers, or procurers, it is likely that the U.S. meat system will continue to move toward more traceability.

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Made in China: Is it Over for the U.S. Textile Industry?

by Siyi Guo, Ereney Hadjigeorgalis, and Jay Lillywhite

On January 1, 2005, after more than 40 years of protection, the remaining quotas on textile and clothing imports established under the Multifibre Agreement were removed. The impending liberalization sent a shock through the U.S. and global textile and clothing industries. Fears mounted that China's textile industry would take over world markets and decimate domestic textile industries. International organizations and producer groups predicted that China would account for 50 and 75% of the world trade in textiles and clothing, respectively, and 65 to 75% of the U.S consumer market. The American Textile Manufacturers Institute predicted U.S. job losses in the range of 650,000, and the National Council of Textile Organizations put the number of global job losses at 30 million.

In response to historical quotas being removed, several countries began erecting barriers to Chinese textile imports. U.S. textile manufacturer organizations filed safeguard petitions with the U.S. Commerce Department in November 2004. Turkey placed emergency import quotas on 43 categories of Chinese textiles to avoid disruption of its thriving textile market. The EU, amid worries that products could flood European markets, also blocked Chinese textile imports.

These fears are not unfounded. The Chinese textile industry benefits from an array of subsidies, direct payments, export tax rebates, and subsidized utilities and shipping costs. In addition, the fixed exchange rate gives Chinese exports a competitive advantage by undervaluing the Yuan and making Chinese exports relatively less expensive than competing exports from other countries. Add to this low labor costs and a perceived abundance of unskilled labor and China's textile industry appears to be a formidable opponent.

But is there another side to this story? Perhaps. To begin with, China's textile industry is broader than the U.S. industry, which generally specializes in spinning. But more importantly, the Chinese textile industry faces many constraints that could put a drag on any long-term export expansion. Governmental quotas that limit cotton imports, increasing competition for unskilled labor, restrictive re-zoning regulations, electricity shortages, and mounting concerns over pollution could hold off the long-term dominance of Chinese textiles and clothing imports in the United States.

Not Enough Cotton

Cotton is needed to produce textiles and clothing, and China is coming up short in this area. While China's consumption of cotton has been steadily increasing since 1970, production has been volatile (Figure 1). Stocks were completely exhausted in 2003 when consumption outpaced production by almost 2 million tons. This means that China will have to import 1.6 million tons of cotton in 2005 (China Chamber of Commerce for Import and Export of Textiles [CCCT]) to meet current consumption needs. However, cotton imports are controlled by quotas, which for 2005 are set at 894,000 tons. Without government intervention, China faces a shortfall of 706,000 tons of cotton, which could significantly affect the country's textile and clothing production. Any increases in textile manufacturing would have to be matched by either increases in domestic cotton production or increases in import quotas set by the government, both of which are possible but may not be likely given other constraints faced by the country.

Competing for Workers

Contrary to popular belief, China has recently been experiencing labor shortages in key sectors. Labor shortages are spreading rapidly among the belt of manufacturing cities on China's eastern coast – the country's most important

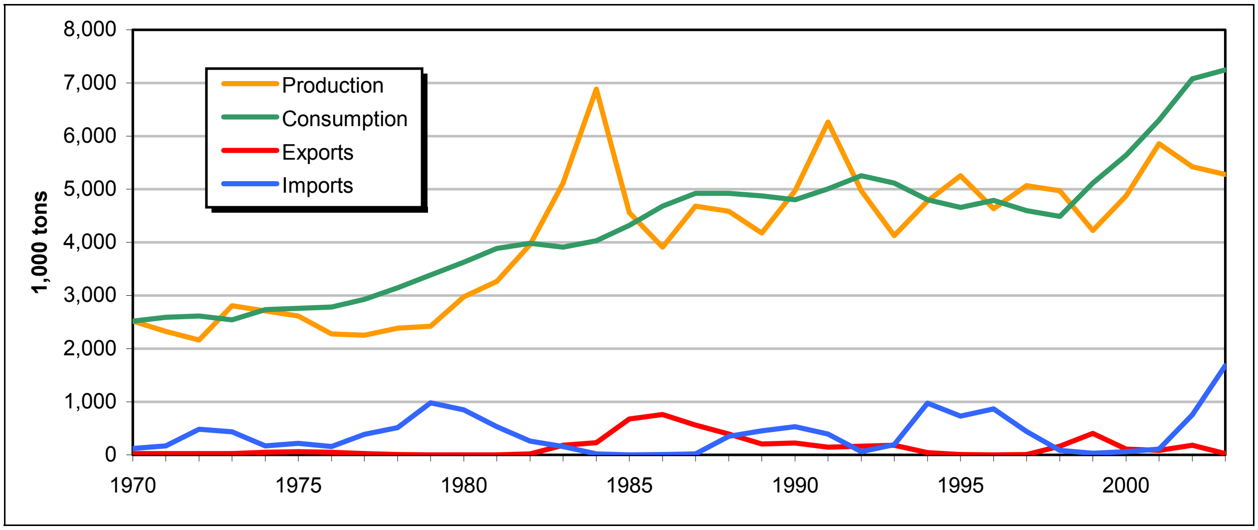

Figure 1. China's production, consumption, exports, and imports of cotton.

industry center (see Figure 2). Most Chinese textile and clothing factories are located in Guangdong, which accounts for nearly a third of China's total exports. This province is experiencing an unprecedented labor shortage of two million workers. Although Guangdong's labor shortage appears to be most acute, it is not unique. Other areas, like neighboring Fujian, report a similar shortage. In fact, the labor shortage has spread widely from Guangdong up through Zhejiang, to the south of Shanghai (*Economist*, Oct. 2004).

A growing service sector and the increasing reluctance of rural residents to seek employment in urban areas have contributed to this critical labor shortage in manufacturing. The service sector, in many cases, offers higher salaries, and the work is less physically demanding than in manufacturing. Rural residents are finding it more attractive to stay on the farm because increased demand for agricultural products has increased incomes and living standards in rural areas. These factors, coupled with a restrictive rural to urban migration policy, have reduced the pool of unskilled labor in urban areas where textile factories are located.

Competition for workers comes not only from the service and agricultural sectors. The textile industry must also compete with other manufacturing industries that have grown rapidly in recent years. Figures released by China's Ministry of Commerce show that foreign and domestic investment, mostly geared towards labor-intensive industries, increased 20% in 2003 over 2002. This investment has spurred a growth in industries such as electronics, telecom equipment, and chemicals that have absorbed a large number of workers that could have alternatively been used by the textile industry.

Running Out of Land

China's economy has been growing rapidly over the last few years, raising concerns of overheating the economy. While an overheated economy is characterized by a high level of economic activity, it also brings with it shooting interest rates and inflation. In China, the steel and cement industries are over-invested, energy consumption is skyrocketing, rice prices are rising, and the volume of real estate loans is growing rapidly. This rapid growth has forced the Chinese government to look into real estate bubbles and adopt restrictive measures on both real estate loans and land. These concerns and corresponding measures to alleviate possible overheating have made land available for industry expansion more expensive and effectively scarcer in recent years.

Adding to these restrictions is the Chinese government's recent policy agenda to eradicate misuse of farm land to benefit farmers (Ministry of Land and Resource PRC). One of L.L. Bean's major suppliers was forced to delay a big expansion this year when Beijing tightened land-use regulations. TAL Apparel of Hong Kong, a garment-making giant that makes wrinkle-free shirts and pants, had planned to build a second 350,000-square-foot factory near a plant in Dongguan. Beijing then ordered a moratorium on the conversion of farmland for industrial uses, and the project was shelved. (Buckman, 2004).

Who Turned Out the Lights?

China has faced a persistent electricity shortage in recent years. In 2003, severe electricity shortages forced China to impose usage restrictions in 23 regions, affecting about 20 prov-

Figure 2. Map of China.

inces and cities (Denlinger, 2004). In 2004, the Chinese National Electric Watch Committee announced a 20 million kilowatts shortage in the country (Wang & Wang, 2004). The areas most affected in 2004 were primarily the eastern and southern provinces. Eastern China is short 10 to 15 million kilowatts, southern China 5 million kilowatts. In addition, northern and central China are short 3 million kilowatts (Wang & Wang, 2004).

The National Development and Reform Committee reports that in regions with severe electricity shortages, some manufacturing companies are operating on alternate schedules, able to produce only every other day or even every fourth day (Wang & Wang, 2004). .Several Japanese companies operating in China reduced production or delayed their product delivery as a result of the modified or shortened operating schedules. One of Panasonic's companies in the Shunde District of Foshan City in Guangdong province has been without power on Mondays and Tuesdays since February of 2004. Honda's Automobile plant in Guangzhou, the capital of Guangdong province, was asked to close every Friday and Kirin in Zhuhai was asked to close every Wednesday (Lyengar, 2004).

Although China is constructing the new Three Gorges Dam that will provide the country with an additional 18.2 gigawatts of electricity, it will not enter into operation until 2009 at the earliest. The project is also plagued by a myriad of environmental concerns, since inundation of the area with water on the Yangtze River could bring with it dangerous concentrations of toxic waste and pollutants from neighboring industrial centers. For now, and perhaps quite a while, there is no evident solution to China's electricity problem.

It's Not Easy Being Green

Land, air, and water quality in China are deteriorating at a rapid rate. Rampant deforestation for fuel and mining for ore result in desertification. Water demand is growing at a rate of about 10% a year in cities, and about 5% for industry. Sixty million people in the country find it difficult to get enough water for their daily needs (China Growth Cost, 2004). The World Health Organization (WHO) reported in 1998 that of the ten most polluted cities in the world, seven were located in China (EIA, 2003). More recently, the World Bank reported that sixteen of the world's twenty most polluted cities were in China, and it estimated that 300,000 Chinese die each year from respiratory diseases (*Economist*, Aug. 2004).

While pollution has been a growing problem in China for years, there are indications that the government is beginning to take this issue more seriously. In its Ninth National Five-

Year Plan, the Chinese government specifically cited the need to prevent and control pollution in the textile and other highly polluting manufacturing industries. The textile, papermaking, chemical, and food industries have been targeted in particular in the pollution of the Huaihe River, China's third largest watercourse. These industries are responsible for 94% of the ammonia nitrogen discharge in the river and have been blamed for record Chemical Oxygen Demand (COD) levels in the river. In July 2004, the Huaihe Water Resources Committee reported that the river's water quality was at its worst level in history. In December of 2004, *China Daily* reported that only 57.8% of the water in the river was considered safe for domestic, agricultural, or industrial use.

In response to this crisis, the government has gone as far as to call for a restructuring of these industries. Wang Jijie, Vice-Director of China's State Environmental Protection Administration, demanded that local governments restructure the manufacturing sector in accordance with the river's capacity. He urged the enactment of water quality laws and regulations. Kai Ma, Director of the National Development and Reform Commission, stated in a speech to the Fifth China Development Forum that it is vital to restructure industry and to change the current economic growth pattern into a more efficient, environmentally sustainable one. This movement towards a greener China will not be compatible with increased production in these industries in the short term.

Conclusion

Removal of existing trade import quotas has appropriately caused concern for U.S. and global textile industries. An undervalued Yuan, favorable governmental treatment of the Chinese textile industry, and low labor costs add to this concern. While countries have protectionist measures at their disposal to alleviate such competitive disadvantages with China (e.g., tariff and safeguard measures and antidumping legislation), the need for these measures may not be as necessary long term as once thought. China faces a number of resource constraints that, taken as a whole, may restrain its textile industry from dominating world markets to the degree previously projected.

Rapid economic growth in recent years has thrown China into an era of unprecedented and profound change. The textile and clothing sectors are caught in this web and are constrained in ways that are inherent to a changing Chinese economy. Volatile cotton production and increasing demand for cotton in textile and clothing production, the urgent labor shortage in manufacturing cities, the strained resources of land and electricity, and an alarming environmental deterioration could impede China's textile and clothing industry from future expansion. Whether these constraints will compensate for the advantages that China enjoys in textile production remain to be seen, but these issues must form part of any balanced debate on world textile trade. In the short run, safeguards and trade agreements, such as that recently concluded between China and the E.U., may buy some much needed time for the U.S. textile industry. The future is uncertain, but for now it's not yet over for the U.S. textile industry.

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