Spring 2006
Industry Study

Final Report
Agribusiness Industry

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National Defense University
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ABSTRACT: The U.S. Agribusiness industry feeds some 300 million Americans daily, provides nearly 13% of the Gross Domestic Product and, throughout its value chain, employs approximately 17% of all U.S. workers. Of the three main responsibilities of a sovereign state, governing, defending and feeding its population, the last one towers over the others in terms of meeting the hierarchy of human needs. Agriculture in the U.S. is robust due to its supporting foundation of arable land, water, extensive government support and, most of all, the hard work of those who make up this industry, from the farmers to the retailers. It also has some critical vulnerabilities, be they urban encroachment, sustainable water resources, labor, agro terrorism, the threat of pandemics and the sometimes negative effects of globalization, which must be addressed in order to enable the U.S. to continue feeding its population.

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COL Amy Frisk, US Army, Faculty
COL Sam Palmer, US Army, Faculty

PLACES VISITED

Domestic

US Department of Agriculture (USDA), Agricultural Research Service, Beltsville, MD
Campbell Soups, Camden, NJ
Clagett Farm, Upper Marlboro, MD
Purdue U. Agriculture Dept., West Lafayette, IN
Tate and Lyle Fructose Plant, Lafayette, IN
Hardin Farm, Danville, Indiana
Mason/Dixon Farms, Gettysburg, PA
Hollabough Brothers, Inc., Gettysburg, PA
Mott's Processing Plant, Gettysburg, PA
Agriculture Experimentation Station, Adams County, PA
Office of US Trade Representative, Washington DC
USDA Chief of Staff, Capital Hill, Washington DC
Senate Ag Committee staffer, Capital Hill, Washington DC
Paramount Exports, Oakland, CA
American President's Line, Oakland, CA
Stag's Leap Vineyard, Napa Valley, CA
SYSCO Foods, Salinas Valley, CA
Duda Fresh Farms, Salinas Valley, CA
Taylor Farms, Salinas Valley, CA
Kern County Water Agency, Bakersfield, CA
Sunview Farms, Delano, CA
Western Farm Service, Delano, CA
North Kern Farm Equipment, Delano, CA
Randolph Farm, Delano, CA
Stamoules Produce, Fresno, CA

International

US Embassy, Beijing, China
Agripark, Beijing, China
Wumart Fangzhuan store, Beijing, China
Ministry of Agriculture, Beijing, China
China Agricultural Academy of Science, Beijing, China
BAMA Food Processing Co, Beijing, China
Agricultural Museum, Beijing, China
Anqui Wanxin Food Processing Co, Weifang, China
Zucheng Wanyang Food Processing Co, Weifang, China
Shuoguang Market, Weifang, China
Sino Analytica Food Residue Analysis Lab, Quindao, China

Executive Summary

In addition to defending and governing its people, the ability of a nation to feed its populace is one of its greatest sovereign responsibilities. This fact was officially recognized in 2003, when HSPD 9 identified agriculture as a critical infrastructure within the United States. The primary intent of this paper is to assess the role of agribusiness in maintaining our national security.

We discovered that the agribusiness industry contributes to national security in a number of ways. From an individual perspective, it provides food to keep 230 million Americans strong and healthy. On a broader scale, it is a dynamic, highly integrated industry that not only feeds Americans, but also plays a major role in building a strong national economy, which in turn contributes to our overall national security. The food and fiber industry constitutes 12% of our GDP, employs over 23 million Americans, and contributes over one trillion dollars to our economy.

In addition to addressing the relationship of agribusiness to our national security, this paper analyzes the current structure and state of the industry. We discovered that pre-conceived notions of the family farm fail to reflect the complex, highly technical industry that farming has become, and the disservice these notions bring upon the intelligent, innovative and dedicated men and women who put food on the nation's tables. Our domestic travel enabled us to observe the diverse regional differences in American farms: from small Pennsylvania dairy farms, to the massive grain fields of the Midwest, to the incredibly productive fruit and vegetable farms in the Napa, Salinas and San Joaquin Valleys of California. We also observed the complex multi-step

value chain and how vertical integration and market concentration have evolved to meet consumer demands.

Like many other American industries, agribusiness is doing all it can to keep pace with a rapidly changing world. In looking at the dynamics of change in the industry we reviewed the impacts globalization has had on both domestic and international markets. We determined that current American farm subsidies conflict with U.S. obligations, and interests, vis-a-vis the WTO. Our international travel to China gave us an appreciation of the delicate balance China must achieve in trying to feed its population of 1.3 billion people on just 7 % of the world's arable land. We also explored the threats posed by bio- and agro-terrorism, and the necessity to protect our food supply system from both intentional and inadvertent contaminants. Other dynamics of change we investigated were the exhilarating advancements in biotechnology, precision agriculture, and nanotechnology. America's strong commitment to agricultural research and development in these fields has enabled us to remain the world leader and to increase agricultural productivity six-fold over the past 50 years. We also explored the rapidly changing demands of American food consumption, and the how our affluence has led us to the brink of an obesity epidemic.

Unequivocally, one of the key reasons for the success of U.S. agriculture is the government's outstanding direct support to the agribusiness industry. Since the United States Department of Agriculture was first established by President Lincoln in 1862, and the Morrill Act, establishing the massive Land Grant University System and Extension Service, was signed into law that same year the Federal Government has championed the cause of the American

farmer. The industry would not be nearly as productive were it not also for the indirect support provided by the nation's extraordinary infrastructure.

The last half of the paper was devoted to specific issues pertaining to agribusiness, to include mounting concerns over urban encroachment, water conservation and quality, labor shortages and the related issue of illegal immigrants, protection against bioterrorism and avian influenza, and the future impact of the Farm Bill and its relationship to upcoming WTO negotiations. We conclude the paper with several recommendations that we feel will enable American agribusiness to continue to play a major role in preserving our national security.

Agribusiness and American National Security

The history of American agriculture, reaching back three centuries, is one of heroism, labor, ingenuity, and ultimately success. Americans have grown accustomed to a safe, plentiful, and secure food supply—a blessing to us as a people, and a powerful national security asset. This characteristic of our society and our national security posture is often taken for granted. The Agribusiness Industry Study members recognize the power and benefits of a global trading environment, which has strengthened the ability of the agribusiness industry to export its goods while widening the choices available to the American consumer. However, as a group we would be unwilling to rely on external sources for our food supply, considering the ability to feed itself one of the central capabilities of a fully sovereign nation. The complications and price we pay as a nation for our reliance on external sources of energy stand as a strong reminder of the power of national sourcing for critical materials.

Today the United States enjoys abundant food, supported by a wide range of enabling factors—arable land, water, technology from public and private sources, the land grant system, a powerful domestic market, a generally strong transportation infrastructure, an effective regulatory regime that helps ensure a safe food supply, and so on. These conditions enable this nation to maintain the three conditions necessary to claim full national sovereignty: the ability to govern the people, to defend the people, and to feed the people.

But this secure food supply is not guaranteed into the future—its availability will rest on the choices made in the public and private sectors over the next years. In our studies, we identified three broad areas of concern:

- The threat of bioterrorism against the open and widely distributed food chain—from inputs, to production and distribution of food—remains real despite the efforts made by the Department of Homeland Security and USDA. In our travels, we often saw that professionals in this industry lacked both the awareness, and the tools to decide on the steps necessary to protect their firms. The threat of bioterrorism must be assessed both with respect to direct damage to the infrastructure, and the second- and third-order effects across society and with respect to agricultural exports.

- The pressures generated by a large and growing population against the agricultural infrastructure continue to intensify. Urban encroachment, competition for water, and environmental pressures all tend to constrict agricultural production over time. The industry relies heavily on immigrant labor to get the crop in, for processing and transportation—an essential input that is under pressure both from competing industries, and from concerns over security. These competing interests will have to be reconciled by the political systems at the federal, state, and local levels to ensure continued production at acceptable levels of regulation.

- International competition will probably continue to intensify, with Brazil broadening its production of commodities and China continuing to increase its horticultural output. Foreign producers generally have intrinsic advantages of cheap labor and less regulatory burden than their American counterparts. On the whole, American farmers continue to

rely on the intelligent application of advanced technology to maintain their competitive position.

The Agribusiness Industry Study also took the opportunity to look more broadly at the relationship of agriculture and security on an international basis. As far back as Thucydides, national security policy analysts defined the three major causes of conflict: fear, the search for glory, and interest. There is no greater interest than that in feeding the people, and no greater fear than that of hunger. Moreover, the environmental pressures generated by agricultural production are often exported across national boundaries, leading to international tensions. These issues were of special interest to the group in light of the international field study in China, which perpetually faces the problem of feeding 20% of the world's people on about 7% of its arable land. The environmental pressures on land, water, and air have been heavy, and raise questions as to the sustainability of their agricultural sector in the years to come. More broadly, in a world that is likely to be increasingly stressed to feed its increasing population, America's agricultural capability serves as a form of strategic asset and reserve, which policy makers must ensure is preserved despite the pressures on this sector.

This report will examine the structure and state of the industry, the dynamics of changes affecting the industry including globalization, changes in the security environment, emerging technologies, the Farm Bill, domestic budgets and economic trends. It will look at the role of government and the key issues of water availability and land encroachment. Finally, selected essays will provide an in-depth look at the issues which the Agribusiness Industry Study Group found pervasive throughout the study period either in terms of risk, opportunities or a combination of the two.

Section 2 - Structure and State of the Industry

The U.S. is blessed with an unrivalled comparative advantage over other nations by virtue of owning significant arable land distributed along a North/South axis that enables a long, staggered and highly diversified crop-growing season. Some 430 million of the 1.9 billion acres that make up the contiguous 48 states are under production. (USDA NRCS, 2006) In 2005, this enabled the U.S. to grow sufficient food to not only feed its population, but to export $63 billion in agricultural products while only importing $59 billion, giving it an agricultural trade advantage of four billion dollars. (USDA ERS, 2006) The inner workings of this massive effort begin with producers, someone who takes basics inputs of land, seed, animals, water and labour, to produce a crop or animal for consumption. Thereafter, a value chain of processors, manufacturers, wholesalers, and retailers, all linked by a supporting cast of transportation and communications, bring an end product to the consumer's table.

To understand U.S. agribusiness, it is useful to first look at the regional variances in terms of what can be grown where and what the acres are worth in terms of dollar value and revenue. Thereafter, this section of the paper examines the nature, size and types of American farms, some common challenges facing these farms, the historical and current impact of the Farm Bill, and concludes with an analysis of the integrated value chain which brings food from these farms to the nation's dinner tables.

Regional Variations

The Economic Research Service (ERS) of USDA identifies the U.S. resource regions based on characteristics of the land and the commodities produced. These regions are shown as figure 1 below.

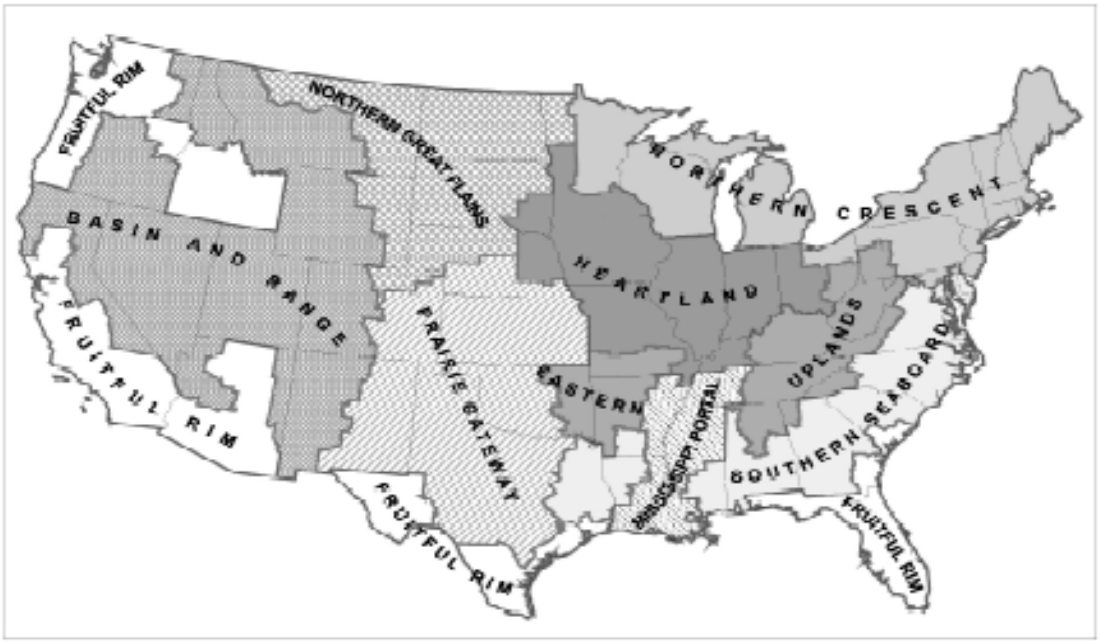

Figure 1 - US resources regions. Source: **USDA ERS**

The average value per acre farmed varies dramatically as shown in Figure 2.

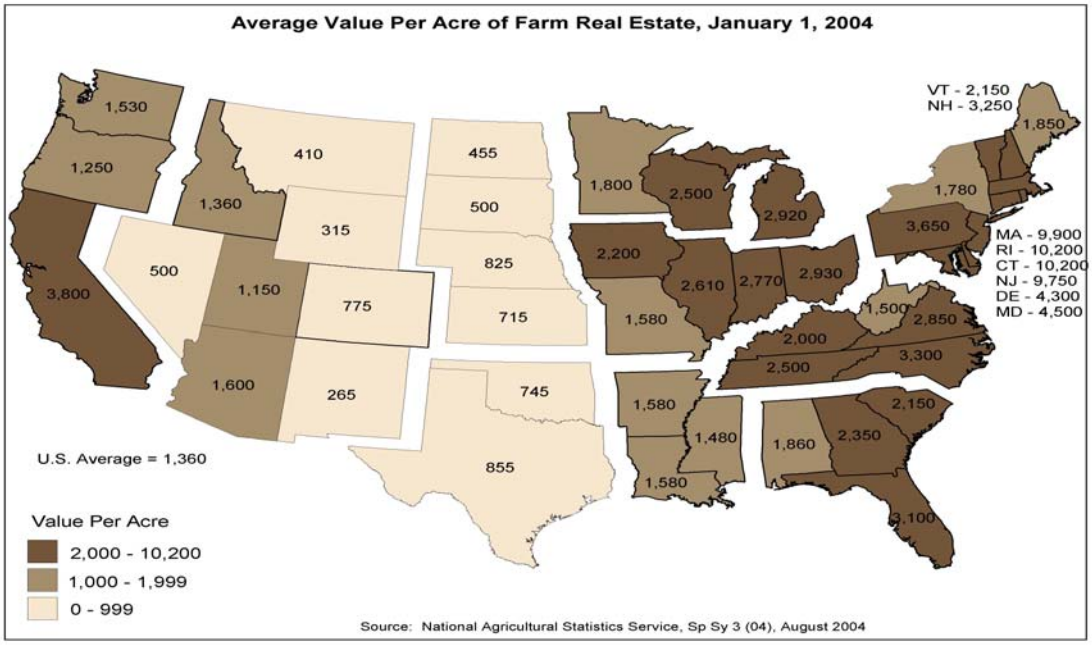

Figure 2 - Average value per acre of farmed real estate

There is a saying that farmers live poor and retire rich. Most farmers spend their lives earning modest revenues from crops and animals they raise. When they retire, however, they have the option of either renting out their land for production or selling it outright. Prime land next to urban areas will in some cases fetch in excess of $40,000 per acre. This issue of land use and encroachment is addressed in greater depth in Section 5 of the paper.

Farms and Farmers

Farms and farmers have changed tremendously in the last 150 years. "The number of U.S. farms fell dramatically after peaking at 6.8 million in 1935, with most of the decline occurring during the 1940s, 1950s and 1960s".(Hoppe, Korbe, 2001)

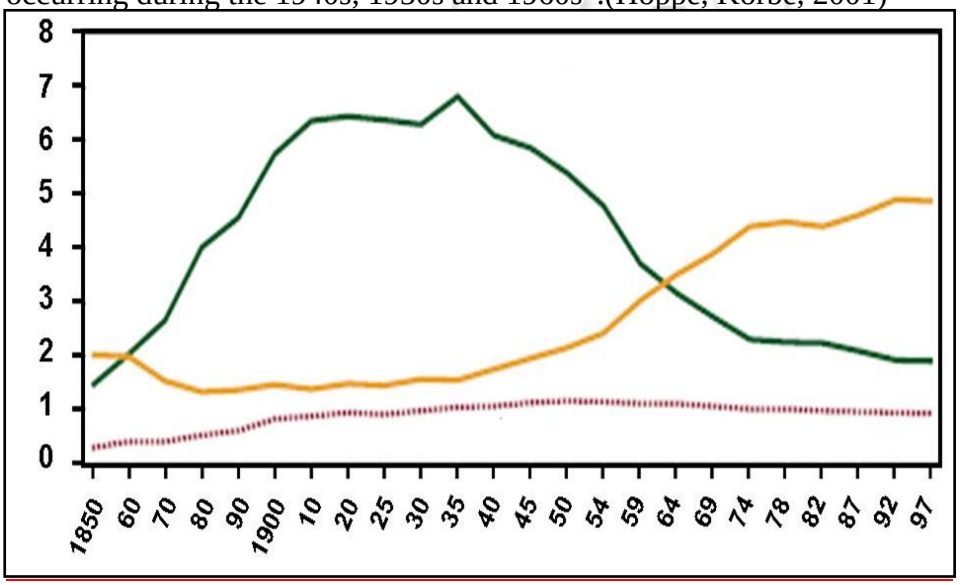

Figure 3 - Farms, land in farms, and average acres per farm, 1850-1997. Source: USDA ERS compiled from census of agriculture data.

As shown above, in the past 50 years, there has been a commensurate increase in the size of the average farm as those acres abandoned or disposed of by farmers were acquired or otherwise incorporated in existing farms. Appendix 1 is a summary table from the latest Census (2002) showing American farms in terms of size, value, crop and livestock production, ownership, and, more telling, value and revenue. The definition of the farm is important; for statistical purposes, a farm is defined by the USDA, the Office of Management and Budget and the Bureau of the Census as any place from which $1,000 or more of agricultural products (crops and livestock) were sold or normally would have been sold during the year under consideration. Small farms, those with fewer than 50 acres, still account for over 90 percent of all farms and 68 percent of farm assets—but only 28 percent of production. Meanwhile, large farms in excess of 500 acres have both increased their share of total farms since 1974, while the share of midsize farms has declined. (Hoppe and Korbe, 2001) Despite this growth in the number of large farms, and greater concentration in agricultural production of certain commodities and crops, the agricultural industry is not overly concentrated compared to other U.S. industries.

The largest misconception about farming is that the family farm is at risk of disappearing. In reality, most farms, even the largest ones, are family farms arranged either as single owner, partnerships or family corporations. (Banker and MacDonald, 2005). During our field studies, we examined five family farming operations which all share the common traits of innovation, marketing knowledge, and passion for their work and chosen lifestyle. All five are also confronting the challenges presented by globalization and other stressors common throughout the domestic industry. Our observations on these farms are found at Appendix 2.

The challenges facing these farmers are not always outside forces. The farming population itself is changing as the industry continues to evolve.There are both opportunities and challenges associated with the changing demographic of our nation's farm population. The average farmer today enjoys greater production and marketing opportunities by leveraging the most forward looking agricultural education and extension services on the planet. The education level of farmers has risen steadily over the past 30 years and approximately 15% now have post-secondary degrees. This lags in comparison to the general population, but can be attributed in part to the ageing population and the fact that much of the knowledge used for farming is learned 'hands-on'. (USDA ERS, 2006) We found that those farmers pursuing innovative practices, be they in terms of farming or reaching the consumer base, had pursued advanced degrees more closely related to engineering and business than agriculture.

The value of this knowledge becomes apparent when examining the integration of the food value chain across the sectors that make up the industry. Those educational and technological tools provide farmers in every commodity area the chance to exponentially improve efficiency and production by experimenting and implementing new processes designed to increase competitive advantage. When combined with irreplaceable experience acquired over decades, American farmers represent the cutting edge of global agricultural advancement. Indeed, one of the farmers we visited was actively courted by three foreign governments to come to their countries, observe their processes, and recommend changes at the micro and macro level.

The 2002 census shows that the average age of operators is 55, four years older than 30 years ago. Figure 4 below compares the average age of heads of farming households to all U.S. households, showing that the farming population is greying more rapidly than the rest of the U.S. households.

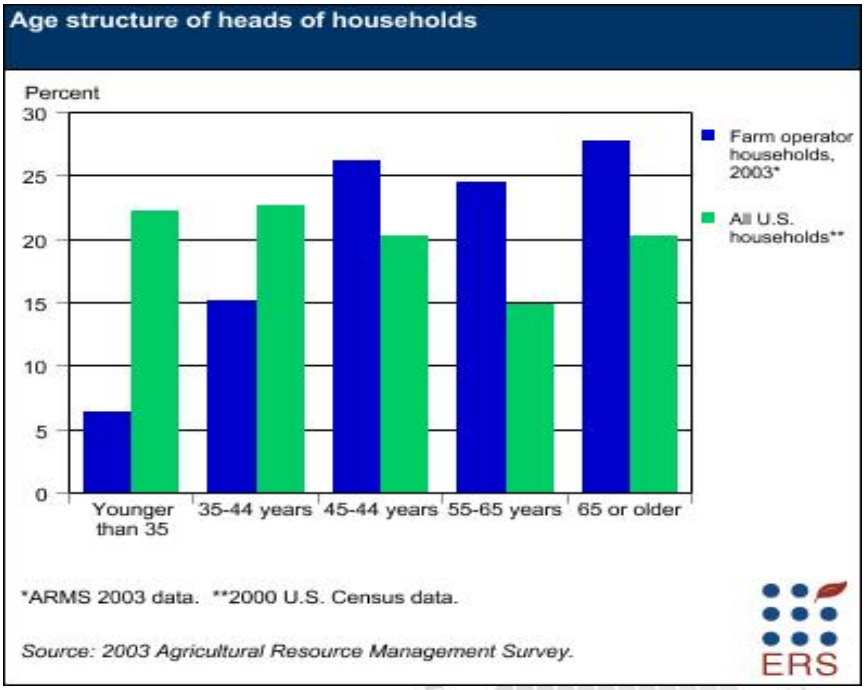

Figure 4 - Age structure of heads of households

The experience providing the depth and foundation for innovation is not being replaced. Fewer farmers see their children returning to the family business because of the risks, slim profit margins, and the declining comparative advantage that our agriculture industry possesses. Even if one child wants to, the economics of the situation are such that the value of the farmer's estate is tied up in the land and it's difficult to leave the entire value to one child. In addition, it is extremely difficult for a young, aspiring farmer to break into farming. Land values and other start-up costs are prohibitively steep. The result of this difficulty has been a greater degree of industry concentration as smaller family farms without descendents poised to assume control are subsumed by large operations, or the land is sold out of farming altogether to meet urbanization's increasingly lucrative appetite for land. Indeed, concentration and vertical integration figured prominently in our examination of the food value chain.

The Changing Value Chain

The traditional value chain begins with the inputs of land, water, seeds, feed, chemical and the like. Producers, processors, manufacturers, wholesalers and retailers then all play roles in getting food on the table. In 2000 over 80 percent of the U.S. food dollar went toward value-added services and materials – transportation, processing, distribution, labor, packaging, and energy – after the costs of the basic inputs. (Martinez, 2002)

Food manufacturers and processors use raw products from growers to manufacture or process foods and beverages for human consumption and other related products, such as

prepared feeds for animal and fowls. (Harris, 2002) They have seen their value added to food products increase 23 percent from $157.2 billion in 1992 to $193.1 billion in 1997 when measured as the ratio of value added relative to shipment value. (Harris, 2002)

The ratio of value added, and where it is added in the journey from the field to the table, is the most important measure of the function of the value chain. A box of broccoli grown and packaged in the San Joaquin valley costs approximately four dollars to produce, does not require additional handling other than transportation which costs only a few additional dollars per box, but sells for $34 in a grocery store; it is easy to see that the high ratio value added, which is passed on as a cost to the consumer, occurs at the wholesaler or retailer levels and translates directly into profit for those participants in the value chain. Different commodities have different value added ratios, with fruits and vegetables having the highest ratios whereas meat and dairy have ratios of less than 30% due to the higher cost of raw input. (Harris, 2002) Regardless of the final ratio, the disparity between the profit margins earned by producers and those achieved by retailers stood out as a glaring point of frustration for the growers and producers that we met throughout our studies.

Relationships in the value chain are changing dramatically, with traditional food wholesalers steadily losing ground due to the increasing interaction between growers, food manufacturers and retail sellers. (Martinez, 2002) Many of the larger retailers are now acting as their own wholesalers and have proved more effective at running their own distribution centers for their specific markets, using the latest supply chain expertise, than traditional wholesalers. These wholesalers are not yet at risk of disappearing, (in 1997 they racked up $597 billion in sales) however they have to adjust how they handle their supply chains by incorporating enabling technologies, such as electronic data interchange and a greater reliance on barcoding, in order to remain competitive and attractive to retailers.

There are now 15 different types of food retailers catering to the demands of U.S. consumers, ranging from corner convenience stores to hypermarkets. Supermarkets carry a median number of unique items (own brand, package size and type) that has expanded from an estimated 14,000 line items in 1980 to over 40,000 in 1999.(Kaufman, 2002) Never in history have so many choices been offered to consumers who, with plenty of disposable income to spend, have taken full advantage of this opportunity. Food stores sales increased by 5.5% from 1999 to 2000, resulting in sales of $483.7 billion dollars. (Kaufman, 2002)

Finally, because they can, consumers insist on fresh fruits, vegetables, meat and fish that were harvested, slaughtered, processed and shipped all within the last 24 to 48 hours. Consumer demand is such that retailers as far away as New York will now routinely bypass wholesalers, talk directly to processors or producers in California, and initiate an order that will be on the customer's table within the next two days. Many of the larger agribusiness operations are pursuing vertical integration throughout the value chain to meet this consumer demand.

Vertical integration, if not done through direct ownership, is accomplished through contract production where growers adhere to exacting growing, feeding and output conditions imposed by those demanding their product. Broilers, hogs and certain crops are uniform in all aspects for a reason.

This vertical integration is but one factor which has led to very high concentration in certain segments of agribusiness. CR4 is the concentration ratio, relative to 100%, of the top four firms in a specific food industry. Flour milling has a CR4 of 63%, broilers 56%, pork production and packers 49% and 64% respectively, while the top four beef packers control 83.5% of their market. Other markets are even more concentrated; Monsanto and Pioneer jointly

control 60% of the U.S. corn and soybean seed market worth some five billion dollars and the CR4 of food retailing has doubled in the space of seven years with Wal-Mart leading the charge. (Hendrickson, Heffernan, 2005)

This trend toward greater concentration is a line that must be walked carefully. Mergers and acquisitions can greatly increase the competitiveness of those who plan and implement them properly. Others who stray too far from their core business and expertise often end up having to get rid of acquisitions to resolve potential bankruptcy situations. Furthermore, the trend toward mono-culture makes crops and livestock holdings particularly vulnerable to pathogens; without sufficient diversity in what we grow or raise, we increase our risk of having entire portions of our food sources destroyed by a single viral or bacterial pandemic. It is essential that the U.S. food industry remain competitive as an exporter of foods but most critically, remain capable of feeding the American population from year to year. Currently, the industry is capable of doing so with some significant advantages but it must safeguard against potential large-scale shocks by maintaining a diverse agricultural sector.

Section 3 - Dynamics of Change

Globalization, changes in the security environment, technological innovation and consumer trends are all contributing to the evolutionary changes within the American food and fibre industry. While some changes are positive, others constitute risks that must be mitigated in order to maintain the competitive edge currently enjoyed by the U.S. Agricultural sector.

Globalization

Trade balance and the WTO regime

In 2004, agricultural products constituted 8.8% of world trade ($783B). Over the last 25 years American agricultural imports have increased from $20B to $50B, while American exports remained consistently between $40-60B during the same time frame. (Bohlje, 2006) Although U.S. agricultural exports continue to rise, imports are increasing nearly twice as fast and the U.S. may soon become a net importer of food products**.** (Jerardo, 2005)

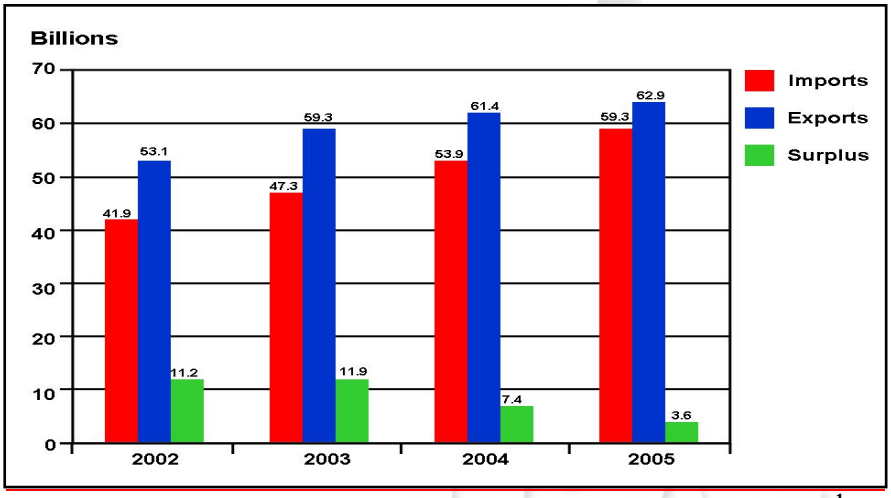

Figure 5 - Agricultural import, export and balance. Source: USDA ERS [1]

The drivers of globalization in the food and fiber industry are numerous. Many countries, China figuring prominently among them, have or are moving to market-based economies with ever growing appetites for trade. Information technology, improved transportation and logistics, and huge advances in agricultural growing methods are facilitating this movement internationally. (Bohlje, 2003) Domestically, high levels of disposable income and consumer demand for ethnic and other value added imported foods also serve to shrink the U.S. trade advantage in agricultural products. While the balance of trade in agriculture continues to narrow and may even reverse, this represents increasing choices available to the consumer more than any weakness in this nation's ability to provide essential food for its citizens.

American agribusiness, and the US economy as a whole, depends heavily on international trade, given the limits of the very large, but still finite domestic market. The maturation of the WTO trade regime has created a deep policy dilemma for the US and other nations. Developed

[1] This is a closer affair than the yearly results in the graph represent. For example, there were three months in 2005 where agricultural imports exceeded exports. (USDA ERS, 2006)

countries around the world—the US, EU, and Japan—have built mechanisms to protect and support their agricultural sectors. Less-developed nations have generally used tariffs and quotas to achieve similar goals. This structure of global support for this sector has resulted in a deadlock in the current round of WTO talks. This deadlock has been persistent and sometimes acrimonious.

The US farm program provides subsidies to major commodities, which tends to concentrate the payments regionally; moreover, given the structure of the program, money tends to flow to larger landowners. These features have created asymmetries in benefits vs. costs within agribusiness, and simplified attacks on the program While subsidized American commodity farmers and lobbyists seek to perpetuate the current U.S. agricultural structure and its associated tariffs and subsidies, many others who have never received federal payments, specifically fruit and vegetable growers, would welcome the opportunity to play on a level international field. As we discovered during our study of American farms, unsubsidized growers believe that subsidies create market distortions that hamper their abilities to generate their greatest potential revenue. Simply put, they want to see the most efficient agricultural production by region in a free market economy.

The US has made an offer to reduce its domestic subsidies as part of a larger trade package. President Bush's pending offer to significantly reduce these subsidies, by perhaps as much as 60%, in return for increased market access around the world for US exports reveals a willingness of this administration to re-consider the interests of American agribusiness in order to obtain more open markets for other American industrial exports.[2] This policy makes good business sense in light of the fact 80% of American industries favor free trade; and that agricultural products constitute only 8.8% of world trade, compared to machinery and transport equipment (17%), fuel and mining (14%), office and telecom (12%), and chemical (11%).[3]

Research conducted for the Economic Report of the President concludes that nearly half of the projected $290B economic gain resulting from a subsidy and tariff-free WTO agreement would be realized by developing countries. An economic boost of this magnitude would also go a long ways toward eliminating rural poverty around the globe, as trade is universally recognized as a much more powerful and lasting engine for economic growth than simply providing developing countries direct financial aid.

In addition to significantly boosting benefits to developing countries, the President's Economic Report also indicates that a subsidy-free WTO agreement would stimulate US agriculture exports by 12%, thereby enabling America to maintain a positive agricultural trade balance, while reducing its overall trade deficit. Moreover, the overall $290B boost in international trade generated by this agreement would further benefit the American economy as these developing countries would gradually develop the purchasing power to acquire America's high value products. The office of the US Trade Representative concludes that 95% of the potential customers for future American products lie outside our borders. Other experts note that the largest potential growth market for American goods and services lies with the projected three

[2] Meeting with Eric Steiner, Majority Professional Staff Member, United States Senate Committee on Agriculture, Nutrition, and Forestry, 11 April 2006.

[3] Data provided during meeting with members of the United State Trade Representative's office, 24 March 2006.

billion people that will be added to the world's population in the first half of the 21st century. (Thompson, 2002)

What about China?

The effects of liberalizing global trade are nowhere more obvious than in the case of China. With a sustained period of economic growth over the last few decades, China continues its trend toward economic prosperity. According to the USDA Economic Research Service (ERS) officials, China's GDP has grown nine percent over the last year, average incomes have doubled every decade, and it sustained no inflation over the past several years (Gale and Tuan, 2006). In 2001, China joined the WTO and their economic standing continued to climb – with a significant part of their earnings attributed to agricultural production and exports. China continues to feed one-fifth of the world's population (1.3 billion people) with less than seven percent of the world's arable land (Gale and Tuan, 2006). According to ERS data, bilateral agricultural trade with the US for 2004 consisted of $5.5 billion in US exports to China and $1.6 billion in imports from China (China: Basic Info, p. 1). Guest speakers and readings prior to our international travel to China ranged from cautiously optimistic to demonstrably pessimistic about the sustainability of the Chinese agricultural industry.

China's demand for grain is severely increasing while its production decreases. As incomes go up, people consume more poultry, fish, and seafood, placing a greater demand on grain requirements to feed humans *and* livestock. According to Lester Brown, the 18% decline in grain production from 1998 to 2003 was the result of a 16 % reduction in grain farming area. This reduction is attributed to urbanization, desertification, and the conversion of grains to higher value crops. If this trend continues, China will impose an enormous demand on the US and the world's grain market to meet its growing demand for a more protein-rich diet. (Brown, 2004) Some of these pressures could be relieved through the application of sound governance and land reform.

China's land 'tenant' policy that forbids farmers from owning their land, and forces farming on small plots of land, continues to be the source of great inefficiencies in production. Farmers avoid making capital investments in the land for fear of losing it, or are unable to even secure loans (Gale and Tuan, 2006). Moreover, although incomes continue to grow in urban areas, rural incomes continue to fall further and further behind. As the gap widens and farmers continue to be treated as second class citizens, civil instability is a growing fear – as evidenced by an estimated 87,000 riots and demonstrations erupting in 2005 (Gale and Tuan, 2006). Finally, other factors are hampering China's ability to feed its population.

China is 16th out of the 20 countries with the worst air quality. 70% of its water is heavily polluted (mostly from industrial run-off) and half of its water treatment centers are not operating. (Turner, 2006) Per capita water availability in China is one-tenth the international average (China En Route, p. 34). Throughout the northern half of China water tables are falling, wells are going dry, and rivers are drained before they reach the sea (Brown, p. 145). And the problem worsens as villagers migrate to cities where they consume four times as much water than in rural areas (Brown, p. 145). To aggravate the situation, water is very cheap and freely used (Turner, 2006).

This over consumption has led to a growing desertification of China which is now affecting its neighbors and North America. In the 1950's, 156,000 hectares per year were converted to desert; in the 1990's, this figure doubled to 360,000 hectares per year. According to

Brown, over ploughing and grazing followed by strong winds and sand storms are the major contributors to this phenomenon. (Brown, 2004) Since the mid 1990s, pollutant-laden dust storms frequently reach the U.S. west coast, and travel inland as far as Denver in Colorado. The Chinese government has adopted an aggressive program to plant trees as a barrier to further desertification and sand storms, which were prevalent everywhere we went in China. However, the long-term effectiveness of this approach remains to be proven.

Invasive species

The rapid flow of agricultural goods around the world, enabled by transportation and market opening, has posed a heightened risk unique to the agricultural sector: invasive species of pests and diseases. (Evans, 2003) Over the past 200 years, more than 50,000 foreign plant and animal species as well as microbes have become established in the United States. (Evans, 2003) About one in seven has become invasive, with damage and control costs estimated at more than $138 billon each year. (Evans, 2003)

Considerable effort has been devoted to assessing the full economic impacts of invasive pests and diseases in order to decide on effective management programs to help prevent, control, or mitigate such invasions. Previously, the focus was on identifying the most cost-effective means of treatment of an outbreak. Now the emphasis is on the benefits and costs of treatments to determine how best to manage the particular pest or disease. (Evans, 2003) Assessing the impact is challenging and imprecise. However, about a fourth of this country's agricultural gross domestic product is lost each year to foreign plant pests and the costs of controlling them. In the case of cotton, the total accumulated cost of the boll weevil**,** which arrived in the U.S. from Mexico in the 1890s, now exceeds 50 billion dollars**.** Leafy spurge, an unpalatable European plant that has invaded western rangelands, caused losses of $110 million in 1990 alone. In eastern forests, losses to European gypsy moths in 1981 were $764 million, while the Asian strain that has invaded the Pacific Northwest has already necessitated a $20 million eradication campaign. (Simberloff, 1996) Introduced plants, animals, and pathogens often pose monumental problems in the U.S. Their harmful effects are often subtle, but the eventual impacts on the economy or natural environment are real and often disastrous and sometimes irreversible.

Government plays a critical role in establishing the legislative and regulatory instruments necessary to prevent or mitigate the impact of invasive species. The role of government in combating invasive species is addressed in Section 5 of the paper.

The changing security environment: Bio/Agroterrorism, Food Safety & Avian Influenza

The response to threats to the agribusiness infrastructure constitutes a second ongoing dynamic of change in this industry. While much interagency coordination and work has been done to improve our nation’s capabilities to counter or mitigate the effects of such a deliberate attack, even a cursory examination of food and water supply chains indicate the potential for catastrophe. More importantly, the Agribusiness Industry Study found that with relatively little effort, a very few number of committed terrorists could have a disproportionate impact by attacking the soft target of America’s food supply as a precursor or complement to attacks against other targets. Anecdotal evidence gathered in interviews with the businesses studied in

the San Joaquin Valley of California indicate that the scope of the threat, the lack of resources available, and the slim profit margins defining this industrial sector limit their ability to deal with any type of terrorist threat. In short, because it was not a crisis, and was not currently affecting their bottom line, most agriculture-related businesses gave the issue little concerted thought. Because America and its population constitute such a desirable target for terrorism, the threat cannot be ignored or denied.

Deliberate agroterrorism does not represent the only agro-based threat to America and its population. All one has to do is pick up any paper or periodical to recognize the severe threat posed by Avian Influenza. Since December 2003, the H5N1 strain of avian influenza has been diagnosed in birds in 27 countries spanning the continents of Africa, Asia, and Europe. (WHO, 2006). The H5N1 avian influenza virus is extremely virulent, capable of killing more than 75% of the birds that become infected. More importantly, H5N1 can be transmitted to human by animals and has resulted in the deaths of more than 105 people world wide. (WHO, 2006). Though the virus has not yet mutated to allow transmissions between humans, every new human case presents the virus with an opportunity to do so. The rapid, global spread of H5N1 influenza has raised the specter of a human influenza pandemic that could rival the Spanish Influenza outbreak early in the 20th century.

The risks to our nation, its economy, and our population from naturally occurring or directed threats cannot be ignored. The Bioterrorism/Food Safety/Avian Influenza essay included within the paper will more fully explore these issues.

Technology

Technology has driven the evolution of American agribusiness since its first days as a frontier subsistence endeavor. Over time, this industry has transitioned to animal power, then to tractors, then adopted a range of production technologies, and it is now in another phase of technological development. Biotechnology, information management, and precision agriculture have radically increased food production through greater crop and animal yields, improved food safety and greater market leverage, while reducing the number of people required in the food value chain. Nanotechnology holds even greater promise as scientists and farmers examine the potential of farming one atom at a time.

Biotechnology

Few issues have polarized individuals, interest groups and countries such as Genetically Modified (GM) foods. This application of biotechnology has greatly increased crop yields, reduced the use of pesticides through infusion of pest-resistant traits into the seeds, and raised the hope for development of hardy GM crops that would grow in disadvantaged parts of the world where previously none would grow. However, the concern also exists from many nations around the world that these foods may not be safe in the long term, and that GM seeds are financially unattainable for developing countries. Developed markets, such as the EU view GM seeds, specifically those developed outside of their member states, as another form of encroachment on their agricultural markets. They have made concerted efforts to bar access to their markets by invoking wide-spread public concerns about the safety of GM. The EU has used this access denial to extract concessions from non-EU biotech companies wanting access to EU markets. A leading U.S. biotech company, Monsanto, was only allowed to export its GM seeds to Europe

after it had made the seed fertile. This means that next year's crop could be seeded from the current EU seed production, something not available to North American, African or Asian farmers who must purchase their infertile seeds from Monsanto every year.

There seems to be general acceptance in the U.S. for GM foods. The major crops (corn, soybean, wheat et al) all tend to be genetically modified unless destined for an export market where they are not allowed. Bovine Growth Hormones or BGH, have also gained acceptance after having been proven safe for human consumption and significantly increasing milk yields. Overall, the Industry Study found that most, if not all places visited approved of biotechnology as a means of increasing yields, safeguarding the environment and improving competitiveness. It was also clear in our studies, however, that GM foods continue to polarize many of the nations of the world, some for health reasons, and others for purely economic ones. Like most developing technologies, there needs to be a continued dedication to research in determining the long-term effects, health and economic, of these products. Other technologies meanwhile are proving themselves in their application today.

Precision Agriculture

Precision Agriculture (PA) is an emerging technology which uses computer-based, very precise geographic coordinates to improve the efficiency of inputs (seed, fertilizer, pesticides, water), and the mechanical maintenance of crops (planting, tilling, harvesting) to increase their yields. Using remote sensing, geographic information systems (GIS) and the global positioning system (GPS), farmers not only grow better crops, but can also detect drought, diseases brought about by micro-organisms and insect damage. The terms specific farming, precision farming or site-specific crop management are also used to describe PA.

Work undertaken by the China Agricultural University and Kansas State University demonstrates that the application of PA technology increased crop yields by 10-15%. (Cowan, 2000) However, when equipping a $160K tractor with the necessary equipment for PA costs an additional $40K, it is not surprising that only roughly four percent of American farmers use PA and then only tend to be very large farms. (Cowan, 2000)

There are alternatives. PA service providers have emerged and, for fees ranging from one to two dollars per acre depending on whether unmanned aerial vehicles or small planes are used, they provide mapping and a bird's eye-view of a crop's needs in terms of pest control and water. As prices are further reduced, this service part of the value chain will likely grow in importance. The other practical application of PA and of mechanization as a whole is its ability to reduce the amount of labor required to produce agriculture's output. Tractors that drive themselves without overlap of ground and without stopping for any need other than fuel are attractive in a highly competitive labor market.

Similarly, maintaining a large herd of dairy cows through precision automation is not only leading edge, but economically sound. As mentioned in Section 2 of the paper, the Agribusiness IS group had the privilege of studying first hand a large dairy farm where 2,400 cows are kept, fed, cleaned and milked three to four times daily, entirely by precision machinery using an array of robotics slaved to laser sensors and regulating computers. The manpower to run this large scale operation consists of less than 10 people, a negligible amount compared to other dairy farms, yet the average milk's output of these cows is an industry leading 90+ gallons per day. This leading-edge farming operation was made possible through PA, from the

computers running the sensor lasers which in turn guided the cleaning and placement of milking apparatus by robotic arms on the cows.

Improvements in farm mechanization in the 20th and 21st centuries have lessened or in some cases eliminated much of the backbreaking labor of the farmer or food processors. In 1900, farmers represented 38% of the US labor force. It took them many weeks to plant and harvest one crop and four farmers to feed 10 people. Today, due to advances in mechanization, the entire Midwestern corn crop can be planted in 10 days and harvested in 20 days.

PA does have its limitations; as we witnessed in California's Napa and San Joaquin valleys, many delicate fruits and vegetables are not suited to mechanical harvesting. In those agricultural areas where PA and mechanization can be utilized, however, the competitive advantages gained by reducing labor costs and inefficiencies make this technological trend one that is sure to grow, along with others which will use nanotechnologies to improve food production.

Nanotechnology

Nanotechnology is the art and science of production and engineering at the molecular level. It is literally building things one atom or molecule at a time, and it has the potential to revolutionize the agriculture industry. From private industry to universities, organizations are pouring money into research and development to harness the capabilities of this emerging technology. Two examples that hold tremendous promise for agribusiness are in the areas of nanosensors and smart delivery systems.

According to the Cooperative State Research, Education, and Extension Service (CSREES) of the United States Department of Agriculture (USDA), nanosensors being developed will be able to detect harmful pathogens, contaminants, nutrients, environmental characteristics (light/dark, hot/cold, wet/dry), heavy metals, particulates, and allergens (Cooperative State Research, Education, and Extension Service [CSREES], 2006). These sensors will be used to scout crops on a daily basis for invasive species from wild animals to fungal pathogens, and alert farmers before significant crop damage occurs. (Scott & Chen, 2003) Using these sensors to monitor crop health will reduce the amount of required pesticides, help protect the environment and increase crop yields. With avian flu in mind, other developments hold even greater promise.

Researches at the Kopeland Laboratory at the University of Michigan are working on non-invasive bioanalytical nanosensors that can be placed in an animal's saliva gland to "detect a single virus before it has had a chance to multiply and develop disease symptoms" (Dunford, 2005). If an animal becomes infected with a life threatening disease today, it can take weeks or months to diagnose. By identifying the presence of a single virus at the point of entry, the nano-sensors can protect not only the infected animal, but the entire herd as well.

Leading edge technology is one of the key factors in establishing and maintaining America's competitive strength. Whether it be biotechnology, PA or nascent disciplines such as nanotechnology, resources must be dedicated to ensure this edge is maintained.

Consumer trends and impacts

Consumer trends constitute another major source of change in this industry. In the 1940s, as income levels rose, the U.S. underwent a dietary transition to a high protein diet. Between 1960 and 2001, total U.S. food expenditure as a share of disposable personal income declined

from 17% to less than 10%. (Martinez, 2002) Of the money spent on food, nearly 45% goes to the ever-expanding food service or restaurant sector. Real sales for restaurants rose 5.2% in 2000 after having grown by 4.5% in 1999. It is estimated that by 2010, 49% of all food dollars will be spent in restaurants. (Price, 2002)

Our study of a major food manufacturer, gave the group an insight in the vast amount of interdisciplinary research and development involved in tempting customers to either switch brands or simply to add a new product to their shopping carts. Dieticians, production line specialists and packaging experts are all involved in attempting to satisfy an increasingly demanding and varied consumer base. Notable trends include a rise in ethnic foods, conveniently packaged items and a seemingly inexhaustible amount of diet related products. This last trend is largely in response to an inevitable result of having cheap, prepared food and the money to buy it.

The obesity epidemic

One of the most worrisome consumer trends within the U.S. population is the result of having significant disposable income and access to a nearly unlimited supply of cheap food that is high in calories while low in nutritional value. Indeed, obesity is an epidemic that is ravaging America. Today, two out of three adults (64.5 percent) in the US are overweight (Body Mass Index of 25 kg/m^2 or higher) compared with 46 percent in 1976-1980, and nearly one-third (30.5 percent) are obese (Body Mass Index of 30 kg/m^2 or higher) compared with 14.4 percent in 1976-1980 (American Obesity Association). According to data from the American Heart Association (AHA) (2003), 136.5 million people among Americans age 20 or older are overweight, and of these 64 million are obese. The figures for overweight children are rising even more dramatically; the number of obese children ages 6-11 has gone from seven percent in 1976-1980 to 15.3 percent in 1999-2000, and for ages 12-19 the numbers have increased from five percent to 15.5 percent (AOA). Currently, nine million children in the US are overweight or obese – that's one in every five kids (Study: Obesity, 2004)

The health and economic impacts of this obesity epidemic result in other disturbing statistics. Obesity significantly increases the risk of diabetes, heart disease and high blood pressure. According to a study by the federal centers for Disease Control and Prevention, a poor diet and physical inactivity caused 400,000 deaths in 2000, a 33 percent jump over 1990 (Study: Obesity, 2004). Tobacco-related deaths in the same period climbed by less than nine percent and the gap between the two narrowed substantially (Study: Obesity, 2004). The rising healthcare costs associated with these diseases should be of grave concern to Americans. Currently, the US is spending $63.14 billion on Type II diabetes, $3.23 billion on hypertension, and $6.99 billion on heart disease (AHA, 2003). According to a report by the Rand Institute, at current rates, health care spending on obesity among people 50 to 69 years of age is expected to increase by 50 percent by 2020 (Study: Obesity, 2004). In view of the immediate costs to American society and an ever-shrinking working base to support an ageing population, the obesity epidemic needs to be addressed by the U.S, with the federal government leading the charge.

Globalization, be it market driven or in the form of invasive species, changes in the security environment, technological innovation and consumer trends are all contributing to the evolutionary changes of the American food and fiber industry. While some changes are positive, others need to be addressed as they represent risks that must be mitigated in order to maintain the competitive edge currently enjoyed by the U.S. Agricultural sector. The role of the U.S.

government in setting the conditions for the success of this critical sector is addressed in the next section of the paper.

Section 4 – Role of Government

The Agribusiness Industry Study's perspective of the role of government in shaping and supporting this industry evolved rapidly. The general image of agriculture as a refuge from government direction and regulation proved to be invalid, as the vast range of US and state measures to support and regulate the industry became clear. Direct support is provided by the United States Department of Agriculture (USDA), including the Land Grant Universities and Cooperative Extension Services. Other direct support includes legislated farm bills, a host of regulations aimed at protecting all those involved in the value chain, and a cooperative security apparatus coordinated by the Department of Homeland Security. The transportation, energy and water infrastructure provide indirect but nonetheless essential support. This section of the paper surveys the role of government in supporting the U.S. agricultural sector.

Direct Support

USDA

Formed in 1862 by President Abraham Lincoln, USDA's initial role was to support the U.S. population, which was comprised of 58% farmers at the time. From this initial intent USDA has grown; it now administers the Federal food stamp, school breakfast, lunch and Women, Infants and Children (WIC) programs, and is the steward of the nation's 192 million acres of national forests and rangelands. USDA is responsible for all of the nation's food safety, is involved in supporting U.S. interests abroad through its foreign agricultural service, and supports rural America through the efforts of the office of the Under Secretary for Rural Development. Its Economic Research Service's (ERS) 450 employees conduct a research program "to inform public and private decision making on economic and policy issues involving food, farming, natural resources, and rural development". (USDA ERS, 2006) Its Agricultural Research Service (ARS) has 8000 employees, 2100 of whom are scientists, and 100 lab locations. (USDA, 2006) ARS plays a major role in the nearly $10 billion spent annually in the U.S. on agriculture related research and development, be it through basic research alone or in partnership with other institutions and the private sector. This government investment in areas from basic science to applied engineering is critical to the sustained health of the industry. It is becoming more so, as profit margins limit private investment in R&D and as international competitiveness intensifies.

Land Grant Universities and Extension Services

All of our major American universities engage in research and teaching, but the nation's more than 100 State Universities and partners have a third critical mission—extension. "Extension" means "reaching out," and—along with teaching and research—land-grant institutions "extend" their resources, solving public needs with college or university resources through non-formal, non-credit programs, most of which focus on agriculture and agriculture related issues. With an office in or near most of the nation's approximately 3,000 counties—extension agents help farmers grow crops, homeowners plan and maintain their homes, and children learn skills to become tomorrow's leaders. (USDA CREES, 2006)

The Morrill Act of 1862 established land grant universities to educate citizens in agriculture, home economics, mechanical arts, and other practical professions. A half century later, the extension program was formalized in 1914, with the Smith-Lever Act. It established the partnership between the agricultural colleges and the U.S. Department of Agriculture to provide for cooperative agricultural extension work. At that time, more than 50 percent of the U.S. population lived in rural areas, and 30 percent of the workforce was engaged in farming. The two-fold purpose of the Act was to develop practical applications of research knowledge; and to give instruction and practical demonstrations of existing or improved practices or technologies in agriculture. (USDA CREES)

Extension's engagement with rural America facilitated the American agricultural revolution, dramatically increasing our nation's farm productivity. For example, in 1945, it took up to 14 labor-hours to produce 100 bushels of corn on 2 acres of land. By 2002 that same 100 bushels were produced in under 3 labor-hours on less than 1 acre of land. Between 1950 and 1997, the number of farms in the U.S. declined dramatically—from 5.4 million to 1.9 million. During the same period, farm production increased from one farmer supporting the food needs of 15.5 persons in 1950 to one farmer supporting 100 persons in 1990. By 1997, one farmer supported the food needs of almost 140 U.S. citizens. (USDA CREES)

The land grant and extension system extends beyond purely agricultural programs to help rural Americans in many ways. During the Great Depression, Extension agents not only taught farmers about marketing and buying and selling cooperatives, but also taught farm women good nutrition, house gardening, home poultry production, home nursing, furniture refinishing, and sewing—skills that helped many farm families survive the years of economic depression and drought. Countless children benefited from the educational and leadership development offered by the 4H Club system. Today, the national Cooperative Extension System remains an important player in American life. It has adapted to changing times and landscapes, and it continues to address a wide range of human, plant, and animal needs in both urban and rural areas. (USDA CREES)

The Farm Bill

Another form of direct support, extremely controversial both domestically and abroad, is the system of subsidies established in the Farm Bill. Revised every five to seven years and scheduled for renewal in 2007, the bill was originally intended to feed the nation and enable farmers to make a living in the face of constantly changing market and weather conditions. Critics argue that the Farm Bill's huge expense, highly politicized process for designating recipients, and trade and production distorting effects all make this legislation obsolete. The question then is whether Congress will perpetuate the funding levels and framework of the current Farm Bill, or phase out the current program. This decision will impact the U.S. internationally and domestically; the reduction or elimination of the subsidies will help open foreign markets to American producers across a range of industries. However, the elimination or reduction will impact those farmers who have traditionally received subsidies and whose survival, in many cases, is dependent on this type of income. It would also come, potentially, at a very high political price for the party or politicians supporting fundamental change. Prospects for this bill were a common theme of our travels, whether among legislators, those receiving

support, and those not subsidized. The effects of the current farm bill, along with a brief discussion of the political forces which will affect its form in the future, is included in Section 6.

Social Regulation – Public Health and Safety

There are literally dozens of agencies and departments, which regulate every step of the food value chain, and implement legislation as it is passed. These include but are not limited to the Food and Drug Administration, Environmental Protection Agency and Department of Health and Human Services, to name just a few. Of greatest interest to U.S. agriculture are the sanitary and phytosanitary regulations implemented to ensure that food products entering the U.S. meet or exceed domestic requirements for quality and safety, an objective that has been successfully met. Oversight and enforcement of U.S. sanitary regulations are performed by the USDA's Animal and Plant Health Inspection Service (APHIS) and Plant and Pest Quarantine (PPQ). Another department, the U.S. Department of Homeland Security, addresses the security of the critical agricultural infrastructure and key resources through the Food and Agriculture Public-Private Partnership Framework.

At the outset of the study, the Industry Study members instinctively shared the normal American distaste for regulatory burden. The visit to China, however, reminded all of the members of the value of environmental and food safety regulation to preserve a liveable society and a safe food supply. A series of factors in China—from the pattern of land use and ownership, to the limited degree of central regulation of farms, to the vast supply of manpower in the agricultural area—all worked to weaken the regulatory framework of their agricultural sector, leaving serious problems in food safety, technological adaptation, and environmental awareness.

Public-Private Partnership and Food Safety

The overarching goal of the National Infrastructure Protection Plan (NIPP) is to build a more secure and resilient America by enhancing protection of the Nation's critical infrastructure prevent or mitigate the efforts by terrorists to incapacitate them, and enabling national preparedness and rapid recovery in the event of an attack, natural disaster, or other emergencies.

The Homeland Security Act of 2002 provides overall authority for DHS's mission for infrastructure protection. DHS has established the Food and Agriculture Sector Coordinating Council (SCC) to represent industry interests, and the Food and Agriculture Government Coordination Council (GCC) for Federal, state and local government representation.

Homeland Security Presidential Directive 7 (HSPD 7) specifically identifies agribusiness as a critical infrastructure and designates the USDA as the Sector Specific Agency for agriculture meat, poultry, and egg products, and, U.S Department of Health and Human Services (HHS) for all other food products. As identified Sector Specific Agencies they lead and work in concert with DHS in implementing the NIPP framework of these designated CI/KR sectors. Other government participants in the GCC include DOD, EPA, National Association of State Departments of Agriculture, and livestock and territorial health officials. It is also important to note that the Food and Agriculture GCC also work closely with the water, energy, chemical, information technology, shipping and public health GCC's.

Indirect Support

Indirect support is provided through the very infrastructure that DHS and other agencies seek to protect. The advantage of a robust infrastructure to the American agricultural industry cannot be overstated. Domestic rail, road, port, inland waterway and pipeline systems allow not only for the transportation of the processed food to the retailer and consumer, but also of all inputs to the farmer for growing the crops or livestock. The telecommunications system continues to grow in importance not only for the transmission of voice and electronic communications, but also for the transfer of data required for the use of Precision Agriculture and automation. The nation's banking system, itself dependent on the electronic infrastructure, is another essential part of the supporting infrastructure for agriculture, as are water and irrigation systems, the electrical grid and the good old U.S. Postal System. Without these indirect forms of governmental support, the U.S agribusiness and most other American industries would not be able to produce and compete as they do.

As with the regulatory regime mentioned above, the trip to China heightened the Industry Study seminar's appreciation for the advantages American agribusiness enjoys in this area. In China we found an inadequate post-harvest and transportation infrastructure, a financial system that was not oriented to supporting this sector, and severe environmental problems affecting the availability of land and water.

Section 5 – Critical Enablers

Land, water and labor garnered our attention throughout the study. All three of these critical enablers for the industry are under pressure from competing users, creating important policy issues as governments seek to balance among priorities while preserving the agricultural capability of the nation.

Urban Encroachment

Employing nearly 23 million people in the U.S., and contributing nearly $1 trillion to the nation's economy, the agricultural industry represents more than 13 percent of Gross Domestic Product (GDP) (American Farmland Trust (AFT), Why Save Farmland, 2006, p. 1-2). Furthermore, American agriculture plays an important role in worldwide markets and the balance of trade as one out of every three acres cultivated in the U.S. is devoted to production that is exported (Dooley, 2006, p. 4). Globalization, coupled with increasing populations, will only further that role. Latin America, including Mexico, purchases approximately $10 billion of U.S. agricultural products annually with Asian markets accounting for $23.6 billion in annual imports (AFT, Why Save Farmland, 2006, p. 2). Although domestic food shortages are unlikely in the short run, census data predict worldwide population growths of 42 percent over the next 50 years (AFT, Why Save Farmland, 2006, p. 2). Couple this with the fact that of the 78 million people added to the world each year, 95 percent live in less developed regions, highlighting the need for an investment strategy that preserves the nation's agricultural base as an increase in global demand for U.S. products is almost certain (AFT, Why Save Farmland, 2006, p. 2). Finally, the World Bank estimates that 140 million people could be lifted out of poverty by 2015 if members of the World Trade Organization ended subsidies and eliminated agricultural trade barriers (AFT, Vision for Change, 2006, p. 3). Therefore, the need for U.S. agriculture, and the invaluable farmland that the nation provides, has never been more critical.

The nation's farmland also supports the economic base of many rural and suburban communities as evidenced by the fact that farms in the 1,210 most urban-influenced counties produce 63 percent of dairy products and 86 percent of fruit and vegetables (AFT, Why Save Farmland, 2006, p.1). Unfortunately, what has made this land desirable for farming has also made it even more desirable for urbanization. Rich farmland tends to be closest to urban centers, tends to be flat and well drained, and is fast becoming more affordable to developers than it is to farmers and ranchers (AFT, Why Save Farmland, 2006, p.1).

Many economists argue that the percentage of prime U.S. farmland lost is small, accounting for only 1.3 percent of the total from 1982-1992, and is offset by technological advances in boosting productivity (Tyson-Scott, 1997). However, conservationists stress that losing even a small portion can have major impacts, particularly on the supply of produce to urban markets where twenty of the most threatened prime farming areas supply half the fruit, two-fifths of the vegetables and a third of the dairy goods produced in the U.S. (Tyson-Scott, 1997).

The trends toward urban encroachment are alarming. Every single minute of every day the U.S. loses two acres of farmland (Wirka, 2003, p. 11). Key among the reasons for this continuing trend in urban sprawl is the nation's insatiable need for more space. Over the past 20 years, the acreage per person for new housing has almost doubled and since 1994, lots of 10-22 acres have accounted for 55 percent of the growth in housing alone (AFT, Why Save Farmland, 2006, p.1). Additionally, despite a population growth of only 17 percent, urbanization has grown at 47 percent (Wirka, 2003, p.11).

More problematic is that the best agricultural soils are being developed the fastest, with the ultimate paradox that where people want to develop most is also the area of the best farmland required to feed them. This is borne out in the fact that less than one-fifth of U.S. land is high quality yet this is the land that is being overdeveloped at a rate 30 percent faster than non-prime land (Wirka, 2003, p.11).

Development of farmland continues at an astronomical rate and shows signs of further acceleration. According to the United States Department of Agriculture (USDA), between 1982-2001, approximately 34 million acres, or roughly the size of Illinois, were converted for development (USDA, National Resources Inventory, 2001, p. 1). More importantly, 10 million acres of the new land developed was considered prime farmland with the rate of development increasing from 1.4 million acres per year from 1982-1992 to 2.2 million acres per year from 1992-2001 (USDA, National Resources Inventory, 2001, p. 1-2).

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It's All About the Water

Water availability is an increasingly critical constraint when it comes to supporting expanding food production in much of the world's agricultural regions. (Wood, Sebastian & Scherr, 2000) Even though it is one of the most abundant resources on Earth, many people abuse this resource making water one of the most undervalued resources. While it is the most important ingredient for farmer's livelihood everywhere in the world, water availability can no longer be taken for granted for sustained agriculture.

Ninety-five percent of all water in the world comes from the earth's oceans and four fifths of the earth's fresh water is locked up in the ice caps and glaciers. (Bleeding the Earth Dry, 2004, p. 36) The rest of the remaining fresh water resides in aquifers, lakes, and rivers, which are slowly replenished by rain fall. There is not much fresh water left to use for agriculture and other forms of consumption for a world population of 6.3 billion people. According to a report published by the World Resources Institute; "by the year 2025, with world population projected to be at 8 billion, 48 countries containing 3 billion people could face chronic water shortages." (Wood, Sebastian & Scherr, 2000)

Water is considered the ultimate renewable resource. In the year 2000, approximately 346,000 million gallons of fresh water was withdrawn from surface and ground water sources such as rivers, lakes, reservoirs, and wells. (Perlman) Of this amount, agriculture accounts for 40 percent of water withdrawn. (Hutson, 2005) Agricultural irrigation is the largest use of freshwater resources in the United States; since 1950, the amount of irrigated acreage has more than doubled and water withdrawn for this purpose totalled 137 million gallons per day in 2000. (Hutson, 2005) The demand for irrigation will only increase as the population in the United States, and the ever increasing demand for high quality fruits and vegetables, continue to grow. Because water withdrawals exceed the rate of replenishment, severe water scarcity presents the single biggest threat to future food production. Most of the United States agricultural production comes from the western states with two main water sources used to irrigate the crops; the Ogallala Aquifer located in the Great Plains states and the Central Valley Project (CVP) in California.

Ogallala Aquifer

The Ogallala Aquifer is a 174,000 square mile body of water that underlies parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. (Torell, Libbin & Miller, 1990, p. 163) It is the largest fresh water aquifer in the world and contains about 3.5 billion acre-feet of water. (Peterson, Marsh & Williams, 2003, p. 15) The Ogallala is essential for the crop production, livestock, and meat processing industries in this region, and many areas of the aquifer have been declining from continued deep well pumping. The aquifer's output is estimated to be 12 to 40 times higher than its natural recharging, and, according to a report called "A New Era for Irrigation" by the National Research Council, "pumping of the aquifer will continue to reduce water availability, reduce well yields, and increase pumping lifts." (National Research Council, 1997, p. 133)

California's Central Valley

Through agricultural ingenuity, California has become a vast fertile land allowing agriculture to become the bedrock industry in the state. With over one million workers supporting more than 77,000 farms and ranches, they produce more than 350 crops and are responsible for over $32 billion in direct farm sales. (Azumi, 2005) California grows half of all the domestically produced fruits, nuts, and vegetables consumed by Americans. (Azumi, 2005)

The largest source of water for California's agricultural industry comes from the Sacramento and San Joaquin River Delta. However, the viability of these rivers is questionable due to the massive amounts of fresh water that is drawn by the Central Valley Project. Because of the sheer volume of water withdrawn and the system's inability to recharge the amount depleted, portions of the San Joaquin River dry up completely every year. (Endangered Fisheries Initiative, 2005)

The Central Valley Project is a federal water project which was undertaken by the Bureau of Reclamation in 1937 as a long-term plan to use water in California's Central Valley. The need for the CVP was mainly due to the fact that the average annual rainfall ranges from 5 inches in the southern end to more than 30 inches in the northern end of the Central Valley, with more than three-fourths of the rainfall coming in a 5-month period from December through April. This condition caused seasonal floods and droughts with heavy winter and spring runoffs, leaving a shortage of water in the summer and autumn when it is most needed for irrigation. Because maturing crops need water at a time of year when natural water flow is lowest, many farmers resorted to irrigating by pumping from wells. As irrigated agriculture expanded, the water pumped from the ground greatly exceeded the natural recharge by rainfall. Thus, hundreds of thousands of acres developed for irrigation in the southern part of the valley drew on a rapidly diminishing supply with an increasing demand for water.

According to a report written by the Environmental and Energy Study Institute, "approximately 24 percent of the farm land in the 48 contiguous states is irrigated… In descending order the top five states are California, Nebraska, Texas, Idaho, and Colorado... Irrigated farms produce approximately 60 percent of the total crops harvested in the United States and approximately 30 percent of farm revenues… Irrigation uses approximately 41 percent of the fresh water withdrawn from surface and ground water." (Fulstone, 1997)

It's no secret; as the population in America increases, access to fresh water resources decrease. As water resources continue to grow scarce and begin to threaten the way of life for everyone in the United States, and not just farmers, people need to recognize the true economic costs of water use in order to encourage conservation. According to National Geographic News, "Reports indicate that rising global consumption rates, poor water management, and increased global temperatures could leave two of every three people in the world affected by water shortages a generation from now." (Frank, 2001) With the Ogallala Aquifer being depleted at a rate higher than its recharge capacity and more water being withdrawn from the CVP in order to farm land that would otherwise be non-productive, a balance must be maintained between supply, demand, economy, and environment.

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Labor, Security, and Production

Most labor sectors of American agriculture have dealt with labor shortages by employing foreign workers at lower cost to meet the necessary workforce requirements. For this reason, farm labor remains disruptive, with policy debates over farm employer access to foreign workers and government enforcement of labor and immigration laws. Currently, immigration and border security proposals are being disputed in the US Senate. If legislative decision makers only address border security and enforcement and single out a viable plan for the workforce currently in the U.S., the impact to American agriculture could be huge. (Farm Bureau News, 20 March 2006)

Farmers have favored development and acceptance of mechanization to manage costs and reduce challenges involved in hiring and retaining non- family labor. Mechanization in the livestock sector for dairy is a good example, where significant advances have been made in mechanical milking through the use of robotics. While these driving forces have reduced the need for farm laborers in certain areas, several agricultural sectors still rely heavily on hired labor. Unlike grains and sugar, certain perishable crops such as fresh fruits and vegetables that are harvested by hand at calculated times of the year in order to escape mechanical damage and meet consumer demands. Although mechanical innovation has progressed significantly, technologies such as robotic systems to totally replace hand harvesting of fruits and vegetables are still in their infancy and are not yet able to reduce the labor demand. (American Farm Bureau, pp 1-6)

Presently, when U.S. workers are not available to meet the seasonal demand for hired farm work, employers augment the permanent labor force with foreign workers, many of whom are not authorized to hold U.S. jobs, for temporary relief. Activists behind regulatory efforts to protect this segment of the workforce and avoid the displacement of US workers argue that farmers can survive with limited unauthorized workers based on mechanization, and that the agriculture industry can increase wages above state and federal minimum wages and continue to compete with imports. Farm growers insist that they need access to foreign labor because there is an inadequate supply of U.S. workers willing to work these jobs, and that substituting lost labor for mechanization is not the solution since some crops still lack feasible mechanical harvesting options. The debate remains whether the supply of foreign labor reduces domestic workers wage and employment opportunities. (Levine, 2004, p. 4)

The temporary agricultural program in the US was authorized in 1952 as the H-2 program, and later amended as the H-2A. Under the H-2 provisions of the Immigration and Nationality Act, non-immigrant foreign workers may be employed temporarily in the U.S. agriculture provided U.S. workers are not available. The employers must meet certain requirements to ensure recruiting efforts were achieved for domestic labor and that the employment of the foreign workers will not detrimentally affect wages and working conditions of domestic farm workers. Employers participating in the H-2A must also provide domestic workers the same minimal wage and period of employment equal to the average wage, and benefits provided for the foreign workers. (Fagnoni, 2000)

The link between immigration policies and farm labor has resurfaced as an issue on the public scene and engrossed political attention. Many continue to argue that the current H-2A program is inflexible, entails taxing regulations, and does not accommodate sufficient guest workers (30,000 a year) each year.(American Farm Bureau, 2006) In response to the immigration issues from the political opposition, the debate involves enforcing tougher border

controls and cracking down on illegal immigrants in the U.S.. The reality is that the number of illegal immigrants continues to dominate the agriculture labor force and grow substantially regardless of the risk associated with penalties and barriers they face when entering U.S. borders.

Faced with issues and concerns of Homeland Security and how to deal with over 11 million illegal immigrants, new legislation for immigration reform is currently a high priority as the Senate debates a proposal to bring immigrants into a legal workforce. "At issue is a guest worker provision that would allow hundreds of thousands of foreign workers legal access to the US labor market each year and the impact those new low wage workers would have on stagnant wages."(Weisman, 2006) The Bush proposal recommends changes to the immigration system that would strengthen border control, support a guest worker program for illegal immigrants who have jobs, and eventually provide opportunities for citizenship. (Gamboa, 2006, p.2) The Senate proposal which is similar to President Bush's plan, is generally in favor of guest workers, enhanced border enforcement, and the opportunity for citizenship to many millions of men and women already in the country illegally. New immigration legislation to bring the bill to a final vote is expected in late May 2006.(USA Today, 22 May 2006)

The use of foreign labor in American agriculture has been proposed to Congress and a constant source of debate for decades. The U.S. should not chase out every illegal immigrant already working in this country. Doing this is counterproductive and costly. We should adopt a revised policy that endorses U.S. laws, supports homeland security, and supports our economy. In recommending a revised immigration policy that satisfies lawmakers, employers, foreign workers, and the nation, it is vital to consider the significant link between labor cost issues, domestic food security, and homeland security.

One short term solution to meet U.S. homeland security concerns is establishing a guest worker program. The policy, similar to Bush and the Senate proposals, would give workers already employed in agriculture the opportunity to work legally, to apply for green cards, and would eventually put them on a path to citizenship. This should help the agricultural industry meet immediate requirements without violating current immigration laws. It is estimated that 300,000 – 500,000 are needed on an annual basis. To accommodate a larger number of workers efficiently and with minimal disruption, we need to streamline the application and review process in the U.S. to protect homeland security, but not at the expense of law enforcement. Lastly, the Senate proposal to augment border control by using National Guard troops for intercepting illegal immigrants at the ports of entry is valid and is required to support U.S. interests in increasing homeland security. Long term solutions to this continued conundrum should include increased funding for research and development to create the required technological innovations to achieve mechanical harvesting of fruits and vegetables. (Krikorian, Jun 2001, pp. 5-6)

Conclusion

Finding a balance that respects the views of all individuals and parties engaged in this immigration issue while protecting the agriculture business is critical. If Congress is not careful in assembling a more restrictive immigration policy, the US growers stand a chance of losing a significant part of their workforce along with their competitiveness with foreign suppliers. The final decision will have world-wide significance, reflect American ideals as a whole, and establish a new precedent for what the American Dream has become and the sacrifices that must be made to become an American.

Section 6 – Major Issues

In keeping with the paper's theme of the role played by Agribusiness in the preservation of U.S. security, two essays have been included for consideration. The first deals with the issue of protection against bio-terrorism and pandemics in the form of Avian influenza, while the second deals with the Farm Bill and the WTO trade regime, and the economic impact this represents to the U.S. economy.

Protection against Bioterrorism and Avian Influenza

CNN WIRE *"Washington D.C, July 2006: Another 10,000 children in the Washington DC area died in the past twenty four hours as a result of botulinum toxin poisoning bringing the death toll to 23,000 in ten days. Among those children included family members of more than 60% of Congress, the Executive Branch, Department of Defense employees assigned to the D.C. area and business leaders of more than half of our nation's Fortune 500 companies whose jobs required their residence here in the DC area. Our government and our nation's economy are virtually paralyzed. Thirty local supermarkets have been attacked in the last ten hours, the DC National Guard has been called out to protect grocery stores and dairy farms in the area, and the New York Stock exchange plunged to its lowest levels in more than forty years today. ….this just in.: An audio tape, reportedly from Usama Bin Laden, has been released by Al Jazeera where the terrorist leader has claimed responsibility for the deaths of the children with this quote: "the spawn of the infidel has now felt Allah's wrath, and once again, the holy warriors of Islam have dealt a blow to an enemy who can never protect itself against the dedication and ingenuity of the chosen fighters of the Caliphate. Allah Akbar!" "Other outbreaks have now been reported in Chicago, New York, Los Angeles, London, Fort Bragg, Travis Air Force Base, Camp LeJeune, San Diego, and Fort Hood." In other news, seventeen outbreaks of foot and mouth disease have crippled our dairy, and pig production in twelve states and Avian Influenza has been detected in five western states along the migratory flyways. "Excuse me…oh no, God no, she was only four…I'm sorry, I have to leave, my daughter just died…."*

Bioterrorism

Loss of life, as well as economic and psychological shock, define the potential impact of bio/agroterrorism against the United States. While much has been done to improve our Nation's capabilities to counter or mitigate the effects of such a deliberate attack, even a cursory examination of food and water supply chains indicate the potential for catastrophe. More importantly, the Agribusiness Industry Study found that with relatively little effort, a very few number of committed terrorists could create a "perfect storm" by attacking the soft target of America's food supply as a precursor or complement to attacks against other targets. Even anecdotal evidence gathered in interviews with dozens of businesses in the San Joaquin Valley of California indicate that the scope of the threat, the lack of resources available, and the slim profit margins defining this industrial sector place agribusiness literally between the proverbial "rock and hard place" when it comes to dealing with the terrorist threat. Moreover, those businesses were so focused on maintaining that competitive edge, that they focused few, if any, resources or time to address the potential terrorist threat. In short, because it was not a crisis, and had the

potential to affect their "bottom line," the issue remains a looming challenge against which additional time, thought, and resources must be committed. Because America and its population constitute such a desirable target for terrorism, the threat cannot be denied.

Compounding this problem is the fact that foreign producers of agricultural commodities are becoming more competitive as economies of scale and transportation capabilities have opened American markets to products produced at the significantly lower cost demanded by the American consumer. Therefore, in order to counter the terrorist threat, American businesses will have to spend even more on protective measures thereby reducing profit margins even further. Indeed, protecting our agriculture against terrorism may be the straw that breaks the camels back in terms of the competitiveness of the American Agricultural industry. Extending the argument further, will the American consumer, or the agricultural sector, insist on the same degree of food security for imported products and in so doing establish trade distorting measures that constitute de facto tariffs that will effectively eliminate many of our foreign competitors? If past is prologue, such measures will likely open our producers for retaliatory measures as international producers react to parochial actions that allow domestic producers to regain an equal footing while simultaneously responding to a uniquely American requirement borne from the war on terrorism. Clearly, security requirements constitute a double-edged sword.

The intention of this essay is not to paint a "sky is falling scenario." On the contrary, our nation's leadership has done much to identify critical vulnerabilities to America's ability to feed itself and much of the world. Indeed, following a logical progression, after doing much to secure the nation against direct terrorist attack, the executive and legislative branches acted to expand their examination of our nation's critical infrastructure and committed additional resources to meet the challenges associated with revealed vulnerabilities. Homeland Security Presidential Directives 5, 7, 8, 9 and 10 provided well thought out roadmaps for dealing with the nation's overall protection and response to critical infrastructure and bioterrorism threats. Significantly however, the examination required by these directives exposed not only the relative ease with which agro terrorism could be committed, but also the scope and complexity of the vulnerabilities and the problematic nature of balancing response to those vulnerabilities with the economic reality of committing resources to address them in a highly competitive market. In short, comprehensive examination of critical nodes of vulnerability in any sector of the industry, and the interconnectedness of every element of the supply chain, in many cases, quickly overwhelmed even the most committed advocates for agricultural protection. How did we get ourselves into this predicament and how do we overcome it?

Many of the same environmental and geographic conditions that traditionally protected America from direct military attack contribute to a false sense of safety that discourages comprehensive action to protect our food supply. After all, geographically, we had the advantage of two massive oceans to protect our food supply from traditional threats. Even unintentional threats to our agriculture in the form of invasive species or unintentional introduction of pathogens have a well-developed system of inspection, monitoring, reporting and treatment/eradication through the Food and Drug Administration (FDA) the US Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS), the Center for Disease Control (CDC), and other agencies. The capabilities brought to the table by these organizations resulted in the quick identification and counteraction against multiple threats to the

agriculture industry throughout their history. While such unintentional attacks against the industry were not without cost, the ability to quickly identify and mitigate the problem reinforced a false sense of security from *intentional* attacks.[4]

After September 11th however, experts within both public and private organizations and companies quickly realized that the threat posed by terrorists to use asymmetric tactics against critical nodes within the agricultural supply chain in deliberate (as opposed to accidental/unintentional) attacks presented chilling possibilities. In response, public and private efforts to mitigate the threat within the past two years have grown exponentially. Nonetheless, the problem is "medusa-like" in its scope. When one vulnerability is exposed and dealt with, others are revealed. As a result, those charged with protecting the food supply are constantly placed on the horns of a dilemma. That dilemma is where, what, and how to protect critical nodes while simultaneously remaining competitive with countries that do not have to commit resources to defend against deliberate attack. And, understanding that even the most extensive effort may not protect against a terrorist willing to die and who, has only to be successful one time, within hundreds, if not thousands of potential opportunities.

Fact or Fantasy?

The potential for attack is not a conceptual exercise. During Operation ENDURING FREEDOM in Afghanistan, US forces seized four documents detailing agricultural targets in raids on Al Qaeda facilities in Khandahar. In February 2003, documents captured in Pakistan provided details of planned attacks against an MRE packing facility in McAllan Texas. Particularly vexing about subsequent actions taken at McAllen to protect against the threat indicated a significant vulnerability with respect to undocumented workers access to products. If visits to multiple firms in the agricultural supply chain in California are indicative of the rest of the nation, the problem of undocumented and potentially hostile workers constitutes a glaring vulnerability among harvesting, packing, and processing businesses who hire such workers to remain competitive with foreign producers. [5]

The 9/11 post-mortem revealed that the aircraft hijackers specifically targeted vulnerabilities in the American agricultural infrastructure. Mohammed Atta attempted to use the USDA's Farm Services Agency loan program designed to help farmers with little or no credit to purchase big-ticket items, to purchase a crop dusting aircraft. Although Atta was turned down because of US citizenship requirements, the possibilities for using this aircraft against agricultural targets or other targets with airborne agents or pathogens remain particularly frightening. [6]

There might be nor shortage of assistance to such terrorism from the home front. Indeed a symbiotic relationship of sorts might be established between organizations like Al Qaeda and the Animal and Earth Liberation Fronts (ALF and ELF) to further their specific agendas. ELF and

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[4] Moon, Harley W. et.al., (2003), *Countering Agricultural Terrorism*, National Research Council of the National Academies, Committee on Biological Threats to Agricultural Plants and Animals, Board on Agricultural and Natural Resources, Board on Life Sciences, The National Academies Press, Washington , D.C.
[5] Hoffman, John T., Col USA (ret.) *Protecting the Nation's Food and Agricultural Infrastructure*, PowerPoint Briefing to Agribusiness Industry Study, Slides 3& 4, 10 March 2006, Ft. McNair, Washington, D.C.
[6] Ibid, slide 5

ALF have conducted at least ninety-two specific attacks against agricultural targets since 1996. Even disgruntled workers can pose a significant threat. In January 2003, a disgruntled Michigan employee deliberately contaminated beef with a nicotine-based insecticide, poisoning 111 people. This type of post-kill step introduction of a poison or pathogen presents perhaps the greatest potential for massive terrorist impact in the short term. [7]

An uphill struggle

As indicated above, the potential for agro terrorism is more than just a fanciful exercise in mental gymnastics. Indeed, despite considerable improvements since 9/11:

- Agriculture and food infrastructures, like many of our basic infrastructures, are open and ubiquitous.
- Most food and agriculture infrastructure is privately owned, and therefore not directly controlled by the organizations charged with ensuring the nation's safety.
- Food and agriculture transportation systems are vulnerable to attack as are many cross-infrastructure components essential to the operation of the infrastructure, such as water, energy, etc.
- Bio-Security Research and Development efforts across the food and agriculture supply chain are not coordinated or synchronized, resulting in overlaps and gaps in these efforts.
- There still exists a broad sense of complacency within the food and agriculture infrastructure, both within governments and within industry. (Even though some 400,000 domestic and international businesses providing agricultural/food products have registered with the FDA)
- Disease surveillance and detection, for humans and animals, is most often not integrated.
- There are a high percentage of immigrant workers across the sector whose legal status and backgrounds are questionable at best.
- We lack adequate vulnerability reduction plans and deployed mitigation strategies.
- Production system 'Nodes' and granular vulnerabilities that offer effective terrorist targeting points are not generally understood or mapped because even the FDA's Strategic Partnership Program Agroterrorism vulnerability assessment program *is voluntary*.

Even Hurricane Katrina provided salient learning points that indicate unaddressed vulnerabilities:

- Heartland US Production agriculture uniquely dependent upon the Gulf Coast
- Animal agriculture operations not addressed in most states response planning – animal population still not a part of most state's preparedness plans.
- Most production agriculture firms lack a direct planning and coordination relationship with their state's emergency management elements.
- Infrastructure're-start' not central to most states planning.
- Most consumers and most of the private sector not prepared for major disasters – few have planned for 3-5 days self sufficiency – despite warnings.

[7] Ibid, slides 6 & 7

Despite all of the above examples and recent lessons, implementing HSPD's 5, 7, 8, 9, and 10, remain limited by resources and the constraints of reality. Indeed, despite the "command guidance" provided by the directives, the National Infrastructure Protection Plan (NIPP) for agriculture as a specific strategic sector remains unfinished. [8]

The light at the end of tunnel is not a train!

The USDA, DHS, FDA and CDC, do however continue to move ahead as resources and awareness improve. Specifically, based on "understanding the nation's food supply as a system, they continue to identify its most critical components in terms of the threat, vulnerability and consequence, and then develop means to reduce that risk at each critical node within the system." (Hoffman brief p. 53-54) As they accomplish this however, they admit that they will find additional gaps in the system and technologies needed to close those gaps. Indeed, DHS's Office of Domestic Preparedness now includes the food and agricultural sector in training programs and national preparedness goals as part of a "public-private effort that builds and sustains a protected national food supply chain where the U.S. Food and Agriculture Infrastructure is secure, resilient and prepared." [9]

U.S. Department of Homeland Security (DHS):
Food and Agriculture Public-Private Partnership Framework

The overarching goal of the National Infrastructure Plan (NIPP) is to:

> Build a safer, more secure, and more resilient America by enhancing protection of the Nation's critical infrastructure and key resources (CI/KR) to prevent, deter, neutralize, or mitigate the effects of deliberate efforts by terrorists to destroy, incapacitate, or exploit them; and enabling national preparedness, timely response, and rapid recovery in the event of an attack, natural disaster, or other emergencies. (p. vii)[10]

This goal is supported by four objectives: (1) Understanding and sharing information about terrorist threats and other hazards; (2) Building security partnerships and coordination mechanisms; (3) Implementing a long-term risk-management program; and, (4) Maximizing efficient use of resources for CI/KR protection.

The Homeland Security Act of 2002 provides overall authority for DHS's mission for infrastructure protection. To establish strong collaborative working relations between the public and private sectors, DHS has established the Food and Agriculture Sector Coordinating Council (SCC) to represent industry interests; and, the Food and Agriculture Government Coordination Council (GCC) for Federal, state and local government representation. Both senior representatives of the GCC and SCC also represent their interests in a joint Coordinating Committee. This committee represents food and agriculture infrastructure interests in a larger overall organization called the Critical Infrastructure Partnership Advisory Council (CIPAC).

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[8] Ibid, slides 8,9,11, 51
[9] Ibid, slide 55
[10] National Infrastructure Protection Plan, page vii.

Their collaborative activities with other infrastructure representatives include critical infrastructure protection planning, coordination, implementation, and operational issues, and incident response, recovery and reconstruction.

Specifically in agribusiness, Homeland Security Presidential Directive 7 (HSPD 7) identifies the U.S. Department of Agriculture (USDA) as the Sector Specific Agency for agriculture meat, poultry, and egg products; and, U.S Department of Health and Human Services (HHS) for all other food products. As identified Sector Specific Agencies they lead and work in concert with DHS in implementing the NIPP framework of these designated CI/KR sectors. Other government participants in the GCC include DOD, EPA, National Association of State Departments of Agriculture, and livestock and territorial health officials. It is also important to note that the Food and Agriculture GCC also work closely with water, energy, chemical, information technology, shipping and public health GCC's.

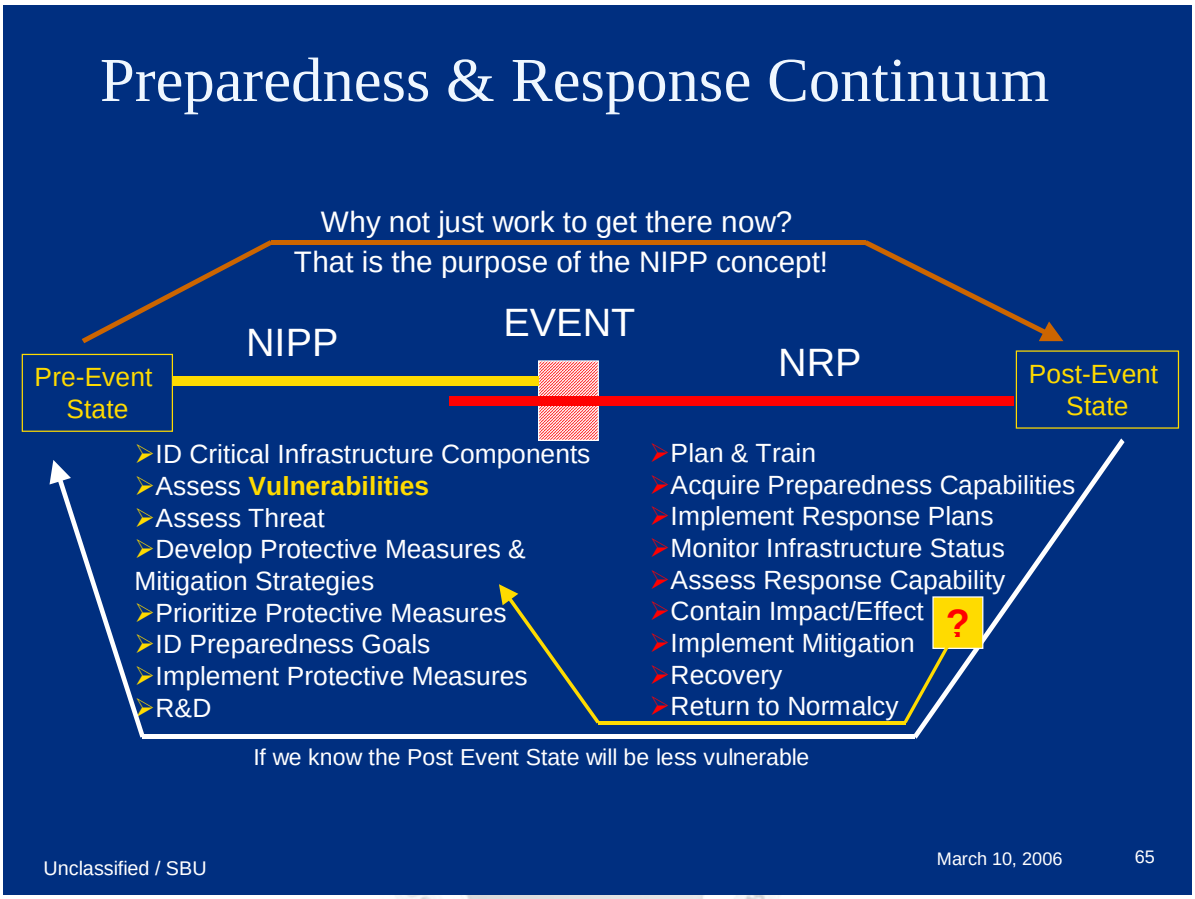
SCC's are divided into (7) sub councils including: Producers/Plant (30 firms and associations; Producers Animal (42 firms and associations and affiliated industry groups); Processors and Manufacturers (61 trade associations); Restaurant/Food Services (6 associations); Warehouse and Logistics (10 associations); and, Agriculture Production Inputs and Services (16 firms and trade associations).

The GCC and SCC's collaborate on strategic issues via the NIPP and day-to-day operations through the National Response Plan (NRP). Strategic and tactical activities include consensus building, national response and program planning and implementation, and both strategic and information sharing. Complementing those efforts is the introduction of a National Bio-Surveillance Integration System that:

- Refines current processes and develops a bio-surveillance situational awareness capability
- Integrates and exploits various government and industry bio-surveillance and detection "systems" and capabilities now in place (not replace them).
- Fosters development of new technologies.

Conclusion

Considering the above, the combined efforts of multiple agencies continue incremental improvements designed to understand traditional versus asymmetric risks, key threats to include foreign animal diseases, contaminants and pathogens, plant and crop disease, and infrastructure disruptions and the macro and specific vulnerability to those threats. The agencies also continue to scrutinize the perceptions to those risks to our food supply, the impact of statutory requirements on the industry and the potential 2nd, 3rd, and 4th order effects of such risks to the nation's food supply chain as well as the specific roles that local, state, and federal governments need to play in addressing the challenges. The below slide illustrates the current thoughts within DHS regarding Preparedness and Response to a terrorist attack against our nation's agriculture industry:



Clearly, significant efforts continue to meet the threat to (and from) agricultural sector. A great deal has been done in the past few years to enhance the safety and security of the food supply in the United States. "Within HHS, the Food and Drug Administration (FDA) has worked with food safety agencies, as well as with law enforcement and intelligence-gathering agencies, and with industry to significantly strengthen the nation's food safety and security system across the entire distribution chain, from farm to table, to better protect our food supply against deliberate and accidental threats. This cooperation has resulted in greater awareness of vulnerabilities, the creation of more effective prevention programs, new surveillance systems, and faster foodborne illness outbreak response capabilities. HHS's Centers for Disease Control and Prevention (CDC) maintains national surveillance for specific infections and for outbreaks of foodborne illnesses, supports states in investigating and controlling outbreaks, and maintains cross-communication with FDA and USDA." [11]

Based on the above lessons and actions, it is clear that our public health, food and agriculture industry partners are the front line in protecting our animal industries, our food supply chain and more than a sixth of our national economy. Moreover, "functional, two-way, protected communications between government partners and between industry and government to

[11] Azar, Alexander M II, Deputy Secretary, Health and Human Services, Testimony before the US Congressional Subcommittee Field Hearing: Bio-security Coordination, January 9, 2006, Harrisburg, Pennsylvania.

exchange threat, incident, and trend information and the ability to present a shared, common bio-awareness capability remain central to implementing a comprehensive protective strategy."[12]

> Nevertheless, significant effort and commitment of additional resources are required if we are to effectively mitigate the threat. Not only will significant resources be required directly, but significant examination of current World Trade Organization regulations may need to be conducted in order to allow resources to be applied and still keep American agriculture competitive against countries who do not share the same commitment or concern when it comes to protecting their food supply. Complementing such an economic examination must be diplomatic and informational efforts designed to reduce the conditions resulting in terrorism. Nevertheless, in order to mitigate the chance for the notional news story provided at the beginning of this essay and its follow on report provided below to become real, both public and private efforts must expand and intensify to counter threats to our most basic need…to feed our populace.

CNN WIRE

"Washington D.C, August 2006: The Senate select committee on Intelligence and the Senate Armed Services Committee will hold a joint hearing today to examine why so much of the nation's critical infrastructure was left unattended during the July terrorist attacks that left 50,000 dead across the nation and why the attacks on those sites resulted in the deaths of another 150,000 Americans either directly or by the 2d and 3d order effects of those attacks. It would seem that the botulinum attacks were only the start of a much more sophisticated plan that created the "perfect storm" for Al Qaeda to launch its most devastating attack on the West to date. In further news, more than fifty percent of the nation's livestock has been infected with foot and mouth disease, and the corn and soybean crops have been devastated by other plant pathogens. Protective embargoes have crippled the American economy, and the State Department has begun negotiations with more than fifty countries to reduce or eliminate American military presence in order to consolidate forces here at home."

Avian Influenza

In addition to the concerns of deliberate introduction of pathogens or viruses that might have an enormous impact on the agricultural industry, recent concerns regarding Avian Influenza highlight yet again the potentially catastrophic effects of inadvertent or unintentionally introduced threats. As an example, Avian influenza has had a significant impact on poultry markets around the globe. Trade barriers, eradication efforts, and consumer practices have all reduced the economic potential of poultry producers. The U.S. must be able to quickly identify H5N1 when it reaches the country and have plans for response and recovery of the industry in place. Additionally, restoration of consumer confidence and international trade should be considered. This virus has also created a unique confluence of events that constitutes a significant threat for human public health threats. Governments have been forced to divert funds from essential programs to prepare for the *possibility* of pandemic flu, the lost opportunity costs are enormous and will have long-lasting impacts on many nations.

There are an estimated 6 billion poultry birds in Asia. Just over half of those birds are in medium to large, intensive production facilities. Small producers account for less than half of

[12] Hoffman, slide 66

the birds, but amount to a majority of owners. In Thailand for example, small producers own 30% of poultry stocks but represent 97% of the holdings. In China, backyard producers represent 56% of the poultry sector and in Cambodia, 75% of poultry production is by subsistence farmers. These farmers depend on poultry for food security, employment, and income.

Although most European farmers are better able to stand the temporary loss of their poultry flocks, the affects of avian influenza on their markets has been extensive. The discovery of avian influenza in France, Europe's leading poultry exporter, resulted in 43 countries banning importation of French poultry. Furthermore, consumer reaction to avian influenza in Europe resulted in a reduction by more than half in Greece and Italy, with more moderate decreases in most other European Union member states. The long-term effects on trade patterns will negatively affect countries that have had sanitary trade embargos placed on them. For example, Thailand supplied 25% of European imports from third countries and almost half of all Thailand's poultry exports went to Japan. It is expected that the bans placed on Thai poultry exports due to avian influenza will result in Brazil and other competitors capturing this market.

U.S. poultry markets are substantial and must be protected. Currently, the U.S. is the world's largest producer and exporter of poultry meat and the second largest egg producer. In 2003, the U.S. poultry industry accounted for $23.3 billion in production, with broiler production valued at $15.2 billion, eggs at $5.3 billion, and turkey at $2.7 billion. Additionally, the U.S. is the world's leading exporter of broilers and turkeys. In 2003, broiler exports were valued at $1.5 billion and turkey exports accounted for $265 million in sales.

An outbreak of highly pathogenic avian influenza in the U.S. would result in substantial losses for the poultry industry due to export bans, quarantines and bird depopulation programs. Losses could also be expected due to consumer fear and a reduction in consumption of poultry products. In fact, 2006 poultry exports are down 95 million pounds from projections due to decreased European and Asian consumer demand for chicken.

Protecting US Poultry Industries

The preparations to combat avian flu in the US are separated into four key areas: prevention, surveillance, response, and recovery. The primary focus for preventing the spread of H5N1 avian influenza is to prevent the importation of infected birds. To that end, the USDA's Animal and Plant Health Inspection Service (APHIS) maintains trade restrictions on importing poultry or poultry products from countries affected by avian influenza. Surveillance is being conducted in cooperation with federal, state, and private partners in four key areas: live bird markets, commercial flocks, backyard flocks and migratory bird populations. Response and recovery is the responsibility of APHIS, in coordination with State animal health resources, these groups have established procedures and plans to quickly marshal resources to the affected area.

Implications of Pandemic Influenza on U.S. Agriculture and Food

Experts compare the potential of an outbreak of H5N1 influenza among humans to the 1918 Spanish flu pandemic that resulted in the deaths of more than 675,000 Americans and somewhere between 30 and 40 million people worldwide. If H5N1 influenza undergoes an antigenic shift and launches a pandemic on par with the 1918 outbreak the global GDP is

predicted to drop 2 to 6 percentage points. In the U.S. alone, the predictions call for 89,000 to 207,000 human deaths and more than 47 million ill, resulting in an economic impact of up to $166 billion in losses.

The two largest concerns for all of the businesses we spoke with were labor and preservation of their supply chains. All three of the companies polled believed that labor was a less significant problem. Most of the food production industry is highly automated and production can be maintained with a small staff. Some activities that are non-essential and require more human capital would most likely cease during a pandemic, these activities would include research and development, marketing, and some administrative processes.

The supply chain posed tremendous problems for every producer we visited. Most of the raw food products brought into a processing plant are perishable and are delivered as needed. Even supplies of non-perishable food products are kept low as holding large inventories is not efficient in these businesses. In fact, the food business has adopted the "just in time delivery" practice and there is no infrastructure in place that would be capable of holding large amounts of raw food materials at factories. Most businesses had no more than two days supply of raw materials on hand. The food commodities that constitute the raw material of food production are stored on farms, cooperative grain elevators, warehouses, in the field or on the hoof. This means that agribusiness is exceedingly dependent on transportation and their success or failure during a pandemic will largely coincide with how well the trucking and rail industries respond to the pandemic.

Farm policy and the WTO trade regime: Something's got to give

Globalization of free trade, the upcoming Doha round of negotiations with the WTO, and the pending battles over the 2007 Farm Bill will all have a significant impact on the future of American agribusiness.

Over the last century and a half, the federal government has offered various support programs to ensure American farmers were able to not only feed our nation, but to also ensure that American farmers were sufficiently compensated to earn a living off their farms.[13] As the 2007 Farm Bill approaches, the 110th Congress, and the President face a series of new and complex challenges as they attempt to negotiate a bill that must appease an increasingly complicated and interrelated group of constituencies with direct and indirect interests in American agribusiness. As the US and world economies become more integrated, it is no longer simply a matter of concerning ourselves with making sure our farmers can feed the nation and make a living. It is much bigger and more complicated than that now.

First of all, there are growing perceptions among various interests groups that the provisions of the 2002 Farm Bill are not serving the best interests of our nation; that it is not putting money where it is most needed or most beneficial. For example, farmers in need of money are not getting it, and those getting it, don't really need it. In the 1950s, the average farm income was less than half that of the average American household. Today's farmers earn 35% more than the average American household.[14] Since farm payments are tied to production, a large majority of payments (72%) are paid to just 10% of American farms. Only 40% of American farms received payments. In fact, one of the most productive sectors of our agricultural industry, the cattle industry, received just 1% of program payments.[15]

Budgetary issues add to the pressure on the existing program. During the initial three years of the 2002 bill farm subsidies and payments grew from just under $15B to a record $22B in 2005. The $22B subsidy in 2005 accounted for 6% of the 2005 federal deficit, and over 30% of discretionary spending for the year.[16] Unfortunately, the economic picture of our nation has changed for the worse since its favorable position in 2002. While these record subsidies were being paid to farmers, farm incomes were soaring; doubling from $40B in 2002, to $82B in 2004. Meanwhile, our federal deficit continued to grow ever higher. The fact farmers received record subsidies in times of soaring profits and record deficits has not gone unnoticed; prompting many interested parties to assert that it is now time for farmers to help shoulder their fair share of the burden to reduce our federal deficit.[17]

Despite these imposing figures, proponents for change will be up against one the most non-partisan political caucuses in the country. The agricultural committees of Congress have

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[13] For an interesting article summarizing the history of American farm policy see: *U.S. Farm Policy: The First 200 Years*, Agricultural Outlook/March 2000.

[14] Economic Report, supra, p. 176.

[15] Boehlje, supra.

[16] Boehlje, supra.

[17] Thompson, supra, p. 7.

long prided themselves on their solidarity and non-partisanship.[18] The ability of the individual commodity states to work together on farm bills has enabled them to historically obtain far more than they could have achieved through independent efforts. The generous provisions of the 2002 Farm Bill, in particular, were the direct result of a team effort among the various agricultural commodity caucuses.[19] However, rising budget deficits, regional interests, the rising influence of specialty crop (fruit and vegetable) growers, and pressure from the American industrial sector to negotiate a more favorable WTO agreement for increased exports, have created significant cracks and seams in this traditionally unified congressional caucus.

For example, program crop growers (wheat, rice, cotton, soybeans, and corn) have traditionally received the vast majority of farming subsidies (as much as 92%), as they consistently produced the greatest total crop value in the country and subsidies were tied to productivity. However, the total value of non-program (specialty crops), is now almost equal in value to that of the traditional program crops, leading these specialty growers to believe that they are entitled to a bigger portion of the benefits historically provided to program crop growers.[20]

There are also signs of an impending North-South divide among American farmers. Northern wheat, corn and soy producers are critical of the large subsidies paid to big southern cotton and rice farmers that led to the WTO's finding that these subsidies were price distorting in violation of existing WTO agreements. Moreover, recent changes to the nation's energy policy to double the use of ethanol and bio-diesel as alternative fuel sources, may also widen this North-South wedge as southern farmers watch northern corn and soybean farmers reap the benefits of increased demands for their ethanol and bio-diesel producing crops. Finally, the President's proposal to impose subsidy caps at $250K would have a disproportionate impact on the south, where close to 25% of large southern cotton and rice farms currently receive payments over $250K, as opposed to the north, where only 2-3% of farms receive payments in excess of $250k.[21]

In addition to the internal strife, there are external threats also working to erode the powerful political force of American agribusiness. The energy industry will work hard to prevent any further policies directed towards the increased us of ethanol and bio-diesel as alternative energy sources.[22] Other major American industrial groups (machinery, fuels and

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[18] Meeting with Eric Steiner, Majority Professional Staff Member, United States Senate Committee on Agriculture, Nutrition, and Forestry, 11 April 2006.

[19] Thompson, supra, p. 8.

[20] Meeting with Dale Moore, United States Department of Agriculture Chief of Staff, 11 April 2006.

[21] Boehlje, supra.

[22] Thompson, supra, p. 11.

mining, telecom, chemicals, automotive) will also continue to aggressively lobby Congress and the President for reduced agricultural subsidies if that's what it takes to secure a more favorable WTO agreement that will provide them greater access to world markets. It remains to be seen how these internal and external pressures will be reconciled during the upcoming negotiations over the 2007 Farm Bill. The seminar concluded that the existing levels and forms of farm support are unsustainable given budgetary pressures, and that they work overall to the detriment of the national and farm economies. Our recommendations are summarized in the concluding section.

Section 7 – Recommendations

Urban Encroachment

- Increase funding for Agricultural Conservation Easements and reduce associated "red tape" and program restrictions.

- Increase funding for "Green Payments" to be used for farm modernization, assisting young farmers in getting established, providing assistance with marketing, and for use in agri-tourism and preservation of cultural heritage.

- Provide tax incentives to reward farmers for their role in enhancing the environment and offer tax credits to developers who agree to build on less desirable land.

Water

- Provide federal funded incentives to States for creating efficient water management policies.

- Increase R&D funding for water-efficient agricultural production technology

Revised Immigration Policy

- Support a guest worker program that provides the workers who are already employed the opportunity to work legally, apply for green cards, and to enter on a path to citizenship.

- Combine enhanced border control with the guest worker program to enforce the laws against illegal immigrants at all ports of entry to improve U.S. homeland security.

- Under the H-2A program, cap the number of guest workers (between 300,000 and 500,000) based on market demand.

- Increase R&D funding specifically aimed at technological innovations for fruit and vegetable harvesting

Terrorism and Bio security

- Complete the National Infrastructure Protection Plan (NIPP) for agriculture as a specific strategic sector.

- Make participation in the Strategic Protection Program Agro terrorism a required public-private venture and resource vulnerability reduction plans and mitigation strategies. Those identified vulnerabilities should include not only agriculture specific weaknesses, but cross-infrastructure components essential to the operation of the agriculture infrastructure, such as water, energy, etc.

- Bio-Security Research and Development efforts across the food and agriculture supply chain must be synchronized in order to eliminate overlaps and gaps in these efforts.

- Ensure disease surveillance and detection, for humans and animals, is properly integrated.

- Work closely with DHS and INS to more closely track and address the issues associated with the high percentage of immigrant workers across the sector whose legal status and backgrounds are questionable.

2007 Farm Bill

- Pass a Farm Bill that reduces domestic subsidies in conjuction with a negotiated WTO agreement that provides the U.S. greater market access for all goods and services in order to:

    - Increase overall U.S. and world trade

    - Improve world economy which, in turn, will improve the U.S. economy as developing countries gradually develop the wealth and appetite to purchase high value U.S. goods and services

    - Help stabilize developing and at-risk nations through economic development

- Pass a Farm Bill that focuses on conservation to help increase the amount of arable land in the U.S. to offset losses due to encroachment

- Pass a Farm Bill that funds greater research and development in order to maximize our competitive advantage and enhance our food security (the ability to feed ourselves)

China

- Helping China feed its population is a worthwhile diplomatic and economic effort which will draw the nations closer, reduce tensions, and assist U.S. businesses in pursuing economic ventures in China. The U.S. should therefore consider the following actions:

    - Continue and expand the cooperation between U.S. Land Grant Universities and Chinese universities and colleges in order to transmit best practices and farming techniques to increase crop yields, reduce the use of pesticides, promote water-saving irrigation techniques and food processing protocols, such as field heat removal, to prolong shelf-life for China's crops.

    - Encourage China to pursue the development of the rule of law and property rights in order to create the right climate for U.S. and other foreign trade and investment.

    - Create joint U.S./China agriculture economic development hub zones within China to encourage and facilitate U.S. agricultural exports to the relatively untapped Chinese market.

Appendices

Appendix 1 – 2002 Census – Farm size, value and output data
Appendix 2 – Domestic travel – observations on the farm
Appendix 3 – International travel – observations on China

Table 1. **Historical Highlights: 2002 and Earlier Census Years**

[For meaning of abbreviations and symbols, see introductory text]

All farms		2002	1997	Not adjusted for coverage					
				1997	1992	1987	1982	1978	1974
Farms	number	2,128,982	2,215,876	1,911,859	1,925,300	2,087,759	2,240,976	2,257,775	2,314,013
Land in farms	acres	938,279,056	954,752,502	931,795,255	945,531,506	964,470,625	986,796,579	1,014,777,234	1,017,030,357
Average size of farm	acres	441	431	487	491	462	440	449	440
Estimated market value of land and buildings [1]:									
Average per farm	dollars	537,833	416,007	449,748	357,056	289,387	345,869	279,672	147,838
Average per acre	dollars	1,213	967	933	727	627	784	619	336
Estimated market value of all machinery and equipment [1]	$1,000	136,624,880	119,302,923	110,256,802	93,316,496	85,801,360	93,662,947	77,600,689	46,402,624
Average per farm	dollars	66,570	53,861	57,678	48,605	41,227	41,919	34,471	22,303
Farms by size:									
1 to 9 acres		179,346	205,390	153,515	166,496	183,257	187,665	151,233	128,254
10 to 49 acres		563,772	530,902	410,633	387,711	412,437	449,252	391,554	379,543
50 to 179 acres		658,705	694,489	592,972	584,146	644,849	711,652	759,047	827,884
180 to 499 acres		388,617	428,215	402,769	427,648	478,294	526,510	581,631	616,098
500 to 999 acres		161,552	179,447	175,690	186,387	200,058	203,925	213,209	207,297
1,000 to 1,999 acres		99,020	103,007	101,468	101,923	102,078	97,395	97,800	92,712
2,000 acres or more		77,970	74,426	74,612	70,989	66,786	64,577	63,301	62,225
Total cropland	farms	1,751,450	1,857,239	1,661,395	1,697,137	1,848,574	2,010,609	2,081,604	2,157,511
	acres	434,164,946	445,324,765	431,144,896	435,365,878	443,318,233	445,362,028	453,874,133	440,039,067
Harvested cropland	farms	1,362,608	1,545,681	1,410,606	1,491,786	1,643,633	1,809,756	1,904,602	1,954,700
	acres	302,697,252	318,937,401	309,395,475	295,936,976	282,223,880	326,306,462	317,145,955	303,001,943
Irrigated land	farms	299,583	308,816	279,442	279,357	291,628	278,277	280,779	236,733
	acres	55,311,236	56,289,172	55,058,128	49,404,030	46,386,201	49,002,433	50,349,906	41,243,023
Market value of agricultural products sold (see text) [2]	$1,000	200,646,355	201,379,812	196,864,649	162,608,334	136,048,516	131,900,223	107,073,458	81,526,126
Average per farm	dollars	94,245	90,880	102,970	84,459	65,165	58,858	47,424	35,231
Crops, including nursery and greenhouse crops	$1,000	95,151,954	100,668,794	98,055,656	75,228,256	58,931,085	62,256,087	48,203,200	41,790,365
Livestock, poultry, and their products	$1,000	105,494,401	100,711,018	98,808,993	87,380,078	77,117,431	69,644,136	58,870,258	39,503,850
Farms by value of sales [3]:									
Less than $2,500		826,558	693,026	496,514	422,767	490,296	536,327	460,535	649,448
$2,500 to $4,999		213,326	265,667	228,477	231,867	262,918	276,208	300,699	257,263
$5,000 to $9,999		223,168	267,575	237,975	251,883	274,972	281,802	314,088	296,373
$10,000 to $24,999		256,157	293,639	274,040	301,804	326,166	340,254	394,876	(NA)
$25,000 to $49,999		157,906	179,629	170,705	195,354	219,636	248,828	300,515	(NA)
$50,000 to $99,999		140,479	163,510	158,160	187,760	218,050	251,501	263,092	(NA)
$100,000 to $499,999		240,746	282,422	277,194	286,951	263,698	274,580	203,695	141,187
$500,000 or more		70,642	70,408	68,794	46,914	32,023	27,800	17,973	11,412
Farms by type of organization:									
Family or individual		1,909,598	1,922,590	1,643,424	1,653,491	1,809,324	1,945,639	1,965,860	(NA)
Partnership		129,593	185,607	169,462	186,806	199,559	223,274	232,538	(NA)
Corporation		73,752	90,432	84,002	72,567	66,969	59,792	50,231	(NA)
Other-cooperative, estate or trust, institutional, etc		16,039	17,247	14,971	12,436	11,907	12,271	9,146	(NA)
Principal operator by days of work off farm [4 5]:									
None		962,200	832,585	755,254	801,881	844,476	861,798	942,603	829,843
Any		1,166,782	1,254,537	1,042,158	992,773	1,115,560	1,187,374	1,203,286	1,011,476
200 days or more		832,348	870,945	709,279	665,570	737,206	774,844	770,045	657,971
Principal operator by primary occupation [5]:									
Farming		1,224,246	1,044,388	961,560	1,053,150	1,138,179	1,234,787	1,269,305	1,427,368
Other		904,736	1,171,488	950,299	872,150	949,580	1,006,189	988,470	851,902
Average age of principal operator [5]	years	55.3	54.0	54.3	53.3	52.0	50.5	50.3	51.7
Total farm production expenses [1]	$1,000	173,199,216	157,752,357	150,590,993	130,779,261	108,138,053	(NA)	(NA)	61,007,649
Selected farm production expenses [1]:									
Livestock and poultry purchased	$1,000	27,420,965	22,213,229	21,614,559	23,043,431	19,344,645	17,174,334	16,039,244	9,953,946
Feed purchased	$1,000	31,694,850	34,749,048	32,759,966	24,084,507	19,163,364	18,591,984	15,785,995	13,647,816
Fertilizer, lime, and soil conditioners [6 7]	$1,000	9,751,460	9,999,752	9,597,128	8,204,324	6,684,944	7,689,365	6,330,581	5,137,361
Gasoline, fuels, and oils	$1,000	6,675,419	6,715,936	6,371,515	6,120,452	5,277,227	7,888,052	4,691,425	3,087,606
Hired farm labor	$1,000	18,568,446	15,457,896	14,841,036	12,961,639	10,866,236	8,441,180	6,814,428	4,652,075
Interest expense [8]	$1,000	9,571,577	9,392,431	8,928,107	8,111,337	8,158,268	11,666,942	(NA)	(NA)
Chemicals [6]	$1,000	7,608,921	7,934,936	7,581,424	6,133,705	4,690,243	4,282,213	2,889,503	1,757,779
Livestock and poultry:									
Cattle and calves inventory	farms	1,018,359	1,188,659	1,046,863	1,074,349	1,176,346	1,354,992	1,346,106	1,503,244
	number	95,497,994	99,907,017	98,989,244	96,135,825	95,847,299	104,475,827	103,865,109	113,174,700
Beef cows	farms	796,436	899,756	804,595	803,241	841,778	957,698	954,360	1,024,935
	number	33,398,271	34,193,965	34,066,615	32,545,976	31,652,593	34,202,607	34,326,274	41,257,898
Milk cows	farms	91,989	125,041	116,674	155,339	202,068	277,762	312,095	403,754
	number	9,103,959	9,139,812	9,095,439	9,491,818	10,084,697	10,849,890	10,221,692	10,654,516
Cattle and calves sold	farms	851,971	1,121,003	1,011,609	1,034,189	1,150,523	1,278,609	1,320,163	1,437,101
	number	73,509,165	75,005,184	74,089,046	70,562,908	72,603,841	71,216,727	76,020,351	70,019,180
Hogs and pigs inventory	farms	78,895	124,889	109,754	191,347	243,398	329,833	445,117	470,258
	number	60,405,103	61,188,149	61,206,236	57,563,118	52,271,120	55,366,205	57,697,318	45,503,604
Hogs and pigs sold	farms	82,028	112,377	102,106	188,167	238,819	315,095	423,578	449,841
	number	184,997,686	142,956,569	142,611,882	111,326,807	96,569,359	94,783,598	90,757,143	79,897,397
Layers 20 weeks old and older inventory	farms	98,315	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
	number	334,435,155	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Broilers and other meat-type chickens sold	farms	32,006	27,737	23,937	23,949	27,645	30,100	31,743	34,340
	number	8,500,313,357	7,366,526,456	6,741,927,110	5,428,589,485	4,361,975,630	3,516,622,889	3,062,154,490	2,518,513,032

Table 1. **Historical Highlights: 2002 and Earlier Census Years** - Con.

[For meaning of abbreviations and symbols, see introductory text]

All farms		2002	1997	Not adjusted for coverage					
				1997	1992	1987	1982	1978	1974
Selected crops harvested:									
Corn for grain	farms	348,590	450,520	430,711	503,935	627,602	715,171	810,577	883,309
	acres	68,230,523	71,088,454	69,796,716	69,339,869	58,701,505	69,857,993	70,043,480	61,653,842
	bushels	8,613,061,814	8,732,478,098	8,578,634,770	8,697,362,804	6,725,001,837	7,508,721,493	6,805,185,861	4,396,912,922
Corn for silage or greenchop	farms	103,621	123,325	119,308	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	6,683,995	5,771,666	5,727,594	(NA)	(NA)	(NA)	(NA)	(NA)
	tons	97,132,738	89,219,954	88,380,934	(NA)	(NA)	(NA)	(NA)	(NA)
Wheat for grain, All	farms	169,528	252,922	243,568	292,464	352,237	446,075	378,574	533,520
	acres	45,519,976	62,084,743	58,836,344	59,089,470	53,224,174	70,910,293	54,155,168	62,957,215
	bushels	1,577,005,140	2,329,807,815	2,204,026,684	2,206,729,476	1,867,103,964	2,373,246,659	1,607,540,430	1,691,553,354
Winter wheat for grain	farms	141,062	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	29,303,293	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
	bushels	1,104,334,391	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Durum wheat for grain	farms	5,325	7,070	6,887	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	2,717,841	3,202,949	3,099,732	(NA)	(NA)	(NA)	(NA)	(NA)
	bushels	81,170,077	86,251,199	85,802,466	(NA)	(NA)	(NA)	(NA)	(NA)
Spring wheat for grain	farms	30,333	47,193	46,268	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	13,498,842	18,024,687	17,488,113	(NA)	(NA)	(NA)	(NA)	(NA)
	bushels	391,500,672	537,892,213	519,176,940	(NA)	(NA)	(NA)	(NA)	(NA)
Oats for grain	farms	63,763	94,811	89,606	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	1,996,916	2,739,810	2,680,958	(NA)	(NA)	(NA)	(NA)	(NA)
	bushels	109,840,449	154,654,269	151,327,329	(NA)	(NA)	(NA)	(NA)	(NA)
Barley for grain	farms	24,747	43,269	41,930	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	4,015,654	6,108,682	5,944,951	(NA)	(NA)	(NA)	(NA)	(NA)
	bushels	214,800,035	346,413,080	336,435,009	(NA)	(NA)	(NA)	(NA)	(NA)
Sorghum for grain	farms	33,172	50,860	49,397	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	6,755,326	8,647,643	8,470,353	(NA)	(NA)	(NA)	(NA)	(NA)
	bushels	333,485,523	569,984,239	559,070,136	(NA)	(NA)	(NA)	(NA)	(NA)
Sorghum for silage or greenchop	farms	7,042	7,962	7,918	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	406,031	384,320	382,024	(NA)	(NA)	(NA)	(NA)	(NA)
	tons	3,904,834	4,669,985	4,640,291	(NA)	(NA)	(NA)	(NA)	(NA)
Soybeans for beans	farms	317,611	367,300	354,692	381,000	441,899	511,229	537,037	542,029
	acres	72,399,844	67,773,274	66,147,726	56,351,304	55,291,205	64,832,842	61,339,849	48,118,849
	bushels	2,707,719,216	2,560,330,804	2,504,307,294	2,053,163,265	1,838,053,979	1,989,993,158	1,722,154,229	1,145,788,470
Dry edible beans, excluding limas	farms	8,647	11,348	10,911	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	1,691,775	1,731,898	1,691,899	(NA)	(NA)	(NA)	(NA)	(NA)
	cwt	29,687,475	27,888,555	27,223,851	(NA)	(NA)	(NA)	(NA)	(NA)
Cotton, All	farms	24,805	33,640	31,493	34,812	43,046	38,266	52,628	89,536
	acres	12,456,162	13,897,404	13,235,236	10,961,720	9,826,061	9,781,404	12,693,772	12,223,500
	bales	17,145,345	18,706,703	17,878,743	15,370,310	13,280,143	11,375,524	10,686,447	10,887,205
Tobacco	farms	56,977	93,530	89,706	124,270	136,682	179,141	188,649	197,764
	acres	428,631	837,363	838,530	831,231	633,310	931,655	963,224	877,113
	pounds	873,350,412	1,744,192,909	1,747,702,321	1,697,831,562	1,215,221,360	1,871,309,459	1,918,189,782	1,733,365,121
Potatoes	farms	9,408	11,649	10,523	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	1,266,087	1,372,458	1,355,241	(NA)	(NA)	(NA)	(NA)	(NA)
	cwt	451,405,823	465,221,318	459,886,344	(NA)	(NA)	(NA)	(NA)	(NA)
Sweet potatoes	farms	2,366	1,976	1,770	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	92,310	80,953	77,384	(NA)	(NA)	(NA)	(NA)	(NA)
	cwt	13,651,312	11,896,063	11,419,653	(NA)	(NA)	(NA)	(NA)	(NA)
Forage-land used for all hay and haylage, grass silage, and greenchop (see text)	farms	884,831	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	64,041,337	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
	tons, dry	154,976,932	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Rice	farms	8,046	9,627	9,291	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	3,197,641	3,161,576	3,122,120	(NA)	(NA)	(NA)	(NA)	(NA)
	cwt	210,358,014	184,412,536	182,231,457	(NA)	(NA)	(NA)	(NA)	(NA)
Sunflower seed, All	farms	7,506	11,176	11,067	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	1,833,435	2,559,990	2,534,708	(NA)	(NA)	(NA)	(NA)	(NA)
	pounds	2,042,510,240	3,218,848,621	3,198,790,249	(NA)	(NA)	(NA)	(NA)	(NA)
Sugarbeets for sugar	farms	5,027	7,057	7,102	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	1,365,769	1,449,819	1,453,824	(NA)	(NA)	(NA)	(NA)	(NA)
	tons	27,793,126	29,740,760	29,775,479	(NA)	(NA)	(NA)	(NA)	(NA)
Sugarcane for sugar	farms	953	1,079	973	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	978,393	890,193	875,180	(NA)	(NA)	(NA)	(NA)	(NA)
	tons	35,319,767	31,986,258	31,549,377	(NA)	(NA)	(NA)	(NA)	(NA)
Pineapples harvested	farms	34	28	28	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	10,211	(D)	(D)	(NA)	(NA)	(NA)	(NA)	(NA)
	tons	314,526	(D)	(D)	(NA)	(NA)	(NA)	(NA)	(NA)
Peanuts for nuts	farms	8,640	12,788	12,221	(NA)	(NA)	(NA)	(NA)	(NA)
	acres	1,223,093	1,377,097	1,352,155	(NA)	(NA)	(NA)	(NA)	(NA)
	pounds	3,137,586,781	3,434,648,039	3,377,142,874	(NA)	(NA)	(NA)	(NA)	(NA)
Vegetables harvested for sale (see text) [9]	farms	54,391	60,631	53,727	61,969	60,819	69,109	73,183	78,566
	acres	3,698,744	3,906,983	3,773,219	3,782,358	3,467,563	3,330,637	3,534,142	3,124,257
All land in orchards	farms	113,649	123,420	106,069	116,207	120,434	123,663	121,852	105,997
	acres	5,330,439	5,349,292	5,158,064	4,770,778	4,560,163	4,750,667	4,463,627	4,190,340

[1] Data are based on a sample of farms.
[2] Data for 1974 include the value of forest products sold.
[3] Data for 1982 and prior years exclude abnormal farms.
[4] Data for 1997 and prior years do not include imputation for item nonresponse.
[5] Data for 1974 apply only to individual or family operations (sole proprietorships) and partnerships.
[6] Data for 1982 and prior years do not include cost of custom applications; data for chemicals include the cost of lime for 1978 and prior years.
[7] Data for 1997 and prior years exclude cost of lime and manure.
[8] Data for 1982 do not include imputation for item nonresponse.
[9] Data for 1974 were from land area used.

Appendix 2 – Domestic travel – observations on the farm

Dairy Farming

Our group visited a large family dairy farm with 2,400 cows on 3,000 acres. First established in 1784, this farm has remained a family operation over the years but its methods have clearly changed with the times. Our IS group was particularly interested in the dairy's ability to remain competitive through its use of technology, which focused on increased milk production and waste management efficiencies. The operation produces 80,000 quarts of milk daily, designs and manufacturers its own equipment, and generates enough electricity from its cow manure to receive a monthly check from the local utility company for its contribution to the grid. In fact, the Dairy hasn't purchased electricity since the 70's.

The farm is able to achieve the astounding ability to produce 50% more milk per cow than traditional dairy operations through the use of a complex, computer and laser controlled robotic system that ensures each cow is milked at the right time for the optimum yield, up to four times daily. Whereas most large dairy farms average one worker per 89 cows, this farm's use of cutting edge automation increased this ratio to 400 cows per worker. (Smith, 1996) The same system also ensures that waste from the cows is automatically removed from the barns and sent to the power generating plant. This innovation not only enables this family farm to be competitive, but also allows it to address the real pressures of environmental stewardship while making dairy production a viable option for future generations to choose as their life's work.

Fruit

The IS group also studied an apple direct marketer not far from the dairy farm and found that this family-run operation is also under increased threat from global competitors whose operations result in both increased production costs, and labor challenges. Although in operation since 1955 with 500 acres and over 120,000 trees dedicated to fruit production, the current owners are greatly concerned about the viability of the farm for future generations.[3] While they are using computers to monitor yields and assist in weather predictions for pest control, the nature of the crop does not allow the same technological efficiencies we found at the dairy farm. Specifically, most fruit must still be picked by hand due to the delicate nature of the product, and accordingly necessitates a greater reliance and commitment of resources to labor.

The farm must contend with significant challenges in hiring a labor force to maintain the orchard. Local laborers refuse to work in the orchards, seeking easier and more lucrative employment outside of traditional agricultural venues. Labor surfaced as one of the persistent themes throughout our studies and is addressed in greater length in our issues in depth section.

The other challenge facing this operation is globalization. As an example, in 1999, the American apple industry criticized China, the largest apple producer in the world, for selling apple-juice concentrate in the U.S. market at prices 91% below cost of production. (Ashton, 1999) This competitive challenge impacts those American growers who do not receive subsidies. When combined with the lack of progress in the WTO trade negotiations regarding reduction and eventual elimination of trade distorting practices, the competitive advantage of large producers like China creates increasing uncertainty and risk for domestic tree fruit operations like that which we visited in Pennsylvania.

Swine Farm (Danville Indiana)

One Indiana pork producer provided the industry study team yet another perspective. This was a 600 sow farrow-to-finish operation run by a well-educated, politically active Midwest farmer and his son. The owner had served as President of the National Pork Producers Council (NPPC) and chairman of the United States Meat Export Federation, and currently serves on the NPPC's Trade Committee and is a representative on the Agricultural Policy Advisory Committee to the US Trade Representative and the Secretary of Agriculture. His efforts were an important factor in the restoration of the U.S. as a net exporter of pork for the first time in half a century

This swine farm faces many of the same global market, labor and environmental challenges as the tree fruit producers in Pennsylvania. The farm is too large for his immediate family to run but, as a mid-size farm, is challenged with paying the kind of salaries necessary to retain long-term labor with the technical skills required to maintain his high-tech operation which utilizes precision farming equipment.

This farm also helped to emphasize the important and delicate balance many farmers try to achieve with the right mix of chemicals to protect crops and increase yields, while attempting to diminish the dangerous levels of nitrogen and phosphorus that can build-up due to Concentrated Animal Feeding Operations (CAFO). This family demonstrates the same character found in other farms studied, as they continually seek not only to be good stewards of the land, but also efficient and profitable farmers.

Table Grapes

The 2,400 acres farm owned by a multigenerational family has been growing table grapes for more than 50 years. The operation focuses on 12 different varieties of table grapes catering to both domestic and international customers. Entirely organic, no synthetic pesticides, herbicides or fertilizers are used, they have also pursued innovative practices to gain and hold a competitive advantage in the marketplace. The industry leading process by which they remove heat from the grapes via computer controlled cooling enables their product to arrive in 'field' condition at destination, and added days to the shelf-life. In addition to their technical innovations, vertically integrating their value chain from grower to the retailer means a degree of control few farming operations possess. The family hierarchy, assisted by a small team of long-trusted advisors, provides efficient and highly successful management of this operation.

The farm, however, faces the ubiquitous American challenge of labor availability. It also dependant on the State run water system for irrigation without which the growers of the San Joaquin Valley would not exist. Though there are mounting pressures related to water, viable solutions are not forthcoming. Water is addressed in greater detail in Section 6 of the paper.

Vegetables

The IS group also spent time at another family run farm founded 79 years ago, which began by growing cantaloupes and expanded over time to include broccoli, bell peppers and sweet corn. The farm consists of 12,000 acres of land, much of which is harvested more than once per year, providing the equivalent yield of 20,000 acres of produce yearly. This operation, like the others we visited in the San Joaquin valley, faces the same labor challenges and

uncertainty over the long-term availability of water in California. However, they have taken innovation to a new level in the manner in which they process their produce for sale. Their cold storage facility was designed to achieve cost cutting efficiency in every step of preparation required, including cooling, packaging and icing the produce, to maximize profits. Their irrigation and fertilization system minimizes the use of water and fertilizers, is computerized to minimize manpower costs and is scheduled to utilize electricity at those times in the day when rates of kilowatts per hour are at their lowest. Finally, the operation does not enter any part of the value chain beyond processing the produce. Once palletized and placed on their loading docks, the product is no longer a concern of the farm. Purchasers, be they wholesalers, other processors or retailers, assume all responsibilities and risks for transportation and final conveyance to the consumer. Management is also done through the family hierarchy, with an even smaller team of trusted advisors.

Appendix 3 – International Travel – Observations on China

Observations made in China generally reflected our readings and the presentations by our guest lecturers prior to the travel. We also concluded, however, that China's agriculture sustainability is an even greater challenge than what we expected. Visits made to the US Embassy, China's Ministry of Agriculture, the Chinese Academy of Agricultural Science, and a food testing laboratory revealed additional information supporting this finding.

The first observation, and an important impediment to Direct Foreign Investment in China, is that the rule of law as it applies to business dealings and property rights is rudimentary and rarely enforced. Business success is often based on relationships and, in its darker manifestations, patronage and corruption. That being said, U.S. companies are not taking advantage of the opportunities that China represents; these opportunities do not necessarily reveal themselves in direct food production, a complex undertaking due to numerous factors, but in those industries related to food such as the logistics of packaging and transportation, and all services related to sanitary and phytosanitary standards.

The time spent with the Chinese Ministry of Agriculture was illuminating in its close adherence to a scripted message touting the continued success of Chinese agriculture, and China's undisputed ability to feed its population. While there was acknowledgment that family incomes needed to increase, our second observation was that there was also a pointed refusal in acknowledging any problems, including the pressing issues of water scarcity and desertification.

The members of the Chinese Agricultural Academy of Science were open and forthcoming in their analysis of their country's agricultural capacity. They discussed the significant issues of food safety, pollution and the environment (which is worsening due to additional food requirements), and farmer's enrichment (increasing income) in an effort to curb unrest. Not surprisingly, they identified China's desire to meet 95% of their food requirements through domestic production as unrealistic considering their current situation and continued land encroachment on limited amounts of arable land. As we were leaving, they expressed great interest in continuing a relationship with the Industrial College of the Armed Forces, which in the interest of U.S. security is one of our recommendations. Clearly, our third observation is that the scientific community is more forthright in their evaluation of China's challenges than their bureaucrats of its official ministries.

Some of the best observations on the state of China's agriculture were provided by a small expatriate community which has been directly involved in large scale farming and related industries in China itself. They offered a ground-level view of the complexities of Chinese customs and politics and their effects on agriculture and joint ventures in general. While they saw China's ability to feed its population as marginal, they were quick to point out that their standards do not equate those of developed countries such as the U.S. Food picked in a Chinese field, for example, does not require heat removal or long term packaging to ensure freshness as it will be consumed within the next 24 hours.

As a result, our fourth observation was that in contrast to the anecdotal evidence gathered during our studies and our domestic travel, the expatriate community did not perceive China as a risk to U.S. agribusiness. They believe that the pressures faced by China in feeding its own population and the challenges associated in competing on the world stage for agricultural trade have the Chinese concerned more with meeting the internal pressures than tackling the world's most successful agricultural nation.

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