

Economics of Production, Processing and Marketing

The North American livestock industry is undergoing major structural change due to rapid change in product characteristics, worldwide production and consumption patterns, technology, size of operation, and geographic location. Production once dominated by independent, family-based, small-scale firms is now led by large firms that are tightly aligned across the production and distribution chain. Contracts and other types of marketing arrangements are increasingly important across nearly every market level—from input supply and seed stock to finished food product markets. The traditional production and marketing firms and linkages still exist, but are gravitating to niches for differentiated products that may command a premium from some consumers. As the industry has become more industrialized, specialized and managerially intense, location options have expanded beyond traditional production regions.

There is great diversity in how livestock is produced in North America and the world, but common themes are emerging. As in North America, many countries worldwide are experiencing major structural changes in their production sectors, and environmental concerns in production are nearly universal. Technology adoption is rapid, and a “world standard” is evolving to greater commonality of technology, size of production units, processing and quality—particularly in the pork and poultry industries. Differences exist across species and parts of the world that differentiate competing suppliers of animal proteins.

This analysis assesses the global competitiveness of the North American livestock industry by focusing on:

- Industry cost and coordination structures;
- Market demand for source verification, traceability and emerging markets;
- Government regulations, policy and standards; and
- Cost drivers, including feed costs; nutrition and production technology innovations; crop-livestock synergies; financing, risk and capital access/cost; energy costs and ethanol production; and access to and the price of land, water and labor.

The chapter begins with an assessment of the current situation and then moves to the drivers of change impacting livestock

production, processing and marketing in North America. It discusses policy options and implications, ending with topics for additional research.

Current Situation

Industry

Cost, Size and Competitiveness: Consolidation has occurred and continues throughout the livestock industry; however, the rate and form of consolidation vary by species. The strength of the North American livestock industry depends on the degree to which increased concentration in production and processing reduce production costs and address market segmentation. International market power will be gained from increased firm size, especially in processing, in sectors that exhibit economies of size.

Economies of size exist in animal production. Most animal production displays an L-shaped average cost curve. Costs decrease rapidly as size of operation initially increases, then much more slowly beyond a certain size, which is typically larger than what is generally defined as family-size.

Cost-of-production advantages associated with large operations vary across species. Recent research indicates that dairy and poultry have considerable economies of size; in pork, costs of production are management related after a certain size operation is reached. Scale economies for beef cow operations are more difficult to distinguish because many production units are part time and subsidized with off-farm income. A recent Iowa study of feedlot environmental regulations indicates that operations just large enough to fall under the environmental regulation requirements had higher per-head costs of production than did large feedlots with environmental regulation requirements and small feedlots exempt from feedlot environmental regulations. Other beef feedlot technologies, such as steam-flaked corn to improve feed conversion, have economies captured at much larger sizes.

Cost comparisons among countries are difficult to find and generally use different assumptions and measurements. A recent analysis of U.S. and Mexican costs of producing pigs to

weaning weight (11 lbs. to 13 lbs.) indicates that feed costs are 68 percent higher in Mexico than in the United States. However, lower labor and management costs in Mexico more than offset higher feed costs. From a total cost perspective, costs are approximately 10 percent higher in Mexico than in the United States. This study supports the common perspective that, in general, while labor costs for the livestock industry are lower in Mexico than elsewhere in North America, other costs of production, including feed, are high—resulting in a cost disadvantage relative to the United States and Canada. Cost comparisons show that Canada has a competitive advantage over the United States in the production of weaner/feeder pigs. However, the U.S. Corn Belt has a competitive advantage in finishing hogs. Taking all costs into account, it is estimated that the United States has a \$4 per-head advantage over Canada in producing a 250-pound pig from farrow to finish. The United States also has lower pork-processing costs. A growing number of Canadian pigs are exported to the U.S. Corn Belt for finishing and slaughter to capture the advantages in both countries.

Because of the size of the market or the nature of production, some types of specialty production—such as specialty pork, grass-fed beef and free-range chickens—favor small operations. These production systems are generally more labor and management intensive and less conducive to automated production techniques. While growing, specialized niche production does not appear likely to become the dominant segment of the market (see Consumer Demand Chapter). Any significant market expansion of these specialty products would likely attract large production firms.

Significant consolidation in the U.S. processing industry has generated larger harvest or slaughter capacity, resulting in more efficient plant operation and lower procurement costs. There is a limit to the amount of concentration that can occur in production or processing without encountering market or regulatory barriers. Consolidation appears to be accelerating for dairy, slowing for swine, and stable for beef and poultry. The number of processing plants and access to those plants have already reached a critical point in many areas of the country with limited producers.

In Canada, consolidation continues in both production and processing. About 20 percent of the livestock farms in Canada produce 80 percent of the product. There has been expansion of both hog production and cattle feedlots in Western Canada during the last decade. Reduced freight supports for grain shipments encouraged more feeding of livestock, and there has been new investment in pork and beef processing in the region. The two largest beef packers are owned by U.S. companies.

Livestock production in Mexico is influenced by diverse land-ecological conditions. Climatic variability influences the choice of animal breeds, so production systems are very heterogeneous.

Operations range from subsistence farming to high-technology systems. Significant opportunities exist to expand livestock production in Mexico.

There is wide variance in the types of beef produced in Mexico, the result of variability of animal age at slaughter, differences in breed characteristics and climatic variability. In general, productivity indicators from the U.S. and Canadian industries are higher than those of Mexico. For example, in the United States, the calving rate (calves born per cow inventory per year) is more than 80 percent, while in Mexico it is about 50 percent.

In Mexico, hogs are produced through different systems, each with different levels of technology and productivity. Backyard production, with one to 25 breeding animals, has low productivity and is primarily for self-consumption. Small and mid-size farms with up to 300 breeding animals have higher productivity. Some produce under contract. Just as is the case with mid-size operations in the United States and Canada, these units are under severe economic pressure and declining in number. Expanding modestly in number are large-scale family and industrialized operations using modern technology, achieving high productivity, and producing under contract arrangements with processors. The dairy and poultry industries are characterized by similar, but diverse, structures. Larger scale/industrialized systems in this sector are more predominant and growing more rapidly than in pork or beef.

Coordination and Value Chain Structures: Contracts and other types of marketing arrangements are increasingly important across every market level of the livestock industry—from input supply and seed stock to finished food product markets. They provide greater coordination and more detail specification than do arm's-length open market transactions. These marketing tools enable firms to reduce costs of buying and/or selling meat and livestock; reduce risk exposure; enhance access to credit; increase supply chain information flow; ensure closer quality specifications and product traceability; ensure market access; increase flexibility in responding to customer needs; enhance opportunities for product differentiation and branding; increase food safety and biosecurity assurances; and enhance operating efficiency.

Many firms participate in contracts to assure market access. With the dramatic decline in spot market transactions in hogs and cattle during recent years, market access has been a concern, especially for producers located in fringe production areas. Likewise, packers outside major production regions can use contracts to secure necessary supplies. Producers in key production regions use contracts to ensure access to buyers without incurring substantial search costs when animals are ready for harvest. Packers also contend that marketing contracts allow them to source better quality and more consistent quality of animals.

The substantial horizontal contracting growth among hog producers suggests that contracts enable large production operations to get larger. However, numerous other factors contribute to the large horizontal expansion and consolidation in hog production. These include profits that attract external capital and advances in genetics, health, nutrition and production management that increase economies of scale. Many smaller operations have been able to remain in hog production by contracting with horizontal and vertical integrators. Integrators provide production services, capital and risk management options that encourage smaller operations to continue to participate in livestock production.

Packing companies have increased their involvement in production agriculture. Ownership of U.S. fed cattle by the four largest beef packers is approximately 10 percent of harvest/slaughter, though this number varies depending on how ownership is defined. Hog ownership by pork packers represents about 24 percent of total harvest (Hayenga, et al, 2000). Vertical integration by packers or others in livestock markets are a substitute for contracts, partnerships and alliance types of arrangements.

Some people perceive large operators as beneficiaries of marketing agreements and contracts. Others contend that marketing agreements reduce spot market liquidity, lessen the availability of market information for efficient price discovery, and adversely affect smaller operations. It is unclear whether contracts and marketing agreements are a result of, or a factor in, increased concentration of firms involved in meat and livestock markets. It is also unclear if the benefits from improved supply coordination offset any potential costs that the decreased use of open markets may cause.

Asymmetries in market information and captive supply are continuing sources of controversy in the livestock industry. But empirical evidence on market power and pricing suggests that processor advantages are inconsistent and not widespread.

In general, Mexican livestock supply chains are less integrated from production through retailing. This has created a large number of intermediaries and a preference for imported animal products. Challenges facing the Mexican animal industry include:

- Lack of modern storage and transportation infrastructure, resulting in high mortality/losses in the distribution channel.
- Higher quality imported products, which leave Mexican products at a disadvantage in the marketplace.
- Producers sell animals to intermediaries, rather than direct, resulting in lower prices.
- Buyers purchase animals with 90 days' credit, which is not viable for small producers who need the money immediately.

- Limited financing.
- Lack of support from the government to improve production conditions.

In Mexico's dairy and poultry industries, more tightly aligned value chains are growing in importance, with a focus on marketing to higher income domestic consumers.

In summary, new forms of value chain coordination enable large firms to shift risk, leverage capital, increase profitability, improve product uniformity and traceability, exploit comparative advantages, reduce costs, and provide more direct price signals to value chain participants. Industry advocates maintain that increased information flow enhances overall market efficiency and better enables the industry to compete globally and domestically. Critics object to the lower prices allegedly paid to family farms and the loss of access in the marketplace. More intensive value chain coordination mechanisms provide a direct method to verify and ensure particular production, processing and marketing practices, and procedures to enhance product quality, safety and credence for consumers. Some traditional producers that have lost share to large-scale, tightly aligned supply chains are targeting value-added niche markets that differentiate the product by how or by whom the animal was raised. These markets are either direct farmer to consumer or are more coordinated than traditional open markets. The ultimate beneficiaries of new value chain coordination mechanisms are consumers who pay less for products of standardized quality or who pay more for differentiated products.

Market Demand

Source Verification, Identity Preservation and Food Traceability Systems: Consumer concerns about access to and the availability of reliably safe food sources have prompted changes in the global meat and livestock industries. Issues include use of hormones, animal health, bio-terrorism threats, food safety, international trade, credence attributes (which consumers cannot determine from viewing or consuming the product), and improving supply chain management. Economic incentives pushing these new systems, in large part, originate from the international meat marketplace. Increasingly, consumers worldwide are demanding assurance of safe meat products, and assurance that production systems are capable of tracking sources of potential food safety concerns in a timely and precise manner. Countries and producers able to provide such assurances will have a considerable competitive advantage in world meat markets.

Food products that can be traced through production, processing and marketing have strong appeal to consumers. Such products are seen as having greater food safety standards and assurances. For the livestock industry, animal identification

and traceability are critical for effective management and rapid arrest of animal health and disease concerns. National animal and meat traceability programs are being implemented. The discovery of *bovine spongiform encephalopathy* (BSE) in Canada and the United States has increased the urgency of having such systems in place to achieve timely and accurate trace-back of animals.

The U.S. and Mexican livestock sectors are well behind major global competitors in meat and livestock trace-back systems. Canada, Australia, Brazil and Europe all have more advanced and comprehensive animal identification systems than do the United States and Mexico. Primary world competitors are quickly adopting wide-scale traceability systems.

New Markets, Niche Markets: Consumers have diverse preferences. Many consumers, particularly those who are more affluent, are demanding extrinsic food attributes not related to food safety or federal grading standards. Some consumers are interested in issues related to animal production, such as animal welfare, antibiotic free, growth hormones, use of genetically modified organisms and free-range production. Developed economies, such as the United States, Canada, Japan and the European Union (EU), have some consumers that fit this profile (see Consumer Demand Chapter).

Many of these characteristics cannot be verified through physical testing of the product; consumers must rely on supplier reputation, or process verification and certification programs. This requires animal segregation throughout production, processing and marketing. These practices may increase the cost of production, relative to traditional commercial production methods, i.e., reduced growth efficiency due to not using growth hormones in beef production. Differentiated markets and different pricing/product valuation structures are necessary to support such production practices.

Meeting consumer demands for specific product and process attributes can only be assured through verification and audit programs. Such programs often require alliances, partnerships, contracts and/or vertical control or ownership of production, processing and marketing functions to assure complete compliance. National animal traceability systems will provide the infrastructure to trace these animals, but there will still be costs associated with certification and verification.

Challenges Facing Small Farms in Serving Niche Markets: Some highly differentiated products are more expensive to produce and market and may not be able to capture economies of size because of the limited size of local niche markets. It is generally difficult to establish national market presence with highly differentiated products. Such product demands enhance opportunities for smaller-scale operations in localized, niche markets.

But successful small to mid-size producers will have to find opportunities to either increase revenue or reduce costs. Higher revenue may be possible in value-added niche markets where consumers pay high enough premiums for differentiated products to offset the increased cost of producing, processing and distributing small quantities. Small to mid-size producers may be able to capture the access and cost advantages of larger producers by joining a network or alliance that acts like a large producer. Certification programs might be utilized to facilitate the development of these niche markets.

These strategies, like the supply chain model for mainstream animal agriculture, require a higher level of interdependence than that to which North American producers are traditionally accustomed. Even if this strategy is pursued, the challenge to smaller farms/firms is that once the niche market becomes large enough or sufficiently well-established, large operations can take advantage of the economies of size of specialized production or implementing certification programs.

Government

Impacts of Regulations: A sound regulatory framework protects the health and environment of citizens, contributes to economic growth, and promotes investments that, in turn, improve a nation's productivity and its people's standard of living. A dysfunctional regulatory system hinders productivity and innovation and reduces competitiveness and job opportunities. Protecting health and environment is not necessarily a tradeoff for competitiveness and innovation. A slow, burdensome regulatory system can actually harm human health and the environment by stifling the very innovations that could yield improvements.

Increasingly, every aspect of animal production is regulated at some level of government—municipal, state, provincial or federal. Farm-level regulations include disposal of dead stock, environmental (including site selection, waste management and protection of water resources), medicated feeds, sale and use of livestock medicines, transportation of compromised animals, animal identification, animal cruelty, and nutrient management. At the processing level, regulations include livestock and poultry carcass grading, food safety, dairy products regulations, and egg and processed egg regulations, all of which fall under various national regulatory authorities.

The intent of any regulatory framework is to protect the country's citizens while keeping its industries competitive by promoting investments and increasing productivity. The challenge for the future is to seek a balance of regulations that do not compromise competitiveness by imposing too many costs on various segments of the value chain.

State and Federal Policy: Paralleling most other sectors of the economy, the animal and animal products sector is characterized by increasing firm size and consolidation at all levels of the supply chain. This concentration of processors and retailers has prompted concern about the competitive position of producers in the supply chain. Increasingly, economic policies are being considered to shape alternative outcomes in terms of industry structure and conduct. Economic efficiency is only one concern. Equity and fairness issues also are important in debates about economic policies for the animal and animal products sector.

Traditionally, U.S. public policies in the livestock industries have been directed at improving economic efficiency and “leveling the playing field,” especially in protecting the interests of producers relative to those of packers and processors. The Packers and Stockyards Act of 1921 has financial, trade practice and competition provisions. The Agricultural Marketing Act of 1946 and related statutes provide the authority for federal grading and standards activities, provision of market news information, and other market-facilitating functions.

The Livestock Mandatory Reporting Act of 1999 was introduced to correct perceived market failures, which were seen as particularly detrimental to smaller livestock operations. Voluntary reporting of spot market prices facilitated price discovery for many years in the United States. The adequacy of the system was called into question as more trade took place through marketing or formula pricing arrangements that were not reported under the voluntary system. Under mandatory reporting, large meat packers are required to report information on all cattle, hog and sheep purchases and beef and lamb sales transactions. A recent Government Accountability Office (GAO) study indicates mandatory reporting has given the market additional information about prices for different kinds of sales transactions. The study also identified reporting errors to be addressed. The trend toward formula purchases of cattle has slowed since mandatory price reporting was implemented, and the volume of cattle moving under negotiated purchases has increased. It is not clear if mandatory price reporting caused the movement away from formula purchases, or if it coincided with the move that occurred for other reasons. Debate to continue the law centers on its effectiveness and the reporting burden imposed on large meat packers.

In recent years, various state and federal policies have been proposed in the United States to restrict certain types of organization and market conduct in the livestock and meat industries. For example, there have been proposals to prohibit packer ownership of livestock and to restrict certain marketing practices, such as privately negotiated marketing agreements that allow packers to know the supply of animals coming to their plant for more than 14 days in advance. At the federal level, such market conduct regulations are under the purview of

USDA’s Grain Inspection, Packers and Stockyards Administration (GIPSA). Small-farm advocates have long contended that USDA was not enforcing the laws as intended in the original 1921 act, and had pressured states to enact legislation. A 2006 GAO study found that GIPSA had not established an adequate control structure and environment to allow the agency to oversee and manage its investigative activities.

Several states have anti-corporate farming laws to correct market imbalances, particularly between large meat packers and smaller livestock producers. Some laws seek to preserve the ability of livestock producers to operate independently without having to become aligned with a particular buyer through ownership, contract or other vertical alliance. Debate over these policies will continue—one side arguing that such policies do little more than impede economic efficiency and freedom to contract, and the other arguing the policies are needed to prevent abuse of market power and preserve family farms.

In the United States, mandatory country of origin labeling (COOL) has been introduced at both the state and federal levels, with considerable support from smaller producers. Proponents argue that consumers would choose domestic product and pay higher prices for it if country of origin information were provided. Opponents argue that COOL imposes high costs of implementation and impedes the benefits of free trade. A 2002 Farm Bill provision on mandatory COOL for meats and other commodities was to become effective in 2004. Canada and Mexico submitted comments opposing USDA’s proposed rule for mandatory COOL. Subsequent legislation postponed the implementation date to 2008 for all commodities except fish.

Animal identification is another potential area of regulatory policy. The Canadian Cattle Identification Program is administered by the Canadian Food Inspection Agency under the Health of Animals Act. As of January 1, 2001, cattle leaving the herds in which they were born—their “herd of origin”—were required to have an ear tag approved for use in the Canadian Cattle Identification Program. On July 1, 2001, the program was extended to include cattle leaving all premises, whether born there or not. Effective July 2005, tag distributors are required to report all tag sales to the national database within 24 hours of sale to the producer. Producers are required to report all tags from dead stock disposed of on the farm and dead stock leaving the farm to the national database to ensure that the tag number is retired. Similar animal identification regulations are now being debated in the United States.

In Mexico, government support for the livestock industries has the primary objective of promoting productivity in production systems. Programs are operated by the federal and local governments, as well as through farmer organizations. Resources are limited and do not meet demand. Promotion programs for beef production operated through *Alianza para el Campo* focus

on support for genetic improvement, integral project development and shepherding land recovery. Government assistance to hog production is implemented by two programs. The Genetic Improvement Program promotes acquisition of reproductive animals and breeding stock of better genetic quality. The Hog and Poultry Program promotes development of projects for the acquisition of infrastructure and equipment.

Incentive payments are also paid to producers to encourage higher quality production that can meet the standards of federally certified harvest plants. In 2003, Mexico implemented a program to support grain consumption on hog farms, using contracts between hog and grain producers.

Cross Border Animal/Product Movements

Movements of animals and products across Canadian, Mexican and U.S. borders vary depending on such factors as exchange rate, regulatory programs, economies of scale, differences in grading systems, existence of home biases, threats of anti-dumping and countervail actions, and temporary production shortfalls due to disease or growing conditions. Two examples illustrate the impacts of border disruptions on location of investment, industry growth and productivity.

In 1985, the United States imposed a countervailing duty on exports of both hogs and pork from Canada. The International Trade Commission (ITC) determined that exports of hogs from Canada threatened to injure the U.S. hog industry, and the duty on hogs was upheld. No other markets to which Canada was exporting were directly affected. In 1989, another countervailing duty allegation contended that exports of pork were being subsidized, causing injury to the U.S. pork industry. A duty was imposed in May 1989. Canada successfully challenged the decisions on subsidy and injury under both the General Agreement on Tariffs and Trade (GATT) and the Canada-U.S. Free Trade Agreement, and the duty was eliminated in 1991.

The overall impacts of the countervailing duty were twofold. First, harvest/slaughter facilities expanded in Canada at a more rapid rate than had the markets remained fully integrated. Because of the countervailing duty, investment and related jobs in hog processing shifted to Canada from the United States. Second, the Canadian hog/pork industry strengthened efforts to expand market share for Canadian pork products in the Asian markets, in competition with products from other countries, including the United States.

In a second example, the discovery of BSE in Canada in May 2003 resulted in prohibition of Canadian exports of live cattle and beef products to the United States and other countries. This had a number of consequences in Canada:

- The price of cattle over 30 months (OTM) in age fell dramatically, lowering the equity value in the herd held by

Canadian farmers. While the usual expectation in markets with low prices is that the herd would diminish in Canada, the opposite has happened. OTM cattle are being held back and re-bred, in part because of the exceedingly low prices in Canada, and in part from the lack of adequate harvest/slaughter facilities in Canada. At the same time, heifers are entering the Canadian herd. Consequently, herd expansion and subsequent annual calf crops are increasing more rapidly than in previous periods, and more rapidly than would have been the case had the border remained open.

- The fed cattle price difference between Canada and the United States has grown substantially—from about US\$5-\$6 per hundredweight (cwt) to about U.S. \$20-\$30/cwt for the period after trade in boneless product from cattle under 30 months of age (UTM) was re-established. For the packing industry in Canada, the result has been considerably larger margins than before May 2003, stemming from both the domestic market sales (because of the limited change in retail prices) and higher U.S. prices for exported boneless beef.
- Faced with limited harvest/slaughter capacity and the growing realization of long-term insecurity of U.S. trade, major efforts are under way to expand harvest/slaughter and processing capacity in Canada. At the same time, packing plants in the border states of the United States are closing because of the loss of access to Canadian live cattle.

In summary, trade restrictions and the atmosphere regarding trade in animals and animal products between Canada and the United States are prompting greater investment in harvest/slaughter capacity in Canada and a loss of similar investments and jobs in the United States. The Canadian cattle herd is expanding more rapidly than would have been the case without restrictions, and more rapidly than the U.S. cattle herd.

Periodic or extended periods of trade disruption in one or more components of fully integrated markets can cause significant long-term effects in the size and competitiveness of an industry at farm and processing levels. Even though consumer-level prices may remain fully integrated, distribution of the margins within the value chain can change sharply for extended periods. As a result, location of investments, particularly for processing and distribution, can be expected to change over time in response to these unforeseen disruptions.

Cost Drivers

Access to Inputs

Feed Costs and Future Nutritional Technology: Feed is the highest operating cost—50 percent to 60 percent—of most animal production operations. Any change in feed costs dramatically impacts profitability. Use of antibiotics, feed additives, dietary modifiers and specialized feed ingredients has focused on increasing animal productivity. Research works to determine

specific nutrient requirements for specific genetics. Recent biotechnology techniques have provided insight to the mechanisms controlling metabolism at the cellular level, allowing for development of diet modifiers or feed formulations to affect nutrient retention. These tools appear to be cost effective, contributing to increased production and/or an increased price for an improved quality of product.

Reducing the crude protein level in monogastric diets and supplementing with essential synthetic amino acids have been important dietary changes for hogs. These shifts have reduced nitrogen excretion levels 25 percent to 50 percent, and reduced emissions of specific gases and odors from animal housing units. Reducing protein from plant sources and balancing the amino acid profile with synthetic amino acid reduce nitrogen excretion of excess amino acids. Use of the synthetically derived enzyme, phytase, which is also present in wheat and barley, can reduce phosphorus excretion up to 20 percent to 25 percent with no significant cost increases.

Many animal producers use specific feed ingredients or enzymes to reduce phosphorus levels in manure because of regulations on phosphorus applications to agricultural land. Animal production in areas with these regulations is at a cost disadvantage, compared to areas in the world without such regulations. Some nutrition technologies influence the quality of the final animal product, which can potentially fit niche markets and result in value-added returns.

While there will be considerable debate as to how much, as a general rule, U.S. farm support programs have reduced the cost of feed grains and oilseeds. For countries that support feed prices and restrict imports, such as the EU, feed prices are higher but more stable. These differences lay at the root of many trade restrictions in livestock products.

Production Technology Innovations and Crop-Livestock Synergies: The primary method of manure management in North America is recycling the nutrients back into crop production (see Environmental Chapter). If grains and forages can be produced with the correct amounts of nutrients, and rations can be formulated to meet a specific animal's requirements, the need to supplement diets will be reduced, reducing excess excretion of nutrients that need to be stored, treated and used on cropland. Costs would also be reduced, as would the pressure on the environment.

The potential exists for relationships between animal and crop producers—the animal producer purchases grain from the crop operation, which then receives manure nutrients. This trade may result in economic advantages for each operation. In a long-term scenario of fertilizer costs increasing and fertilizer resources diminishing, the use of organic fertilizers may be much more valuable. In farms, regions or countries that import

grain to feed animals because not enough is produced locally, manure nutrient management is more challenging. Operations are looking to treat, compost or generate energy by burning or biogas production from the manure to reduce the volume of nutrient-containing material that has to be hauled to fields (see Environmental Chapter).

Feed costs are very competitive in North America compared to the global market. This is due to the relatively close proximity of feedstuffs and animal production, and the potential for developing market linkages for specialized feed crops and feed ingredients.

Technologies are available to enhance the efficiency of animal production, and control the impact of animal production on the environment. Large operations can better afford and manage manure treatment technologies, particularly those with high fixed costs. They can spread the costs over a larger volume of product and have sufficient volume to potentially sell value-added products. Environmental regulations requiring significant restrictions on producers will force the structure of the animal industry to much larger operations. Some technologies in nutrition or housing designs are size neutral and will not affect the structure of the industry, as long as the technologies are cost effective.

Financing, Risk and Capital Access/Cost: Capital markets are relatively efficient in allocating funds to those who successfully manage risk and generate the highest returns. This generalization is more accurate in its application to the processing, wholesaling and retailing segments of the value chain than to smaller firms in the production sector. Firms that do not use modern technology, that are smaller scale, have relatively high costs, and/or have not used accepted tools and techniques to manage operating risks may encounter difficulty accessing financing at reasonable costs.

The dramatic globalization of the capital/financial markets has dissipated the relative advantage the North American livestock market had over global competitors in accessing the capital markets at a competitive cost. The significant barriers and resulting higher costs that once restricted the flow of funds across country borders have declined. Firms that can show competitive returns are less constrained in access to financing in the form of debt or equity funds, regardless of their location in the world.

One critical spatial or geographic/country difference that still impacts capital markets is country risk—the financial risk resulting from such fundamental economic forces as political stability, inflation, currency values and economic growth. Different countries have different business and political climates that result in different country risk premiums in capital/financial markets. In general, North America, and

particularly Canada and the United States, have a less volatile economic and political climate and, thus, less risk. Consequently, financial markets generally reflect a lower-risk premium and cost of capital for investments in North America, when compared to other countries/locales. But that risk premium has declined and is less of a comparative advantage than in the past.

The North American livestock industries, particularly in Canada and the United States, are well positioned in terms of global competitiveness and cost structure for access to financing and the capital markets. The capital market institutional structure, combined with efficient and effective risk management and mitigation procedures for borrowers and lenders, aids credit access and the flow of equity capital to the sector. Economies of size, combined with the multi-plant replicate expansion strategy and the broader adoption of strategies to manage operating risk, enable larger-scale firms to exhibit lower cost and expand more rapidly than smaller-scale firms. The efficiency and product flow scheduling, quality management, traceability and risk mitigation advantages of more tightly aligned value chains have and will continue to transform the industries from open-access market coordination to vertical linkages through ownership, contracts or strategic alliances.

Energy Costs and Ethanol Production: High energy prices increase costs of production. The United States has an animal production system that requires more fossil fuels than grazing or less confined systems. Some regions or countries will see higher energy prices in the form of higher cost transportation costs to import grain or higher irrigation costs to pump water to grow grain. The impact of increased energy prices will fall more heavily on the United States and Canada, relative to countries using less energy in production, processing and retailing. In 2002, approximately 8 percent of U.S. consumer expenditures for all food were energy related after the farmgate; this is even higher for animal products.

Nitrogen fertilizer is a major component of the energy consumed in producing feed. From 1982 to 1997, the number of livestock farms decreased 50 percent and the number of confined animal units (1,000-pound liveweight per unit) increased 10 percent. This has led to situations where there is excess application of farm manure nutrients and an increasing number of crop farms depending totally on external sources for nutrient needs. The increasing value of animal manure could result in a slowing, if not reversal, of the trend toward more separated grain and livestock production farms.

Corn-based ethanol has become a popular fuel additive in the United States. In September 2005, 77 new ethanol plants were planned or under construction in the United States. Ethanol production is a nonfeed demand for corn. Distillers grain, a

coproduct of ethanol production, is used as an animal feed and will replace some corn and soybean meal as a source of calories and protein in rations. This is particularly true for ruminants—beef and dairy cattle—that can utilize the high-fiber distillers grain, and to a lesser extent for monogastrics, hogs and poultry. A negative impact of distillers grain and other coproducts is a concentration of and therefore higher excretion of nutrients, especially phosphorus. This will require more land for manure application to meet environmental regulations, or a costly treatment of manure to recover phosphorus for distribution off-farm. The increased costs of production due to higher feed costs from increased demand for corn for ethanol will be felt mostly in North America, decreasing the region's world competitive position.

Larger farms may have more options to save energy. To the extent that this is true, increasing costs should have little or no effect. It is currently unclear what impact increased ethanol use will have on the size and size distribution of animal producers. Higher energy prices coupled with ethanol production may move some livestock production closer to ethanol plants to lower transportation and distillers grain drying costs. Those savings may be partially or totally offset, however, by the increase in grain cost the closer to the ethanol plant.

Access to and Price of Land and Water: North American producers have seen higher land values increase production costs and affect the geographic location of animal agriculture. In areas where land values have increased substantially because of urbanization pressures, it is not feasible to have land-intensive animal agriculture. Currently, prices are increasing faster in urban areas and areas with recreation or aesthetic amenities. Intensive animal agriculture has developed in some less-densely populated areas. These types of production systems keep the land cost per unit of output lower by intensifying production levels or moving production to lower land prices elsewhere.

Conflicts among humans, nature and all industrial sectors over access to fresh water will be one of the main challenges of the 21st century. Agriculture is the biggest user of water in the economy. Livestock production's use of water is minor compared to plant irrigation. About 60 percent of livestock water is for drinking. Other livestock water uses include evaporation from stock ponds; dairy sanitation; cleaning and waste-disposal systems; cooling of an animal or a product; and processing animal products. Sufficient access to and availability of fresh water resources will continue to impact the ability of North American livestock producers and processors to produce and compete in the world marketplace. The extent and severity of regulatory policies on water use will affect the cost-competitive advantage or disadvantage.

The Future

Given the current situation detailed above and underlying economic trends, what is implied for the future of the North American livestock industry?

Size, Scale and Supply Chains

The North American livestock industry is expected to see continued consolidation to fewer and larger firms. For producers and processors with old technology, market prices are expected to cover variable costs, but will likely be inadequate to cover depreciation and other fixed costs. They will continue operating until buildings and equipment need replacement, at which time they may consider other alternatives. For small and modest-size operations, niche markets may provide opportunities. Alternatively, networking with others in a cooperative or other form of alliance may have high payoffs. For small-scale operations, the operating principle is not necessarily to be big, but to look and act big through networks or alliances, obtaining the efficiency and market access benefits of size.

There will be increasing emphasis on managing and optimizing livestock supply chains, from genetics to end-users. This approach will improve efficiency through better coordination and quality control throughout the chain, reduce food safety risk, and increase the ability to quickly respond to changes in consumer demands. Retailers will impose consumer preferences on the production process through production specifications, including differentiated or specialized products, such as hormone free, organic or animal friendly.

Food safety is a key risk for all segments of the livestock industry. Food products that make people ill, or in a worst-case scenario cause death, can quickly destroy brand value, the most valuable asset of a branded-food product company. Supply chain management using a traceback system, combined with quality-assurance procedures such as Hazard Analysis and Critical Control Point (HACCP), facilitates control of the system to minimize the chances of a food contaminant, or to quickly and easily identify the sources of contamination. Traceability is increasingly a key motivation for controlled origination of raw materials from certified suppliers to implement a supply chain philosophy.

The management of livestock production is expected to trend toward more micro-management of specific production sites, specific pens and possibly even specific animals. The motivation will be to minimize costs and enhance product quality, and it will increase the amount of information available regarding what affects animal growth and well-being and product attributes that in turn will be used to refine the system.

The supply chain approach will increase interdependence between the various stages in the production/processing/distribution chain. It will encourage producers and other members of the chain to form or join strategic alliances, networks and other linkages to improve logistics, product flow and information flow. Competition will occur in supply chains competing for a share of consumers' animal protein expenditures, rather than individual firms competing for market share.

Supply chain optimization concepts have a significant implication for growth of the livestock industries. In the past, decisions concerning location of production, processing and distribution centers were made in a relatively independent fashion. In the future, this will not be the case. It is unlikely that new processing plants of optimal size to capture economies of scale will be constructed without specific plans for building production systems to supply those plants. Producers are not expected to invest in production capacity without assurance of access to processing plants that can pay competitive prices for their products. The benefits of a coordinated system will result in the development of production-processing centers and the supporting infrastructure as the optimal strategy for growth and expansion of the industry. This strategy will not only influence the geographic location of the industry, but also further increase the interdependence among the segments of the industry.

Industry Mobility and Location Decisions

One of the most critical issues to shape the structure and location of the livestock industries in the future is storage and utilization of manure and other byproducts from production and processing, and mitigation of air and water pollution from the industry. The Environmental Chapter of this report provides a more detailed discussion of environmental issues, but key factors include:

- recycling of animal manure,
- processing manure into energy of other productive resources,
- technological mitigation of nutrients and odors, and
- relocation of the industry to geographic regions where there is more environmental absorptive capacity (lower population density, drier climates, fewer surface waterways, less permeable soils or sufficient crop production), or where there is more willingness to exploit the environment.

Until and unless technological fixes to environmental and odor problems occur, this challenge will continue to dramatically affect the size, location and structure of the livestock industry.

Investment capital is highly mobile, and capital markets are increasingly efficient at allocating funds to industries and geographic areas exhibiting comparative advantage. There is little reason to believe capital markets will not continue to provide adequate financing for future domestic and international expansion of the livestock and poultry industries.

However, lenders are particularly conscious of risk and increasingly impose discipline on their customers to be efficient and utilize the best risk management strategies. This suggests that an increasing proportion of production will occur in integrated production/distribution systems—not only to capture the efficiencies of such a system, but also to reduce risk exposure in market prices, quantity and quality. Consequently, it will be increasingly difficult for traditional independent producers to access adequate funds unless they adopt current technology and use management strategies to reduce their and their lenders' risk exposure.

Technology is also mobile, and technological advances could dramatically alter labor requirements in production and processing. While labor and community issues are discussed in another chapter, the constraint of labor availability in some regions or sectors could be reduced by greater substitution of capital for labor. Production is increasingly automated and sophisticated, including use of electronic monitoring and measuring devices to determine real-time animal product quality characteristics. This information will be useful in rewarding producers for those attributes and in segmenting products into proper categories for efficient distribution to different end-users.

The livestock industries will likely face new instabilities and financial risks from factors not previously considered. The increased interdependence that comes with supply chain alliances trades price and quality risk for relationship risk, such as a plant shutdown, contract termination or disease outbreak. There will also be increased variability in feed ingredient prices because of growing competition with the energy and industrial-use markets for corn and soybean products.

Globalization brings greater dependency on export markets, which increases instability from exchange rate fluctuations, changing political policies in foreign countries, and weather conditions worldwide. Trade disputes and disease outbreaks will have greater impacts on the North American industry, as demonstrated by the outbreak of foot-and-mouth disease (FMD) in the United Kingdom and the cases of BSE in Canada and the United States. In addition, countries such as Brazil and Argentina are expanding production and exporting animal proteins into the global markets.

A major change in North American and world livestock production and distribution is the globalization of ownership and operations of production/distribution firms. Japanese companies have already invested in pork production and processing systems in the United States (Oklahoma, Texas, Wyoming and Indiana). The EU is now encouraging European companies to locate operations in Asia, South America and Eastern Europe. U.S.-based companies have already invested in processing capacity in Canada, Mexico, Brazil, Eastern Europe and Asia. The livestock production/distribution industries are

clearly becoming global in scope, not only with product exports and imports, but also with internationalization of production and processing. Today's technological systems can easily be transferred to other areas of the world, providing an environment where internationally focused livestock firms will likely build capacity offshore. In the future, only a very few livestock firms are likely to dominate world production and processing and will source and sell products globally.

In general, relatively low input costs, including feed, combined with modern technology and well-developed input and product markets, institutions and distribution systems, enable North America to be a competitive producer and supplier of quality livestock products. However, North America will be increasingly challenged in commodity production and lower value and quality animal products by Brazil in beef, pork and poultry, and by Australia and Argentina in beef. It will be important for the North American livestock industry to maintain and increase its emphasis on quality attributes and differentiated products to expand its position in the global animal product markets and industries.

Environmental and odor problems may be significant deterrents to locating livestock production and distribution systems in various areas of North America. But it is highly likely that much of the expansion in production to meet increasing worldwide demand for animal proteins will be by North American or European integrated production/distribution firms or alliances, regardless of where the production and plants are located. North America cannot rest its competitive case on low cost alone—it must adapt products to specific markets and provide enhanced quality control and health and safety assurances.

In summary, the consolidation trend to fewer and larger livestock and poultry operations is expected to continue. The economies of scale in production and processing are significant and will drive the optimal size of the facility, as well as the firm. Firm-level economies will be captured through effective supply chain management that improves cost efficiency and control, food safety and quality, and the ability to respond to consumer demands. Quality concerns will also drive more systemized, micro-managed production and distribution processes to reduce product variability and improve conformance with quality standards and consumer expectations of uniform product attributes. Technology will provide new efficiencies and information to better manage the system. Concerns about food safety and a drive to qualified suppliers and traceback will increase pressures and payoffs of tighter coordination along the production and distribution chain.

Successful small to mid-size producers face serious survival challenges in determining how they fit into integrated supply chain structures. Higher revenue may be possible in value-added niche markets where consumers pay high enough premiums for differentiated products to offset the increased cost

of producing, processing and distributing in small quantities. Small and mid-size producers may be able to capture the access and cost advantages of larger producers by joining a network or alliance that acts like a large producer. Both these options require a high level of interdependence among producers.

Optimal processing plant capacity can be very large, requiring significant capital outlays and adequate supplies of live animals for efficient operations. Producers are not expected to invest in production capacity if access is not assured to processing plants that can pay competitively for products. This interdependence and supply chain advantages will result in development of production-processing centers and supporting infrastructure as the optimal strategy for growth and expansion in the industry.

A critical issue that will influence the structure and location of the livestock industries is storage and utilization of the manure and other byproducts from production and processing. Mitigation of air and water pollution is a related issue. Current strategies are based on recycling manure nutrients to cropland at agronomic rates, or on producing energy from manure. Until technological fixes are developed, this challenge will dramatically limit the size, location and structure of the livestock industry.

Livestock and poultry production and processing are increasingly mobile. Capital and technology can move anywhere in the world. North American firms can and have invested in production-processing centers in regions with comparative advantages. Likewise, such production-processing centers in North America may have foreign ownership. The livestock production/distribution industries are clearly becoming global in scope and in product exports and imports. In the future, few global livestock firms are likely to dominate world production and processing, and will source and sell products globally.

Policy Options and Implications

The business climate and fundamental drivers of change discussed above are likely to result in a North American livestock industry that is:

- more concentrated and consolidated at all levels of the value chain;
- more vertically aligned across the value chain with fewer open access market transactions between buyers and sellers;
- more specialized, particularly at the production level;
- dominated by commodity animal product production and distribution with modest expansion of differentiated products; and
- cost competitive on a global basis, but with increasing concerns about the direct and indirect cost of regulation.

These structural changes would appear to be a result of fundamental market forces combined with public or government policies that, in general, do not mitigate and may augment these forces.

Possible alternative futures for the North American livestock industry include:

- changed global cost competitiveness resulting from regulatory reform;
- greater emphasis on differentiated animal protein products, rather than commodity production and distribution; and
- less concentrated, smaller firms, independent, open market coordination, and more diversified production/distribution systems.

What types of policies or business strategies could cause the industry to change direction, based on existing trends, to one of the alternative outcomes?

Regulatory Reform

Regulatory reforms that change the cost competitiveness of the North American livestock industries might be in the form of changes in environmental regulations, labor rules, immigration regulations or tax laws. Regulatory reform might include added restrictions on business models, such as contract production or vertical integration, more restrictive immigration policies or worker safety rules, increased environmental regulation, or restrictions on the use of feed ingredients/additives—all of which would generally increase costs for the North American livestock industries.

Regulations can create benefits, as well as costs. For example, increased inspection, individual animal identification and other measures to monitor animal health and food safety will likely increase costs, but are increasingly critical to maintain and expand foreign market access. It is also the type of infrastructure necessary for a customer-driven, micro-managed supply chain.

In general, the cost-competitiveness impact of various regulatory reforms is clear—more regulation increases private-sector costs, less regulation reduces costs. But in most cases, the specific magnitude is not known. Furthermore, regulations are frequently implemented, in part, to encourage the private sector to internalize costs that, prior to the regulation, they have been able to pass on to others. What is known in principle—if not in specifics or details—is that regulatory reform that limits economic activity and/or increases private-sector costs is disadvantageous to small-scale firms; decreases the innovation and adaptability of an industry to a changing business climate; discourages the private sector from investing and expanding; and undermines an industry's global competitiveness unless other countries or locales adopt similar regulations.

Differentiated Product Focus

Consumers have diverse preferences among socioeconomic classes and across countries. Many consumers, particularly the more affluent, are demanding extrinsic food attributes above and beyond food safety or federal grading standards. These attributes include animal welfare, organic, social responsibility, environmental responsibility, free-range production, locally grown, and no use of antibiotics, synthetic growth hormones, or genetically modified organisms. Some European countries and/or companies are utilizing these attribute-based brands. Most of these attributes cannot be verified or discerned by the consumer through physical examination or consumption. Consumers must rely on supplier reputation or process verification and certification programs for production assurances.

Assuring these types of attributes requires animal segregation throughout production, processing and marketing. Many of these differentiated production practices increase production costs relative to traditional commercial production methods. Reduced growth efficiency associated with not using growth hormones is one example. In addition to reduced production efficiency and product yield (e.g., less gain, parasite damage, etc.), there are higher infrastructure costs to verify that product standards are met. Differentiated markets and different pricing/product valuation structures are necessary to encourage such production practices.

In general, differentiated products or process markets originate as niche markets. Niche markets often result in higher costs across production, processing and marketing. These are generally small markets meeting particular consumer demands. As such, consumers may be willing to pay the extra costs.

There are essentially two ways to ensure strict production practices that cannot be verified post-harvest: vertical production and marketing arrangements audited to ensure that practices are being met, or vertical ownership of production, processing and marketing. This is one reason why farmers' markets selling directly to consumers have been one of the prominent sources of these types of products. However, farmers' markets or direct-farm marketing are generally only local in scope. Such farms rarely have the scale, logistics, capital, expertise or market access necessary to expand beyond highly localized niche markets. Organic certification, USDA Process Verified Program (PVP) or other third-party verification programs may provide the product integrity and consumer protection needed to sustain a differentiated market beyond the local scope. Larger firms often do not see sufficient market opportunities in specialized small niche markets, whether local or international. Research suggests that customer demands in some Japanese markets, such as pork produced from Berkshire hogs, are likely to be served by smaller packing firms.

Success in developing niche markets generates market-based opportunities to maintain a small-scale independent diversified market segment. While unlikely to accommodate a large number of growers in the short term, it offers a strategy that does not rely on significant public intervention. However, public support for the development and implementation of certification and verification programs may provide the necessary infrastructure. It may offer growth opportunities for independent, small producers and processors. At some volume or margin, however, these markets may eventually attract investment from large-scale operators.

Not all production process control is small, niche-type markets. For example, if a large multinational food service company demands beef produced without the use of antibiotics, this quickly increases the scope of the production, processing and marketing channel needed to meet this demand. Small, local firms generally would not be able to meet this scale of product demand. Where demand for such product differentiation originates will largely determine whether it is scale neutral or favors large or small production, processing and/or marketing firms.

Maintaining Open Markets and Industry Diversity

A North American livestock industry characterized by smaller-scale firms, diversified production systems and traditional open access market coordination would likely result only with significant public-sector intervention to alter the fundamental forces discussed earlier. Particularly in the United States, such intervention has focused on the relationship of livestock producers with buyers and suppliers. Federal regulations in the United States include the proposed Producer Protection Act; banning or limiting packer ownership of livestock; anti-trust laws; the Packers and Stockyards Act; and court decisions concerning concentration and vertical business arrangements in the livestock industry. Some states also have restrictions on corporate farming.

As noted earlier, there are concerns that marketing agreements, contracts and similar business arrangements are more conducive to larger operations; reduce spot market liquidity; reduce the availability of market information needed for efficient price discovery; and adversely affect smaller operations. Whether such arrangements are a result of, or a casual factor in, increased concentration in meat and livestock markets is unclear. The substantial horizontal contracting growth in hog production, for example, would suggest contracts enabled large production operations to get larger. However, numerous other factors contributed to the large horizontal integration in livestock production, including profits that attracted external capital, and advances in genetics, health, nutrition, and production management that increased economies of scale.

Contracting has enabled many smaller operations to remain in livestock production by contracting with horizontal and vertical integrators. Integrators provide a number of production services, capital and risk management that encourage smaller operations to continue in livestock production. For small and modest-sized operations, networking with other producers in a cooperative or other form of alliance is one way to increase competitiveness, increase access to markets and market premiums, and access high-quality genetics and other inputs, including better information and management skills. Public-sector interventions that limit business arrangements or size would make it difficult to capture the efficiency and other benefits of these business strategies.

A key argument for public-sector interventions is concern about monopoly or monopsony power in the livestock industry value chains. Assessments of market power in the U.S. livestock industries have generally been inconclusive, or indicate limited impacts. Further analysis is warranted. If the structural changes are the documented result of market power or similar behavior, aggressive pursuit of remedies under anti-trust or other regulations is appropriate. However, assessing the competitive conduct or behavior of firms in value chain relationships—where risks as well as rewards are shared—requires more complex measures and metrics than the traditional focus on prices and margins currently used in anti-trust and market power assessments.

An alternative to more restrictive interventions is to impose “rules of the game” that level the playing field or give some participants an advantage. For example, a more complete definition of the relative rights of various parties in contracting, ownership and other negotiated linkages might be possible. Prompt payment and custodial account provisions under current legislation for livestock buyers and grain merchandisers are examples. Other rules might relate to contract length, compensation if a contract is terminated early or without cause, and escape clauses for both contractor and contractee. A public policy response of providing educational programs, legal advice and dispute mediation or negotiation services might also be appropriate.

Two additional issues must be assessed. First, how restrictive, comprehensive and limiting must such interventions be to have the desired results? In general, if the fundamental forces resulting in the structural and location changes are market driven, it will be costly to intervene. Such interventions would most likely have to be North American in scope to be effective; if only state or national, the livestock industry will relocate to areas or regions with less restrictive regulations.

The second issue is potential unintended consequences of such interventions, particularly with respect to restricting packer ownership of livestock, various forms of contracting or other vertical business arrangements. For example, it appears that the intended impact of the proposed Producer Protection Act is to

reduce potential exploitation of producers by processors and packers in contractual arrangements, and to foster continuation of a relatively independent agricultural sector. A key concern is whether the rules imposed would maintain a relatively independent agricultural structure, or instead encourage vertical integration through ownership of production facilities by processors and packers.

Restricting packer ownership of livestock would eliminate vertical integration in its purest form—ownership of livestock raw materials—but is unlikely to reverse the trend toward tighter alignment in the livestock supply chain, or re-establish the dominance of independent livestock producers and open access market coordination between producers and packers. Because this restriction would eliminate the possibility of vertical integration, the other choice of governance structure to obtain some of the benefits of vertical alignment is through marketing contracts. The economic pressure may be to create very tightly controlled marketing contracts with a limited set of preferred suppliers—producers with the ability to deliver the quality and quantity of livestock needed by the packer to take advantage of market demand. Preferred suppliers would have an extremely close relationship with the packer and would, in effect, act as an agent or franchisee, imitating the vertical integration structure. This leaves most other producers in an unchanged situation—limited market access and the need to sign contracts (albeit with production companies rather than packers) that specify production practices and livestock ownership.

There is a compelling argument that consolidation and vertical coordination in the livestock industries are driven by fundamental economic forces. Market opportunities for niche products will, in some cases, provide opportunities for small-scale production/processing systems, but government regulations or interventions to recreate a smaller scale, independent firm, diversified livestock industry are likely to be ineffective unless carefully crafted and quite restrictive. If effective, the objectives or anticipated benefits of consolidation and coordination will not be achieved, undermining the global competitiveness of the North American livestock industry.

Knowledge Gaps and Research Needs

Coordination and Value Chain Structures

Development of value chain coordination strategies and systems are costly, time-consuming endeavors, requiring considerable cooperation among vertical partners and customers. More information is needed regarding attributes of effective coordination strategies, understanding of anticipated customer demands, implications of various forms of vertical coordination strategies on economic efficiency, competitiveness, market access, and implication of risk shifting. Having reliable market information from which to negotiate long-term contracts and alliances is a critical need. Livestock harvesting/slaughter is

highly concentrated and information asymmetry is present, especially in contracts and marketing agreements. Additional efforts to determine the type of information needed by market participants is important to ensure a competitive market environment.

Source Verification, Identity Preservation and Food Traceability Systems

There is a critical need for better understanding of the benefits, costs and functionality of food product traceability and identity preservation systems. In the absence of government edicts, economics will dictate the type of traceability system used in each segment of each industry. Developing technology continues to reduce costs and increase technical feasibility of enhancing information collection and product and animal tracking. Coordination among technology developers and economic researchers is essential to assess market needs and economic viability of new systems. Economics has considerable information to bring to the debate about mandated versus market-driven animal and/or meat product traceability systems. Increased assessment of market implications of alternative governance and regulation of traceability systems is needed.

New Markets, Niche Markets

Better information is needed on the scope of niche and highly differentiated markets for meat products. Several critical issues must be addressed to further understand the impact and implications of differentiated products and their respective influence on North American producers, processors and markets. Vertical production and marketing systems must be considered to determine what is required to efficiently verify and supply differentiated markets. The industry will need to carefully assess risks to producers.

Regulatory Costs

The significant impact that regulatory costs have on cost competitiveness relative to size of firm and location is critical to understand the global competitiveness of the North American livestock industry. Uniform regulations are not size neutral because it is generally less costly per unit of output for large firms to comply than it is for small firms. Different regulations in different communities or locales will differentially impact costs. Solid empirical estimates of regulatory costs by size and geographic location are generally unavailable, but are essential to understand regional and global competitiveness.

Cross Border Animal/Product Movement

To understand and plan for border disruptions in the North American animal and animal products markets, further analysis of three issues is needed: 1) the impacts of changing margins on investment location, production levels and changing trade patterns; 2) differences in animal disease regulations and their enforcement; and 3) how to design and implement rules on reopening borders closed by disease outbreaks. Today, reopening

borders is a lengthy and complicated process, even though the foundation by international agreement is science-based. New rules and planning for such disease-related events would contribute to more rapid restoration of trade, more efficient investment decisions and greater certainty in returns.

Production Technology Innovations

Research is needed on chemical, biological and enzyme technologies to enhance the efficiencies of altering and retaining nutrients in manure to give a return for processing manure and reduce environmental issues. One example is technology to stabilize nutrients in the soil, particularly nitrogen, until used by plants. Work is needed on technologies to extract energy from manure and institutions to encourage it. Biogas systems are feasible for large operations, but require significant management. The added costs and lack of incentives from utility companies make this technology impractical for most of the animal industry. The residue or sludge from this process contains considerable nutrients that need to be land applied to cropland similar to unprocessed manure.

Research to manipulate or control the genome of enteric bacteria and control the incidence of pathogens in the animal's gastrointestinal tract could minimize the threat of pathogens contaminating processed food products. The role of microorganisms, feed ingredients and feed additives on the immune function and disease control of production animals is another area of research interest. Advances in determining the action and control mechanisms of disease could result in the development of control agents through diet modifications, genetic modifications or feed additives.

Energy Costs and Ethanol Production

More analysis is needed of the impact of rising energy costs on the North American livestock industry. Higher and more volatility prices will change existing cost relationships. Higher energy costs increase costs of production, but also increase the value of manure as a fertilizer source, and energy from manure may be feasible. Another unknown is what will happen to corn prices and net feed costs as ethanol production increases. Transportation costs for grain, distillers grain and ethanol will be important factors on the location of both energy plants and the animal agriculture industry.

Costs of producing and processing

A critical research need to better understand the competitiveness of the North American livestock industry is a comparative analysis of the cost of producing and processing various animal products in different geographic locales in the world. Critical dimensions of this analysis would be to use a standardized methodology to measure these costs and to complete the analysis for both commodity products, as well as higher-valued differentiated products.

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