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## THEME OVERVIEW: FUNDAMENTAL FORCES AFFECTING AGRIBUSINESS INDUSTRIES, PART II

**Kent Olson and Mike Boehlje**

JEL Classifications: Q13, L10, L22, M22, L80

Keywords: Agribusiness, Market Forces, Structural Change, Porter's Five Forces

This is the second part of the theme on the numerous challenges and opportunities resulting from a number of fundamental forces facing agribusiness industries. The first set of articles followed the value chain for plants and plant products and the retail industry. Those articles were published in [the previous issue of Choices](#).

In this issue, the papers explore the forces affecting the animal and animal products value chain including the animal health industry (Buhr, Holtkamp, and Sornsen); livestock producers (Mintert and Lawrence); and the meatpacking industry (Buhr and Ginn). The article on the input industry is focused on the animal health industry since feed, the other major input for livestock, is covered in the previous issue and its discussion of the plant industry.

The fourth article by Krause is a response to the previous articles on the plant and plant products value chain. This insightful article expands our understanding of the forces affecting the agribusiness industry. It went through a regular review and resubmit process by the guest editors and is included as part of the theme with the hope that it might stimulate additional submissions around the topic of the theme.

An article discussing the forces affecting the fresh produce industry is planned for publication in a subsequent *Choices* issue.

To provide a common thread for the articles, the authors use Michael Porter's Five Competitive Forces (plus two additional forces) to guide discussion of how economic forces are creating opportunities and threats, and how companies and the value chain as a whole are changing. Porter identifies five forces that shape an industry: (1) rivalry among existing competitors, (2) threat of new entrants, (3) bargaining power of suppliers, (4) bargaining power of buyers, and (5) the threat of substitute products (Porter, 2008). Two additional forces affecting competition have been described as: (6) technology and (7) other drivers of change. These last two forces introduce an external dynamic to Porter's forces. These seven forces are described in the introduction to the full theme in the previous issue of *Choices* (Olson and Boehlje).

### For More Information

Porter, Michael E. (2008). The Five Competitive Forces that Shape Strategy. *Harvard Business Review*. (January 2008), p. 79-93.

Olson K. and Boehlje M. 2010. Theme Overview: Fundamental Forces Affecting Agribusiness Industries. *Choices* 25(4) available at <http://www.choicesmagazine.org/magazine/article.php?article=150>.

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## HEALTHY COMPETITION IN THE ANIMAL HEALTH INDUSTRY

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JEL Classifications: Q13, Q18, L11, L22, L2, L66

Keywords: Pharmaceutical Industry, Five Forces, Animal Health, Veterinary, Competition, Economics

**M**odern medicines, veterinary oversight, biosecurity measures, improved housing systems and nutritional advancements have greatly improved the health and productivity of livestock. The animal health industry has been a crucial partner in achieving these gains. Its continued advancement and growth can help livestock producers humanely and economically achieve production levels needed to affordably meet future food demands.

The animal health industry is driven by basic and applied science. Chemistry, biochemistry, biology and genomic sciences are applied and translated into improved products to promote animal health. The animal health industry is inherently influenced by many of the same issues as the animal protein sector including: animal welfare, supply chain structure, identity preservation, food safety, globalization and changing consumer demands.

However, two distinctively compelling influences include the economics of patents and regulation for new product development, and the linkage to human health. The linkage to human health includes improving the quality and safety of food, addressing issues of zoonotic diseases that threaten both animal and human health, and assuring safe and efficacious animal health products that do not adversely affect human health. We will use Porter's Five Factor framework to describe the forces that shape the industry and consider strategic issues confronting today's animal health providers which are a vital economic partner in the animal protein sector.

### The Animal Health Industry's Relevant Market

For this discussion, animal health product scope includes biological agents (vaccines), antibiotics, anthelmintics (de-wormers), antifungals, and parasiticides. The geographic markets in the animal health sector are defined by national boundaries dictated by regulatory requirements and trade restrictions, but many of the companies are global. Table 1 shows the top seven animal health manufacturers based on the market capitalization of the parent company. These firms emerged in the late nineteenth or early twentieth century as human medicine firms based on chemical ingredients. All have now evolved to include antibiotics and vaccines.

Pharmaceutical firms are quite large, with the top four firms having between \$30 and \$50 billion in total revenues. Even though the pharmaceutical industry is often characterized as "big pharma", it is actually quite fractionalized. The 2007 U.S. Census of Manufacturing reports that there are over 1,500 pharmaceutical and medicine manufacturing firms in the United States. (NAICS code #32541). Leaving out King Pharmaceuticals, which only has U.S. operations and is now part of Pfizer, the U.S. share of total revenue of the multi-nationals is about 41%. The U.S. Census of Manufacturing reports total U.S. pharmaceutical manufacturers revenue as \$188.53 billion. Based on this total U.S. revenue and the top four firms' U.S. revenues, the Herfindahl-Hirschman Index of market concentration is calculated as 215.81. Industries with an HHI below 1,000 are considered "competitive" industries by the U.S. Department of Justice.

The same report shows that there are over 100 firms in the United States that have over \$100,000 in sales of veterinary medicines, biologics/vaccines, and medicinal botanicals. This includes those products used for

pets and production animals and some of these firms are in both markets. The animal health division revenue share of the firms' total revenue ranges from about 2% to 6% percent for the major manufacturers. This is not a precise estimate because in some cases the animal health segment is commingled with other products such as over-the-counter consumer products. The 2007 U.S. Census of Manufacturing reports that total U.S. revenues from veterinary pharmaceuticals are over \$5.41 billion. Animal health revenue in Table 1 is greater than this because it includes global sales. No information was found on the firms' respective U.S. share of sales and so an HHI calculation on the animal health share of the pharmaceutical industry is not possible.

**Table 1**

**Top Pharmaceutical Manufacturers of Animal Health Products  
(by market capitalization)**

Parent Company <sup>1</sup>	Animal Health Division(s)	Global Market Capitalization (billion dollars)	Total Revenue (billion dollars)	U.S. Revenue (billion dollars)	U.S. Share of Total Revenue (percent)	Animal Health Revenue (billion dollars)	Animal Health Share of Parent Total Revenue (percent)	Research and Development Expenditures (billion dollars)
Pfizer Inc.	Pfizer Animal Health, Wyeth, Fort Dodge Animal Health	\$132.30	\$50.00	\$21.75	44%	\$2.76	5.5%	\$7.80
Novartis AG	Novartis	\$119.00	\$44.27	\$14.25	32%	\$1.10	--	--
Merck & Company	Intervet-Shering Plough, Merial	\$109.40	\$27.40	\$9.53	35%	\$0.49	1.8%	\$5.80
Sanofi-Aventis	Merial, Intervet-Shering Plough	\$78.80	\$41.02	\$13.19	32%	\$2.55	6.2%	\$6.44
Eli Lilly & Company	Elanco	\$38.30	\$21.84	\$12.29	56%	\$0.54	2.5%	\$4.33
Boehringer Ingelheim	Boehringer Ingelheim	--	\$12.72	\$5.76	45%	\$0.85	6.7%	\$3.08
King Pharmaceuticals	Alpharma	--	\$1.77	\$1.61	91%	\$0.36	20.3%	\$0.10
<b>Total U.S. (2007)<sup>2</sup></b>				<b>\$188.53</b>				
<b>Estimated HHI</b>				<b>215.81</b>				

<sup>1</sup>Source: Respective firms' annual reports

<sup>2</sup>Source: U.S. Bureau of Census, (2007), Economic Census, NAICS Code 32541. Available at: <http://www.census.gov/econ/census07/>.

## **Threat of New Entrants**

The pharmaceutical industry is comprised of basically two production stages: new product development and manufacturing and distribution. The threat of entrance from new product development occurs primarily through small scale innovative start-ups launched from university or other research enterprises. The primary threat of entrance for manufacturing comes from generic drug manufacturers who do not focus on research and development.

Since the 1970s, new entrants in pharmaceuticals have generally come through advancements in biotechnology. The use of recombinant DNA technologies enables companies such as Genentech to manufacture large quantities of product in efficient processes. However, there are large economies of scale and intensive knowledge requirements that create high barriers to entry. Small scale start-ups require a large amount of capital and face many risks, including regulatory risks, in taking a product from concept to market.

The primary form of entrance on the manufacturing side of the pharmaceutical industry is through generic drugs. The Waxman–Hatch Act of 1984 defined the process for approval of generic versions of pioneer drugs. Generic drugs that have the same active, inert and additive ingredients as the pioneer drug are required to test for purity and potency. However, they may not be required to conduct tests to show human or animal safety and efficacy if they are bioequivalent to the pioneer drug according to Food and Drug Administration rules for Abbreviated New Drug Applications (ANDA). This greatly reduces the costs of testing and regulatory approval and eases entrance. However, the pioneer drug manufacturers' patent protection period creates an opportunity to develop a brand, a reputation for effectiveness, and manufacturing and scale efficiencies so that launching a generic drug is not riskless.

Animal drug competition is less susceptible to generic influences than human drugs because there are not the intervening insurance and employer programs that require the selection of generic alternatives when available. Hence, brand recognition can be more effective at creating market buffers. As reported by the Generic Animal Drug Alliance (GADA), "of the top 20 human drugs that lost patent protection between 2005 and 2007, 100% went generic; and of the top 20 veterinary companion animal drugs during the same time frame, only 20% went generic."

The multinational presence of pharmaceutical firms means that most firms already have operations in the United States. However, new entrance may occur on a product by product basis depending on regulatory structures. For example, a superior product in one country may displace an inferior product in a second country if the superior product is approved in the inferior product country. In this sense regulatory structures can create international barriers to entry.

## **Internal Rivalry**

According to the Pharmaceutical Research and Manufacturers of America (PhRMA) the average cost to develop a new human drug in 2005 was \$1.3 billion dollars, partly due to the 10 to 15 year development pipeline, but also because of the high rate of failure. For example PhRMA, also reports that there were 2,950 new medicines in development in 2010 and only 34 were approved in 2009. Figures are not available for animal health products, but the processes are similar, creating similar high costs to develop and release new drugs.

Because of the high risk and high cost of research and development, firms often seek to compete by jumpstarting their research pipelines through the acquisition of start-ups which may emerge from government or university laboratories. Mergers with larger firms are also a way to capture innovative product lines or enter new markets. In the last three years there have been several major mergers in the animal health segment. For example, as reported in Sanofi Aventis' 2009 Annual Report, from 2007-2010 Merck and Sanofi- Aventis entered a sequence of mergers with Schering-Plough and Merial. This ultimately resulted in a joint venture between Sanofi-Aventis and Merck based on the combining of Merial and Schering-Plough. Merial specialized in pet medicines, while Schering was more focused on livestock health so that the merger represented an attempt to create complementary product lines and gain efficiencies in management and distribution. This is somewhat unique in that mergers in animal health are often initiated to meet human health business objectives.

Technical and sales support is increasingly provided by animal health companies directly to agricultural producers to differentiate and sell products and to help producers better use animal health products. The direct support is replacing mass marketing strategies. As the animal health companies become more

integrated into the decision making process within larger companies involved in animal production, there is increasing competition for a seat at the decision-making table. In some cases, animal health companies are employing veterinarians and others who are dedicated to a single production company. Therefore, there is a trend toward marketing of broad portfolios of differentiated products facilitated by:

- innovation by developing combination vaccines with multiple antigens,
- pricing discounts for multi-product purchases,
- technical service and marketing, and
- outcome-based research directed toward measuring the value of an intervention.

### **Buyer and Supplier Bargaining Power**

The primary buyers of animal health products and services are live animal producers. Over the past 20 years, all species of livestock production have undergone considerable consolidation. Frequently, livestock firms have their own animal health professionals, including in-house veterinary and nutrition services. Due to size, a single account can impact the profitability of a drug firm since health treatment protocols and products frequently become standardized system wide. This creates a 'winner-takes-all' environment for suppliers so that losing a large account has significant implications for profitability.

Animal health companies are also looking beyond producers to interact with packers, retailers, food companies, restaurant chains and even consumers. This is being driven by issues such as food safety, animal welfare and antimicrobial resistance. Due to their expertise, pharmaceutical companies are helping packers and retailers to develop programs, social responsibility statements and communications on these important topics.

Another example of buyer power is increasing demand for social or public good attributes of production. A key shift is that the retail segment is a driver in addressing these externalities, acting as an agent of consumer interests. Both Wal-Mart and McDonald's have social responsibility statements for their suppliers as well as their own operations. McDonald's has specific standards, prohibiting the use of antibiotics used for human medicine and they report that 60% of global suppliers comply with their antibiotics policy. McDonald's also gives preference to suppliers with specific animal welfare practices and these may enhance demand for some products, such as immuno-castration products being produced by pharmaceutical firms. Standards for use of antibiotics may also lead to reduced use of antibiotics, especially growth promotants, marketed by pharmaceutical firms.

The animal health industry is a primary manufacturer and as such has few and diversified suppliers. However, some chemicals and other ingredients used by pharmaceutical firms have very high quality assurance standards to protect against contaminants. This can lead to a form of market power if there are relatively few suppliers of a product who can provide those quality assurances.

### **Threat of Substitutes**

As described earlier, generic manufacturers create substitutes for pioneer drugs. With patent restrictions, these represent a copy-cat strategy more than a strategy that strikes at the foundations of the pioneer drug segment of the industry.

A more fundamental substitution threat is in the form of biopharmaceuticals. In broad terms, biopharmaceuticals are pharmaceuticals manufactured using biotechnology. Biotechnology can be applied to vaccines, antibodies and therapeutic protein products. This has the potential for new competition to emerge and firms in the plant sciences may have a significant stake in this development. For example, Dow Agrosciences has developed a plant-made vaccine technology called "Concert™". Plant based vaccines have the potential to reduce the risk of animal virus contamination, are highly stable and cannot produce virulent pathogens that can spread to other animals. In addition, they may be administered as an inherent part of feed, assuring treatment of all animals and reducing the need for additional treatments and management.

As with the use of other genetically modified crops for food production, there are concerns about the environmental and ecological risks of releasing pharmacological plants into the field. Containment in these situations is uncertain with potential for genetic drift to occur or for unknown allergens to be released into the food chain. As such the regulatory structure includes the USDA's Animal Plant Health Inspection Service, the Food and Drug Administration and the U.S. Environmental Protection Agency. As with other genetically

modified organisms, the regulatory structure differs by country so that there are challenges to international regulatory approval as firms seek to expand their markets in these areas.

This raises additional market considerations for competition. Prior to recombinant genetic technologies pharmaceutical firms focused on chemistry and microbiology for their research and development, while biotechnology firms based their work on the field of genomics. However, as their development interests intersected there have been mergers and investments that have essentially vertically integrated genetic technology with the chemistry, biochemistry and manufacturing processes of biopharmaceuticals.

Improved overall health management, diagnostic testing, and bio-security systems are substituting for pharmaceutical treatments. For example, a significant technical change in the swine industry was the use of all-in-all-out multi-site production systems that reduced disease pressure in animals, reducing the need for treatments. Increasingly, intensive diagnostic testing is being used to determine the optimal timing for vaccine or antibiotics and to monitor their effectiveness. Another trend is the use of individual animal identification for targeted individual animal treatments rather than herd or population treatments. With early detection of disease, sick animals can be treated more quickly, reducing the number of treatments and perhaps reducing the infection of more animals in the herd, also reducing treatments. Improved information technologies are being developed to help producers record and manage their use of antibiotics in livestock. This substitution of information for treatment also meets some societal concerns about over-use of drugs and pharmaceuticals in production systems.

A significant effort is being undertaken to find substitutes for antibiotics. These have included cytokines which are proteins that modulate animals' immune systems as well as vaccines that reduce the potential for infections requiring antibiotic treatments.

Another new genetic-based innovation is the identification and testing of genetic markers in livestock for disease resistance. For example, the discovery of a gene marker for E.coli F18 resistance resulted in PIC, a swine genetics company, offering a commercial line of pigs marketed as being resistant to a specific disease. E.coli F18 is an enteric disease which strikes pigs after weaning that can kill them or slow their growth. Progress in this area has been slow and initial attempts to commercialize the technology have not always been successful but the potential is great. Another potential market value for genetic-based innovation may be the ability to design treatments for specific livestock genetic profiles.

### **Other Drivers of Change**

From a policy perspective, there are several key issues affecting the use of animal health inputs in animal agriculture. These include policies related to patent protection and intellectual property, regulations for testing and drug approval and regulations on the use of antibiotics due to concerns about antibiotic resistance. Less directly, the demand for feed ingredients and pharmaceuticals is driven by trends in organic foods and other production systems that rely on alternative methods for managing welfare, growth and health in animals.

The issue of antibiotic resistance is particularly important for animal and human health issues. Restrictions on antibiotic use not only have implications on the profitability of manufacturers, but also on the animal production chain. Antibiotics are used prophylactically to improve the health status of animals which improves their overall productivity. In 2006 the European Union eliminated the use of antibiotics for growth promotion. There are similar concerns in the United States as evidenced by recent legislative action such as the "Preservation of Antibiotics for Medical Treatment Act of 2009" (H.R. 1549, 111th Congress 2009-2010) which denies an application for a new animal drug that is a critical antimicrobial for humans unless the applicant demonstrates that there is a reasonable certainty of no harm to human health due to the development of antimicrobial resistance. The challenge is that the issue of antibiotic resistance represents a complex biological process with potential for unintended consequences. For example, bans on nontherapeutic antibiotics in Denmark have led to increased therapeutic use (DANMAP, 2008).

The increasing concerns for animal welfare, antimicrobial resistance, and demands for low cost, reliable and safe food will likely drive development of new technologies by the animal health sector to meet these demands. The same forces will also create near term demand for alternatives to pharmaceuticals such as vaccines, nutraceuticals, alternative production practices, disease resistant animals and probiotics. Animal welfare issues will also create demand for innovative technologies that allow for elimination of production practices that are viewed unfavorably, such as surgical castration, yet still enable the efficient and safe production of food. An example of a product improving animal welfare is an immuno-castration product

marketed in international markets by Pfizer.

Increasing frequency of emerging diseases such as porcine circovirus type 2 (PCV2) and new strains of existing diseases such as porcine reproductive and respiratory syndrome (PRRS) will increase demand for technologies that will shorten the time required to produce vaccines and other animal health products to deal with them. Many of the human diseases that have been emerging or reemerging are zoonotic, caused by pathogens that originate from animals. Examples include pH1N1 influenza and methicillin-resistant *Staphylococcus aureus* (MRSA). Longer-term, infectious diseases in livestock may also be affected by regional climate change. Pharmaceutical companies will play a critical role in addressing both animal and human forms of these diseases.

Finally, the animal pharmaceutical industry is affected by the change in demand for meat products. It is expected that global meat consumption will continue to grow as incomes rise in developing markets. However, increasing human populations, increased competition for feed-stocks from biofuels and concerns about the environmental impacts of increased meat consumption will limit meat consumption and demand for animal drugs. Interestingly, pharmaceuticals are endogenous to this process as they increase efficiency of meat production, reducing resource pressures.

### **Concluding Comments**

Animal health and nutrition inputs are critical to the health and wellbeing of animals. This sector is rapidly evolving based on new technology developments in the biological sciences. In all likelihood the sector will continue to evolve as it has over the past one-hundred years, into life-sciences firms relying on genetic innovations to both develop new products and better understand the interaction of animal genetics with animal health outcomes.

Increasingly animal health decisions will not occur independently from production systems, but rather in concert with these production systems as both suppliers and production systems seek to optimize outcomes on animal health. Further demands will be made on the food system by consumers to deliver products in a way that reduces social, environmental and other externalities. This will likely require even greater collaboration and communication among vertical chain participants so that goals of providing high quality protein driven by an increasing array of global demands can be met.

### **For More Information**

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## FUNDAMENTAL FORCES AFFECTING LIVESTOCK PRODUCERS

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JEL Classifications: L10, L22, L80, Q13

Keywords: Market Forces, Livestock Production, Porter's Five Forces

In a seminal *Harvard Business Review* article published in 1979, Michael Porter identified five competitive forces that shape industry competition, all of which feed into rivalry among existing competitors. Porter's framework has most often been applied to industries producing and marketing differentiated products. Conversely, U.S. livestock and milk production still mostly resembles a commodity market with largely undifferentiated products marketed to a processing sector that, based on the Herfindahl-Herschman Index (HHI)-an industry concentration measure based on market shares that is easily computed and compared across industries- and Department of Justice and Federal Trade Commission definitions, is unconcentrated to approaching moderately concentrated. Despite this distinction, we find that several aspects of Porter's forces are important in analyzing the U.S. livestock sector. The remainder of this article reviews the key aspects of Porter's five forces as they relate to the competitive structure of the U.S. livestock sector, plus two additional dynamic forces which we believe are also important; technology and drivers of change.

### Rivalry Among Existing Competitors

Although inter-firm rivalry is one of Porter's key factors, it is not the primary force impacting profitability in the pork, beef, and dairy production sectors. All three industries are still characterized by a relatively large number of production firms and a relatively low HHI (Table 1), compared to nonagricultural industries in the United States. Consolidation has been occurring for a long time, but it has mostly been the result of unprofitable, high cost firms exiting the industry. In a broader sense, however, rivalry in the livestock sector can sometimes be viewed as taking place on a more regional or structural basis, rather than firm level. For example, traditional small herd milk producers in the upper Midwest may view large-scale dairies in the western states as rivals when market share shifted to these regions. High Plains cattle feedlots considered cattle feeders in the "ethanol belt" as rivals when energy policy supported higher corn prices and more abundant supplies of distillers' grains and solubles, an excellent corn substitute in cattle rations, near ethanol plants. Diversified crop-hog farms in the Midwest viewed large scale specialized hog production companies as rivals when new technology facilitated large scale production that was no longer tied to a land base led to a pork industry restructuring. Specialized pork producers focused on adopting new, cost-reducing technology and expanded while many diversified farms using older technology stagnated and found themselves at a cost disadvantage. In periods when production margins turned negative, older assets that were not well adapted to newer lower cost technology were often idled first. As the remaining assets were more difficult to retire, regions—and in some cases firms—behaved more like rivals that played out their response in the policy arena rather than the market place.

The broiler industry provides a glimpse of inter-firm rivalry for the red meat and milk sectors in the future. Firms invested heavily in branded products are reluctant to reduce production when margins are narrow for fear of losing market share to another firm. This type of behavior is more common at the processing level where firms have branded products and developed retailer relationships or contracts that will be lost to competitors if there are supply disruptions. As the hog, beef, and dairy production sectors consolidate into fewer and larger firms similar issues will arise. For example, supply agreements between production firms and processors have become commonplace and the need to keep the product pipeline full will make the decision-making process regarding production cutbacks more strategic and less reliant on simple marginal cost

economics.

**Table 1**

**Herfindahl-Herschman Indices (HHI) for the Largest Firms in Selected Meat and Dairy Sectors.\***

Sector	HHI, 4 Largest Firms	HHI, 8 Largest Firms
Beef packing	1430	1460
Pork packing	1180	1310
Milk cooperatives	540	575
Hog production	290	315
Cattle feedlots	60	70

Source: John Lawrence, Iowa State University.

\*U.S. Department of Justice and the Federal Trade Commission categorize a market as "unconcentrated" if the HHI is less than 1500, "moderately concentrated" if the HHI falls between 1500 and 2500, and "highly concentrated" if the HHI exceeds 2500.

Examining each meat production sector closely reveals several differences. Beef production in the U.S. is fragmented, but the level of concentration varies greatly by industry segment. The cow-calf sector, which supplies calves to various intermediate production segments and to feedlots, is still heavily populated by small scale firms. For example, in 2007 nearly 90% of the 758 thousand U.S. farm operations with beef cows had an inventory of less than 100 cows (USDA, 2007). Conversely, feeding cattle to slaughter weight on high grain concentrate rations is much more concentrated, with the 10 largest firms in the industry marketing 22 to 29% of the steers and heifers processed for beef production (Mintert, 2003). Still, the HHI is well below 100 for these top firms. Economies of scale and scope in cattle feeding, combined with excess capacity, have largely driven the consolidation. Inter-firm rivalry has, historically, not been a significant driver of change in the cow-calf sector and that's expected to continue to be the case in the future. Large cattle feeding firms, however, are more likely to view each other as rivals in the future as they strive to be low-cost producers, fulfill a growing number of market niches often defined by branded products, and increase market share. Competition for improved technology providing advantages in cost of production and the ability to better meet customer needs is expected to be an industry driver in the future.

U.S. pork industry consolidation, which has been underway for several decades, recently reached the point that less than 200 firms, each marketing 50,000 or more hogs per year, produced nearly two-thirds of the hogs raised in the United States (Lawrence and Grimes, 2007). Furthermore, just 27 firms, each marketing at least 500,000 hogs per year, sold 43% of all U.S. hog production during 2006. In total, firms with annual sales over 10 thousand head accounted for 85% of U.S. hog production. The remaining 15% of hogs were sold by more than 54,000 firms, each of which marketed fewer than 10,000 hogs. Importantly, these smaller firms continue to lose market share as operations in the three larger size categories expand. In spite of the consolidation, the HHI for the four largest hog producers is under 300, well below the 1500-2500 required to be considered a moderately concentrated industry. Rapid restructuring to capture new cost reducing technologies fueled expansion by larger firms throughout the 1990s. More recently continued exodus of high cost producers, in addition to mergers and acquisitions, led to further industry consolidation. Productivity increases continue to outpace domestic demand growth and, therefore, it is likely that future growth of the U.S. pork industry will depend on export increases.

Even though the U.S. pork industry is much more concentrated than it was just a few years ago, inter-firm rivalry has not been a dominant consideration for industry participants. But the ability and desire to produce branded pork products is becoming a more important pork marketing strategy for some hog producers. As branded pork production becomes a more important part of hog producers' sales marketing strategy, it will

lead to increasing inter-firm rivalry.

Similar to the pork industry, the number of milk producers has been declining for many years. However, despite the long-term decline, there were still over 71 thousand operations with dairy cows in 2007 (USDA, 2007). The large number of firms in the industry has limited competition among firms and, as a result, internal rivalry has not been a significant issue. However, the pace of dairy industry consolidation is increasing rapidly. Over the last decade the only firm size category that gained market share was operations with 500 or more cows, and actually much of that increase was concentrated among dairies that milk several thousand cows. Still, it's likely to be some time before enough concentration occurs among dairy producers to fuel a high degree of inter-firm rivalry. In contrast, first purchasers of milk have become highly concentrated. Cooperatives market 82% of U.S. milk production and have sought to increase prices paid to milk producers through a voluntary dairy cow supply reduction program known as Cooperatives Working Together. Further, the Federal Milk Marketing Orders reduce the incentive to compete for fluid contracts for sales to retailers by blending minimum prices. Looking ahead, continued consolidation in herds or cooperatives could encourage dairy producers to vote to eliminate Milk Marketing Orders, which could lead to rising inter-firm rivalries as firms compete for retailer contracts.

### **Power of Buyers and Sellers**

Bargaining power of buyers in the beef market place has been studied extensively by economists over a long period of time (Ward, 2010). Concentration among beef processors increased markedly over a span of several decades, but especially from the mid-1970s through the mid-1980s. By 2007, the four largest steer and heifer slaughter firms had a combined market share of approximately 80% and a HHI of 1430. Pork processors also consolidated and the four largest firms collectively processed 65% of barrow and gilts marketed in 2007 (USDA, 2009), resulting in a HHI of 1180. Processing technology changes meant that not only were firms larger, but plant sizes also became much larger. The transition to larger firm and plant sizes encouraged adoption of alternative procurement agreements to secure a consistent supply of livestock that met processors' quality specifications. The increase in efficiency that arises from operating plants near their optimum capacity, and the greater risk associated with operating larger plants, encouraged wide-spread use of longer-term supply agreements with livestock producers. At the same time, some larger livestock operations were interested in marketing agreements with processors that reduced risk by ensuring they had a market outlet for their production. The change in marketing and procurement practices has altered the bargaining power landscape as both buyers and sellers increasingly find longer-term contractual arrangements effective at managing risk.

Supplier bargaining power is relatively low in animal agriculture. Feed cost is the single largest expense for livestock, dairy and poultry production, often representing 60% or more of total production costs. There is new competition for corn from ethanol production but, because grain is a commodity, bargaining power is low. Other significant inputs, such as most pharmaceutical technologies and genetics have many close substitutes, which limits market power. Rivalry may exist among firms for key inputs, but sellers seldom have sufficient leverage to shape the industry. As sectors restructure or expand, competition for critical inputs can be a bottleneck to growth. Livestock firms compete for construction sites with preferred characteristics of transportation and utility access, land for manure application, and distance from neighbors. Firms not competing for company owned sites are often rivals for contract growers, competing by offering different contract terms, building designs, costs, and payment schedules. Firms also compete for investor capital. For example, cattle feedlots compete for investors to feed cattle in their lot rather than elsewhere. Expanding firms need to attract investment capital and want to be seen as the firm of choice in their sector. Labor and management is another critical input in short supply in a rapidly growing/changing industry. Competition for labor tends to be a local rivalry and includes other industries competing for entry level labor. Managers for production sites are more mobile and are typically hired away from another firm.

Concern about market power of meat and milk processors has spawned numerous Congressional hearings, agency listening sessions and court cases. Research results regarding processors' market power have been mixed. Most published research suggests market power exists in the slaughter cattle and hog markets, but the economic damage due to measured market power has been insignificant. Since processors compete heavily based upon their cost structure, minimizing production costs is critical to profit maximization. The cost structure of meat and milk processing requires consistent, optimal through-put for profit maximization, which makes it difficult for processors to exert market power. In the case of milk, the federal marketing order system also makes it difficult to use market power to processors' advantage. However, consolidation at the retail level is a concern for both producers and processors of meat and milk and it has been a major influence on dairy industry structure. Being big enough to serve a mega-retailer contract requires either a big cooperative or a

federation of cooperatives.

### **Barriers to Entry**

While it is relatively simple to get into livestock production, the entry barriers to produce a meaningful supply can be significant in part because production infrastructure is costly to build or buy. Yet, new entrants may be better financed, organized differently such as being vertically integrated, or have new markets related to foreign ownership or becoming a full line supplier—providing them with a competitive edge over existing competition. Risk of entry by potential competitors is more of a concern at the product level in the form of imports or substitutes which impact livestock and dairy producers. Imported live cattle and hogs are often seen as a threat by U.S. cow-calf operations and feeder pig producers. However, some cattle feedlots and hog finishers see the imported animals as an increased supply of feeder livestock and a profit opportunity. U.S. producers view competitors in export markets as a threat to the demand for their product.

### **Substitute Products**

The risk of substitute products as a force depends on where it is measured, but in general it is a force impacting producers. By the nature of commodity products each unit is a near perfect substitute for the next one. As a result producers are largely price takers. There are increasing attempts to differentiate products based on credence attributes such as “cage-free” eggs or “organic” beef or pork. To date these are relatively small markets, and in some cases these niche producers have used disparaging remarks about conventional production systems to further market their product. At the product level, substitutes are a significant driver of profitability for animal agriculture. Chicken is a lower cost substitute for beef and pork and the poultry industry over the years has been more innovative in product development, branding and industry focus. While there is not a direct substitute for milk, a variety of products including soft drinks, energy drinks and soy milk are substitutes in consumers’ shopping carts.

### **Technology**

Technology is an important force impacting animal agriculture. One measure of productivity in animal agriculture is pounds of meat or milk produced per breeding animal. Although there are other factors that can influence this productivity measure, over long periods of time it provides a reasonable comparison of differing impacts of technology across sectors. And the differences in productivity observed across sectors are striking. In the case of pork, annual pork production per sow in the breeding herd inventory increased 30% just since 2000. This productivity increase is adjusted for increased pig imports and is primarily attributable to improved reproductive performance and increasing carcass weights driven by genetics and management. By comparison, broiler meat per broiler hen increased 25% and milk production per cow increased more than 16% over the same time period. Just as artificial insemination increased genetic potential a generation ago, sexed-semen is expected to push milk productivity up in the future, partly by accelerating genetic improvement and also by increasing the percentage of heifer calves born, which effectively raises total herd production. The hog and milk industries in particular have seen firms more adept at adopting new technology expand at the same time that existing firms are going out of business. In contrast, the beef industry in recent years has focused more on improving product quality and has not benefitted as much from rapid development and adoption of cost reducing production technologies. As a result, commercial beef production per cow — adjusted for live cattle imports—in 2010 changed little compared to a decade earlier, which is in sharp contrast to the large productivity improvements observed elsewhere in the livestock sector.

### **Other Drivers of Change**

“Other Drivers of Change” which include government regulations by the United States and other governments, advocacy by nongovernmental organizations, and shifting consumer preferences, are perhaps the largest forces shaping animal agriculture today. Government regulation and policy that address water quality, air emissions and dust, country of origin labeling, marketing practices, trade restrictions, and renewable fuels that emanate from a variety of government agencies all impact animal agriculture. An example is the Concentrated Animal Feeding Operations (CAFO) rules related to federal water quality requirements, which were revised by EPA in 2003, subsequently challenged in court and revised again. EPA is now moving forward with rules under the Clean Air Act that proposes regulating emissions from livestock facilities, including dust from farming operations and feedlots. While the requirements are not finalized, the proposed changes and ensuing discussion has taken a lot of energy, created tremendous uncertainty in the industry, and has hampered investment.

Country of Origin Labeling (COOL) divided the industry, consumed a lot of industry energy and created uncertainty about which and how meat products were to be labeled in retail stores. We are now more than two years in to implementation of this labeling requirement and, although it is still unclear how beneficial this has been for consumers, it has certainly created more record keeping requirements and raised costs for firms throughout the marketing channel. More recently, proposed changes to marketing practices by USDA-Grain Inspection Packers and Stockyard Administration (GIPSA) has also divided the production sector and may sever relationships between producers and processors that evolved over the last two decades (Ferrell and Rumley, 2011). Marketing agreements designed to address market failures and allow segments of the industry to improve product quality, and reduce supply and price risk, could be prohibited. The result could be a supply channel that is forced to operate at a higher total cost level and reduced investment in the industry.

Exports have become a much more important component of demand for U.S. poultry, pork and beef than they were a decade ago. As such they are more susceptible to trade restricting actions by foreign governments that, in some cases, are unrelated to agriculture. Coupled with animal disease risks—for example, Foot-and-Mouth Disease (FMD) and *Bovine Spongiform Encephalopathy* (BSE)—that can result in restricted or complete loss of access to export markets, has added uncertainty to producer decisions. These “stroke-of-the-pen” risks that impact production costs or demand will continue to shape the livestock sector in the future.

Perhaps the largest recent economic shock to the livestock sector was due in part to the change in the U.S. energy policy that set targets for the use of renewable fuels from 2008-2022. The implementation of these annual Renewable Fuels Standard (RFS) targets, coupled with weather problems in major grain producing countries, resulted in feed grain costs that are significantly higher and more volatile than prior to implementation of the RFS. The change in corn usage attributable to the new standard has been dramatic, with nearly 40% of the U.S. corn crop during the 2010 crop year devoted to ethanol production. Looking ahead, the amount of corn used for ethanol production may soon surpass the amount consumed by animals. This new demand has not only contributed to higher feed costs, it also helped boost feed cost volatility. The result has been an increased exodus from the animal production industries by higher cost firms, thereby accelerating industry consolidation and, ultimately, leading to a smaller industry than otherwise would be the case.

Livestock and poultry production is on the defensive from attacks by NGOs regarding animal care and welfare, the use of sub-therapeutic antibiotics and contributions to green house gas (GHG) emissions. The Humane Society of the United States (HSUS) successfully spearheaded ballot initiatives in California, Arizona and Florida that restrict animal housing practices. HSUS negotiated similar restrictions in Colorado and Michigan and impacted the ballot in Ohio that led to an oversight board for animal housing and care. There has also been a push to restrict the use of sub-therapeutic antibiotics as growth promotants in animal agriculture for fear of contributing to antibiotic resistant pathogens in humans. A 2007 U.N. FAO report attributed 18% of GHG to global animal production. Although EPA estimates the contribution of livestock and poultry at just 2% in the United States, the sector finds itself defending its track record with prospects for mandated change on the horizon. Ultimately, all of these restrictions lead to higher production costs and discourage livestock production in the affected regions.

While some of these external forces, if successful, will drive up production costs and/or favor one production system or region over another, other forces actually seek to eliminate the production of animals for food. And, on some issues, retailers are becoming the new regulators. NGOs have found that retailers with a brand to protect can be influenced through shareholder action or the threat of boycott easier and faster than legislation and regulations can be passed and implemented.

## **Concluding Comments**

Key animal agriculture issues in the years ahead will be:

1. Consumer demand in domestic vs. international markets. Stagnant population growth, and aging of the U.S. population, will make domestic demand growth more difficult to achieve. The focus in the domestic market will be increasing product differentiation to increase market share. Increasing demand and market share in international markets will focus on meeting the needs of consumers in importing countries, which vary significantly around the globe. This will lead to an increase in inter-firm rivalry.
2. Cost competitiveness. Cost competitiveness historically was based on being competitive within the domestic industry. In years ahead, cost competitiveness will focus much more closely on competition across borders.
3. Product differentiation. Niche markets will continue to splinter from mainstream products and

marketing. Rivalries will emerge within these smaller markets as producers vie for retail shelf space and between mainstream production and niche products as they compete for customers.

4. Driving forces—either by regulations, retailer decisions or activist’s movements—will trump economics on some hot button issues.

These key drivers will shape animal agriculture in the years ahead. Consolidation is expected to continue and Porter’s framework will provide insight into how firms behave and the resulting industry structure that evolves. In addition, objective and timely economic analysis of consumer demand, producer costs and proposed policies will be essential to making decisions that foster a viable livestock, dairy and poultry sector.

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## U.S. MEATPACKING: DYNAMIC FORCES OF CHANGE IN A MATURE INDUSTRY

**Brian L. Buhr and Bruce Ginn**

JEL Classifications: Q13, Q18, L11, L22, L2, L66

Keywords: Meatpacking, Five Forces, Competition, Supply Chain, Vertical Coordination, Relevant Markets

**M**eatpacking in the United States is a mature industry. Overall domestic per capita meat consumption levels have been stable for the past 25 years. As typical of mature industries, meatpackers compete by reducing costs through technical change, increasing in size and scope through acquisition or vertical coordination and by expanding into developing international markets. Meatpackers have also gained subtle product differentiation and pricing advantages and modest brand loyalty by vertically coordinating genetics, feeding, and processing. This has resulted in improved ability to meet consumer demands; enhancing revenues rather than simply competing on costs.

Although meatpacking is a mature industry, this is not to say that it does not face many dynamic forces of change. Entry into the U.S. market by foreign competitors has raised the global competitive ante. Environmental and social issues such as climate impacts on crops and water resources, the emergence of zoonotic diseases, and calls for improved animal welfare are changing management practices. Policy issues, including proposals to improve meat product safety, to reduce the use of antibiotics, and to place limits on animal ownership and contracting strategies, are also impacting packers. Our goal is to address the impact of these forces on meatpackers' competitive strategies using Porter's "Five Forces" analysis.

### Meatpackers' Expanding Relevant Market

Porter's 2008 article, *The Five Competitive Forces that Shape Strategy*, includes a side-bar about the importance of defining the relevant industry for completing a Five Forces analysis. We will use examples from industry to illustrate the expanding relevant market for meatpacking.

Meatpacking as a production process is defined by the North American Industry Classification System (NAICS #3116) as the stage from live finished animal delivery through carcasses and processed meats. However, meatpackers as firms extend activities far beyond the production process definition. For example, Tyson Foods' 2009 Annual Report states that it is completely vertically integrated in chicken production from genetics to feed to broiler production and case-ready products. Similarly, Smithfield Foods reports in its 2010 Annual Report that it owns approximately 790,000 Smithfield Premium Genetics (SPG) breeding sows and is integrated from swine genetics to case ready pork products. However, Smithfield's vertically integrated pork segment accounts for only 46% of its hog production. Beyond vertical integration, USDA market news reports show that 85% of hogs and 57% of cattle are purchased on some form of forward contract. Vertical integration is viewed by meatpackers as reducing their exposure to market volatility in adjacent segments and results in improved food safety and other quality attributes of products.

Vertical integration also brings packers into horizontal competition at stages of the supply chain other than meatpacking. On the sell side, meatpackers supply their fresh product from their slaughtering and fabrication operation to their own further processing operations which manufacture cooked and cured products. At the same time they sell fresh product to outside further processors such as Kraft Foods or Sara Lee who also manufacture cooked and cured products, resulting in horizontal competition at this stage. No information was found on the share of meat sales to outside meat processors, but these shares affect packers' branding and revenue strategies. Clearly, this sort of horizontal competition also occurs with upstream genetics, animal

production and feed operations as well.

Major meatpackers also have horizontal multi-species operations. Tyson, which purchased IBP in 2001, JBS, a recent Brazilian entrant to U.S. markets, and Cargill Meat Solutions (CMS) are most broadly diversified. Each has significant holdings in beef, pork, and chicken and, in the case of CMS, turkey production. Tyson and JBS each have about 45% percent of their sales in beef products, and 14-18% in pork products. JBS's recent acquisition of Pilgrim's Pride makes it the second largest chicken producer next to Tyson. Hormel Foods goes a step farther and competes in the broader food markets similar to nonmeat food companies. These strategies allow for broadening branding presence across meat categories as well as servicing the entire meat case for large national grocers.

Meatpackers' relevant markets extend beyond the live animal to wholesale product stage. Vertical and horizontal coordination enhances their ability to capture improved returns to value added products. This scope also represents a complex web of supply chain competitive interactions between meatpackers and other players in the livestock and meat supply chain.

### **Threat of Entry and Rivalry**

The expanding horizontal and vertical scope of meatpackers means that entry and rivalry can occur at any stage of the supply chain. New domestic entrants into the meatpacking industry have historically entered as single species firms. For example, IBP was founded in 1960 as Iowa Beef Packers and began as a single plant specializing in beef production. IBP's growth into the largest red meat producer in the world resulted from a revolutionary technological development; "Cattle Pak" or boxed beef. In addition to improved distribution efficiencies, this also led to changing plant design into a more efficient, modern assembly line model that reduced labor costs. IBP managed to enter and dominate a mature industry based on "leapfrog" technological innovations that improved operation efficiencies and reduced costs. Tyson later acquired IBP as a way to efficiently capture large scale production in the red meat markets, which has been a more recent strategy for entry into U.S. markets.

Smithfield similarly specialized in pork markets when it began as a regional company in 1935. Growing through acquisitions of regional pork processors in the southeast, their major strategic change included vertical integration in pork production as well as horizontal brand expansion as they acquired firms. Eventually acquisitions lead to investment in beef processing, but in 2008 their beef assets were sold to JBS returning Smithfield's primary focus to pork markets. Smithfield became a global competitor based on business organization innovations that aligned the supply chain rather than technological change as in the case of IBP.

Triumph Foods in St. Joseph, Mo. recently entered meatpacking using a hog producer led vertical integration strategy. Triumph Foods is a joint venture of swine production companies including Christensen Farms, New Fashion Pork, and Hanor. However, recent failed attempts by smaller scale producer groups, such as Meadow Brook Farms in Illinois or Prairie Farmers Cooperative in Minnesota, suggest that economies of scale in meatpacking still create major barriers to entry.

A major foreign entry into U.S. meatpacking occurred when the Brazilian meatpacker JBS acquired Swift & Company in the U.S. in 2007. Nippon Pork was an early example of foreign direct investment in U.S. meat markets. Nippon Pork's strategy was one of gaining production resources to export pork products back to Japan. However, JBS now competes in pork, beef and chicken markets with Hormel, Cargill, Tyson and Smithfield on a global operations basis in countries and regions including Australia, China, The Philippines, South Korea, Argentina, Mexico, Europe, Japan and of course the United States.

The demand side of meat markets plays a key role in entry and rivalry. Meatpackers increasingly produce "case-ready" meats at the processing plant. Case-ready meat products integrate the traditional in-store retail fresh cut fabrication back to the meat packing plant. Case- ready fresh meat improves the efficiency of distribution and wholesaling, improves food safety with less handling and improves merchandising cost efficiency for retailers. This has resulted in meatpackers that are dedicated suppliers to specific retail chains. For example, Hormel Foods has a tying agreement with SuperValu to supply Cub Foods' fresh pork category.

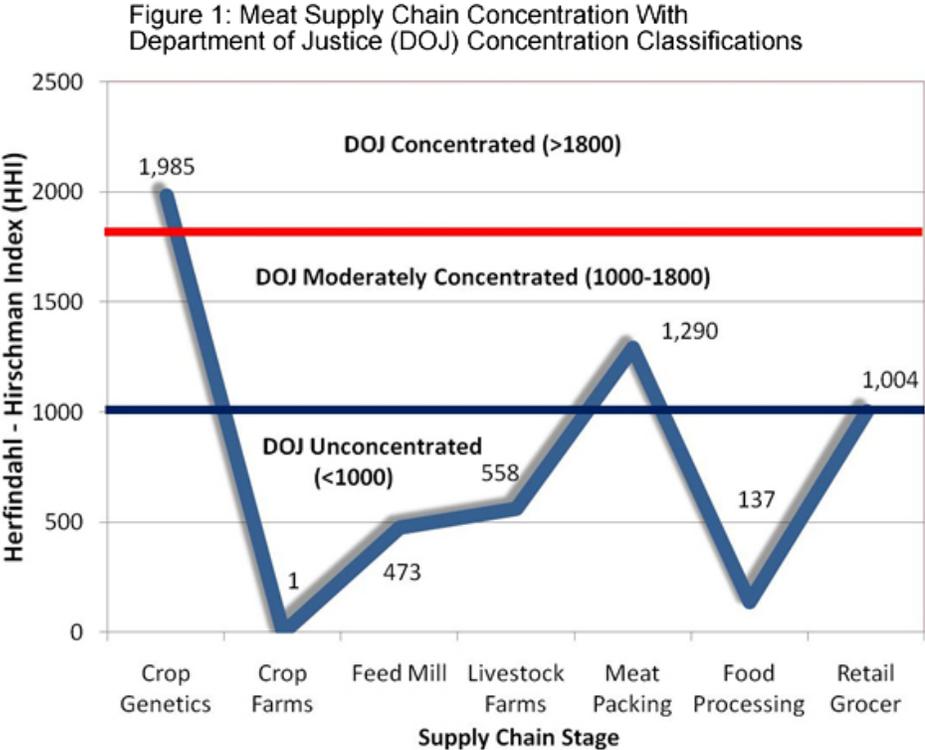
Private label meat products represent an additional tying arrangement between packers and retailers. Retailers often compete on the quality of their fresh meat and produce offerings, and outsourcing the meat case to the packer's brand can reduce their ability to differentiate offerings. Private labels allow retailers to differentiate their case and for the packer to have a dedicated buyer. An example is Sutton & Dodge Steakhouse Quality Angus Beef sold by Target. Sutton & Dodge is produced under Precept Foods, LLC,

which is a joint venture of Hormel Foods and Cargill Meat Solutions. Private labels create a trade-off for meatpackers. On the positive side, private label arrangements reduce revenue risk. On the negative side, private label products compete with packers' own national brands and often are sold at a lower price point.

Both private labels and packer branded case-ready products may create barriers for smaller processors which lack the capacity to supply larger retail customers. Even larger packers may find them a barrier to entry because they must displace the incumbent supplier completely rather than incrementally or offer an entirely new private label product line.

**Market Competition—The Power of Suppliers and Buyers**

Figure 1 shows a simplified supply chain representation of concentration by using a line graph of Herfindahl-Hirschman Indexes (HHI) linking each stage of the meat supply chain. The HHI is defined as the sum of the squared market shares of the top four firms in the sector. Data used was collected from secondary sources including trade publications, firms' annual reports and United States Department of Agriculture (USDA) data. The data was subjectively aggregated to form sectors such as "meatpacking" that includes beef, pork and poultry.



The disparity in the HHI between meatpackers and livestock producers is often viewed as evidence of the potential for monopsony power—control by one buyer. Recent horizontal and vertical mergers and acquisitions have added to these concerns. For example, JBS proposed to purchase National Beef in addition to Swift, but a threatened legal action by several states and the Department of Justice resulted in JBS abandoning the offer. As a response to these and other such concerns, in 2010 the USDA and Department of Justice held joint hearings on *Agriculture and Antitrust Enforcement Issues in Our 21<sup>st</sup> Century Economy*. The USDA Grain Inspection and Packers and Stockyards Administration (GIPSA) more proactively proposed a rule restricting meatpacker and livestock and poultry producer contracting and ownership.

While, an extensive literature examining monopsony power provides some evidence of market power, it is usually found to be at levels sufficiently low to be compensated by efficiency gains. For those interested, a Livestock and Meat Marketing Study completed by GIPSA in 2007 provides a thorough analysis of the implications of contracting in livestock and meat markets.

However, these analyses often ignore the broader supply chain perspective illustrated by Figure 1. The

modern value and production chain for meat products is a complex web of interactions of crop and livestock genetics, animal nutrition and health, livestock rearing, crop nutrient management, meat and food ingredient production and human health. In this structure all stages of the chain impact other stages and while the product flows downstream, trait values must be passed upstream from the consumer. Focusing on the price impacts at a single node in the chain ignores the fact that the business organization of the supply chain is important for assigning value to where it is created, improving incentives for innovation and also for reinforcing quality incentives through the chain. Limiting these strategies has the potential to reduce packers' ability to deliver on quality traits, potentially offsetting gains from competition.

Meatpackers have little ability to exert monopoly power. In Figure 1, food processors are relatively diffuse. However, the food sales of the top four supermarkets as reported by *Supermarket News* are almost 51%, and Wal-Mart alone has nearly a 29% market share. Sara Lee, Hormel Foods, Tyson Foods, ConAgra and Kraft all report between 11 and 16% of their net sales revenue is attributable to Wal-Mart. Only Smithfield Foods reports less than 10% of its net sales revenue derives from Wal-Mart.

This does not include restaurant or away from home venues that, according to the Bureau of Labor Statistics' Consumer Expenditure Series, now account for about 42% of all food expenditures. According to the National Restaurant Association's *2008 Restaurant Industry Review*, restaurant industry sales reached about \$588 billion in 2008 of which 10% were accounted for by McDonald's worldwide sales. It's unlikely that meatpackers can effectively maintain monopoly pricing against the countervailing size of retailers acting as agents with similar interests as consumers in obtaining lower prices.

A new form of socially driven market power is also emerging in the meat supply chain. For example, McDonald's supports suppliers who phase out gestation crates in swine production. This resulted in Cargill Meat Solutions and Smithfield Foods, announcing plans to phase out gestation crates. Similarly, both Wal-Mart and McDonald's have social responsibility statements for their suppliers as well as their own operations. In response meat processors' have adopted publicly available sustainability or corporate responsibility statements. These include initiatives and goals on issues such as: human rights and ethics, environmental issues, animal welfare, community impacts, and corporate compliance.

From a market power perspective, the high profile restaurant chains represent a branded 'point source' to express consumer demands. This allows consumer interest groups to potentially express market power through retailers to the meat supply chain. Minority concerns that result in broad cost increasing production changes impact prices paid by a majority of consumers who have expressed no preference for these attributes. This represents a loss akin to monopoly power. To the extent that retailers and meatpackers are able to push these initiatives upstream to the producer, where many of the socially driven production traits are determined, this can also be interpreted as an expression of monopsony power.

### **Threat of Substitutes**

Demand is inelastic for meats as for most food items. However, there is significant substitution within the meat category. Although chicken began displacing beef consumption beginning in the 1980's, absolute per capita meat consumption in the United States has been relatively constant at 200-210 pounds per person.

Economic growth and rising incomes in key countries such as South Korea, Mexico and China have led to increasing substitution of meat for other food products. For the period 1990-2008 world beef, pork and chicken consumption increased at an annual average rate of 2.67%, more than double the world population growth rate of 1.32%. However, since 2008, the three year moving average of meat consumption has been equal to population growth and this has not occurred since 1992. This demonstrates the importance of world economic growth and income to the substitution of meat for other foods as incomes rise. Recent upward price pressures on all foods and expected continued slower economic growth could reduce the growth in meat consumption as worldwide consumers face financial pressures and respond by moving from meat consumption to other food choices.

The other long term factor affecting the substitution of other foods for meats is the resource intensiveness of meat production. Even as incomes rise, pressures on global water and land resources caused by rising human populations will likely increase the relative cost of meats. Improvements in animal production efficiencies as we have seen in the past half-century may alleviate some of this pressure.

### **Other Drivers of Change Affecting Meatpackers**

Beyond Porters' Five Forces of competition that affect firm behavior, there are external factors such as technology and policy that influence the meat packing industry. Key recent policies affecting packers include issues such as country of origin labeling, the recent passage of the new food safety bill, calls for reduced use of antibiotics, improved environmental practices, ongoing trade issues, policies promoting the use of feed-stocks for biofuels, and proposed rules to limit forms of packer contracting and integration. Incremental technologies in food safety, packaging and processing methods are simply part of continuous improvement, but advances in genomics and genetic marker technologies have the potential to be revolutionary.

From a policy perspective there is a subtle shift towards addressing socially acceptable production methods. These are often social issues raised such as animal welfare or country of origin labeling that directly impact meatpackers' costs but with no direct compensating benefit to packers or meat consumers as would be the case with food safety regulations that clearly can benefit consumers. Proposition 2 ballot initiatives in California to regulate animal rearing practices and similar legislation elsewhere have altered the underlying production practices that often create efficiencies in the supply chain. The implication is that for the foreseeable future it may matter more how meatpackers are producing meat rather than what they are producing.

A key technological driver in meatpacking is the use of genetic information technologies to control product quality in a process replete with uncontrolled biological variation. Recent advances in identification of genetic markers for specific consumer traits such as tenderness hold the promise of dramatically improving meat quality along with production efficiency. Computer information technologies are complementary in that the combined information will allow the tailoring and matching of production methods to genetic traits, reducing inputs while improving the quality and quantity of meat produced. Ultimately this may result in managing the individual animal rather than the herd.

A final key factor driving the meat supply chain will be environmental and climate change issues. Life cycle analysis clearly includes meat production as having a role in climate change through intensive crop and energy use as well as greenhouse gas emissions. These are long term influences. However, in the short term the relationship between climate change, emergent zoonotic diseases and meat production will pose significant challenges. High profile examples of the consequences are provided by recent outbreaks of avian influenza and H1N1 influenza. Rising livestock production in proximity to human and wild animal populations creates conditions for increasing incidents of emergent zoonotic pathogens. Improved bio-security and herd health management are critical to managing what will likely be a growing threat to meat animal production and human health.

### **Concluding Comments**

The meatpacking industry is a mature industry facing surprisingly dynamic forces of change. Increased globalization is resulting in new players entering the U.S. market to compete both nationally and internationally. At the same time rising economic growth in developing countries is resulting in increased demand for meat products, expanding the overall market.

Meatpackers are increasingly aligned throughout the meat supply chain from genetics through the retailer's meat case. These vertical linkages result in economies of size and scope beyond the traditional technical economies of size. This enables packers to service large retail customers with consistent and known source products.

With greater integration of supply chains and rising demands for credence attributes—not directly observable by the consumer, such as organic production—and social traits, buyer and supplier requirements are evolving from traditional 'pure pricing' concerns to concerns regarding verification of production methods and practices. Increasingly, asymmetric information and externalities create the need for information transmission beyond that conveyed by prices, resulting in vertical integration and contracting to meet discerning consumers' demands.

Demands for technical efficiency will relentlessly increase as growing world populations and climate change increase competition by the animal sector for scarce resources. Emergent zoonotic diseases will also continue to require improved treatment methods as well as production methods to improve animal health and food safety.

The meatpacking sector's role as interface between the producer and consumer will gain greater importance as these forces accelerate. Those who navigate the multiple and sometimes conflicting demands for product

costs and product attributes will remain competitive.

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## IMPACTS OF PRODUCT DIFFERENTIATION ON THE CROP INPUT SUPPLY INDUSTRY

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In the last issue of *Choices*, Olson, Rahm, and Swanson (2010) describe changes in the plant input supply industry using the framework of Michael Porter's Five Forces model. They illustrate with examples, particularly from fertilizer manufacturing. The Porter Five Forces model explains the structure and performance of the crop production input supply industry well if all forms of rivalry are considered. For a fertilizer manufacturer, the principal forms of rivalry appear to be price competition, control over raw material supply, and logistics. A fertilizer manufacturer has limited opportunities to differentiate its products, leading Olson, Rahm, and Swanson to ignore this form of rivalry. However, many of the changes in the rest of the crop input supply industry can best be understood through a focus on product differentiation.

Seed, pesticide, and farm machinery manufacturing companies compete far more through product differentiation than through price. Product differentiation also has played a major role in determining the structure of crop production input retailers, including fertilizer retailers. Differentiated crop inputs have greatly increased productivity in crop production. Branding and advertising help crop producers identify the most productive crop inputs. Product differentiation also has rewarded the companies that have invested the most in it with higher market share and profitability.

The authors of the agribusiness theme articles in the last issue of *Choices* recognize two additional drivers: technology and other factors, primarily regulatory policies. Technology has impacted structure and performance of the crop inputs industry primarily through product differentiation. Regulatory policies have determined where these technologies have been allowed and supported by government or prohibited. Over the past 15 years, technology developments have dramatically increased product differentiation and thereby transformed most of the crop production segment of agribusiness.

### Observed Forms of Rivalry

The primary forms of rivalry for the seed, pesticide, and farm machinery industries are:

- Product differentiation through performance
- Product differentiation through bundled services
- Price competition through discounts, rebates, and loyalty programs

Product differentiation through performance takes many forms. Seed companies develop multiple hybrids and plant varieties through genetics. Biotechnology has allowed seed companies to add additional traits, such as herbicide tolerance and insect control through the BT genes. Pesticide companies develop and patent new active ingredients and formulations. Farm machinery companies offer multiple configurations of product features. Seed and pesticide companies actively advertise the crop yield and cost advantages of their products. Farm machinery companies advertise the productivity advantages of their products in acres per hour, fuel efficiency, more uniform plant stands, and reduced harvest losses. In general, success in large-scale crop production is driven by productivity and most crop inputs are marketed based on their differentiated

productivity advantages. Quality of product is equally important in production of some crops like fruit, but productivity is always critical for success.

Product differentiation through bundled services also takes many forms. Crop input retailers provide recommendations on which product to use and application rate, usually at no additional cost. Crop input retailers commonly offer application services, sometimes for free and often for less than the full cost of application. Precision farming technology enhances recommendation and application services by allowing variable rates of application within a field. Credit services are often offered with products by both retailers and manufacturers. After-sale service is an extremely important form of product differentiation for seed, pesticides, and farm machinery. Seed and pesticide manufacturers provide consultation, money-back guarantees, and additional product in cases where customers claim that products fail to perform as advertised. Recently, Monsanto partnered with the crop insurance industry to offer programs to growers that both lower crop insurance rates and offer additional yield guarantees to customers of its biotechnology traits.

Farm machinery manufacturers provide maintenance and repair services through dedicated, often exclusive dealers. Precision farming technology has greatly expanded services provided by farm machinery manufacturers and their dealers. Farm machinery manufacturers now provide GPS correction signals, GPS guidance such as John Deere's AutoTrac™, and software to analyze machine-collected data and create prescriptions. Advances in cellular and other wireless communications technology have prompted manufacturers to begin offering remote machine monitoring systems and wireless transmissions of work orders and prescriptions. The complexity of precision farming technology has made equipment installation and setup important, differentiating services for farm machinery manufacturers and their dealers.

Price competition exists, but most of it occurs through selectively applied discounts, rebates, and loyalty programs. Companies with less market share commonly set list prices at a small discount to the list prices of market leaders in order to boost market share. List prices for generic and store-brand products are less than list prices for branded products. However, branded products are usually priced according to customer value and established companies are cautious about destroying the perceived value of products through price competition. Aggressive discounting by a manufacturer would also alienate retailers because it reduces their revenue. Pesticide retailers sometimes respond to aggressive discounting by promoting competitive products. Discounts from list price are offered to selected growers who are the most price-motivated. Additional discounts and price rebates are provided for loyalty, participation in marketing programs, and volume of purchases. Many of the percentage discounts for these programs are widely known by customers, but eligibility is determined by sales persons on a case-by-case basis.

Two technologies have strongly increased product differentiation for the crop production input supply industry in the past 15 years:

- Biotech seed
- Automated GPS-guidance systems and related precision farming technology

Biotech seed was commercially introduced in 1996 with Monsanto's BollGard™ trait to control insect pests in cotton and Roundup Ready™ soybeans for broad spectrum weed control. Both the BT and Roundup Ready™ traits were soon extended to corn and licensed to other seed companies. Adoption was rapid with 92% of U.S. soybean acres planted with Roundup Ready™ soybean seed and 60% of U.S. corn for grain acres being planted with one or more corn seed traits within 10 years of introduction. Substantial cropland areas in Argentina, Brazil, Canada, India, and China are now planted with biotech crops, but adoption elsewhere has been largely prohibited by government policies. The technology used to develop biotech seed traits also greatly accelerated the development process without genetic modification for new hybrids and varieties with high yields or desired quality characteristics.

Biotechnology in seed production has helped the largest seed companies grow their market share and profitability. Only the largest seed companies could afford the hundreds of millions of annual research dollars required to fully utilize the biotechnologies. Monsanto—after acquiring DEKALB, Asgrow, Holdens, and Corn States seed companies—and Pioneer Hi-Bred made the greatest investments, developed the highest-yielding seed, raised their prices to reflect higher value, and grew market share. Many small, regional seed companies in the U.S. could not afford to keep pace and invest in the capital intensive business of molecular breeding and biotech, agreeing to in-license the technology or participate in mergers and acquisitions to maintain competitiveness. Many independent seed companies ultimately cashed in via sale to the innovative biotech-seed companies such as Monsanto and Pioneer Hi-Bred, eager to invest in continued growth.

## Pesticide Industry Transformed

RoundupReady™ seed transformed the pesticide industry. Glyphosate, the active ingredient in Roundup herbicide, became more widely available for broad spectrum weed control at lower costs post-patent, and Roundup Ready technology enabled the use of this effective weed control herbicide across all major crops. Monsanto first reduced list prices for Roundup herbicide by 16-22% in September 1998 and recaptured the value through increased prices for seed with the RoundupReady™ trait in soybeans. This forced other pesticide manufacturers to lower conventional soybean herbicide prices in order to remain competitive to Roundup's "system" pricing including the seed trait cost and the herbicide cost. Roundup's patent expired in 2000 and Monsanto launched a three-tiered pricing strategy based on product differentiation. The flagship Roundup herbicide product was sold with the most effective formulation and a branded after-sale service program, RoundupRewards™. The middle tier was Roundup Original without the most effective formulation but with RoundupRewards™. The lowest tier consisted of retailer store brands with the Roundup Original formulation and all after-sale service provided by the retailer. Monsanto also differentiated its herbicide products by providing retailers with industry-leading logistics and order-to-cash processes as bundled services. After several years, competitive manufacturers improved their formulations and increased the volume of generic products to the point that Monsanto abandoned the multi-tier strategy, but it remains one of the most successful post-patent strategies of record with growers choosing Monsanto Roundup brands for substantial price and value premiums over generic products for many years. Today, many pesticide patents have expired and manufacturers are selling both a differentiated, branded product with superior formulation and service and a low tier generic/store brand product.

Automated GPS-guidance systems were introduced by John Deere as AutoTrac™ in 2002, using global positioning systems (GPS) technology developed for precision farming. Other farm machinery manufacturers soon followed with similar guidance systems and systems have since become increasingly precise and more fully automated, including turns and curves. Precision farming uses the ability to identify global position from GPS satellites in computerized agronomic data collection and operation of variable-rate application and seeding controllers. Yield mapping using GPS receivers and mass-flow yield sensors are now commonplace, but variable rate applications have only reached 15-35% of crop acreage in North America due to data management challenges and skepticism regarding the profitability of this practice. The range reflects various market research results for different types of variable rate applications and seeding. Market research focused on very large crop producers suggests that a majority of them are using variable rate technology, so adoption of variable rate technology will likely grow as farms grow larger.

Automated GPS-guidance was initially expected to be just a convenience, reducing operator fatigue. However, large growers discovered that it allowed:

- accomplishing many management tasks by phone while operating machinery
- continuing field operations many more hours each day without any loss of crop yield
- small increases in fuel efficiency and acres per hour
- reductions in overlapping input applications

Automated GPS-guidance systems therefore have accelerated the concentration of crop production through a smaller number of growers.

Automated GPS-guidance systems have become an important form of product differentiation for farm machinery manufacturers. For large growers who are aggressively expanding their acreage, the GPS-guidance and other information systems in a tractor or combine are now just as valuable as the horsepower and field capacities in acres per hour. Farm machinery manufacturers now market integrated solutions of iron and electronics to maximize the productivity of crop producers. Furthermore, the services that a machinery dealer provides to install and set up these complicated information systems are an important source of product differentiation.

Olson, Rahm, and Swanson (2010) apply a Herfindahl-Herschmann Index to all the companies in NAICS code 333111 and suggest moderate concentration in the farm machinery industry. Casual observation might support this conclusion. If one goes to a large farm machinery exhibition such as the Farm Progress Show in the United States or Agritechnica in Germany, one will see a large number of machinery exhibitors. However, when a crop producer looks for a farm machinery dealer that can sell a full line of machinery that is integrated with information systems for automated GPS guidance and data collection, set up the machinery, and provide rapid repairs as needed, there are very few choices. In many regions there may be only two. As a result of manufacturing a full line of equipment and GPS-based information systems, plus having a very strong dealer

network to provide services, John Deere maintains a high market share in North America and obtains higher prices than its principal competitors. Crop producers have many choices if they want to hook together equipment from several manufacturers and obtain after-sale service from several dealers and service providers, but a large number prefer buying integrated systems and obtaining service from one dealer. The costs of establishing an effective dealer network limit the impact of new entrants. It appears to be for this reason that Claas has a tiny presence in the North American market for all but forage-harvesting equipment although it sells high-quality products and has a high market share in Europe. Similarly, John Deere has a smaller market share in Europe largely because its European dealer channel is not yet as fully developed as its North American dealer channel.

New technology has increased product differentiation through bundled services by crop input retailers. Most crop producers use fertilizer recommendations made by crop input retailers and many also use seed and pesticide recommendations made by these retailers. Most of these recommendations are provided at no additional cost. The services provided by crop input retailers have grown as growers have adopted precision farming technology. Although some of the market-share growth for large retailers such as Helena Chemical, Growmark, and Crop Production Systems is due to bargaining power in purchasing, a large part is due to economies of size in providing precision farming services.

Recently, seed manufacturers have started to further differentiate their products by providing precision farming services at no additional cost to help growers select the best hybrids or varieties for each field and the best seed population per acre. This is partly a response to growers' challenges in learning about new seed products that replace familiar seed products about every three years. Pioneer initiated these services with its FIT program that provides free yield maps in addition to seed recommendations. This year Monsanto announced plans to provide similar services, including remote sensing to identify crop stresses—IntelliScan™— and providing custom seed recommendations for higher yield potential—IntelliSeed™.

### **Other Factors**

The impact of other factors on the structure and performance of the crop production input supply industry becomes clearer when product differentiation is considered. Government policies sometimes have supported product differentiating technology and sometimes restricted it. Supporting policies include the patenting of pesticide and plant genetic innovations, enforcement of penalties for breaking license agreements not to replant biotech seed, making GPS signals available to the public, and funding research to develop precision farming technology. Restrictive policies include lengthy and difficult approval processes, court injunctions, and legislated prohibitions for planting biotech seed in many countries. It appears that the global market shares of Monsanto and Pioneer would be greater if not for the prohibitions of their biotech seed in many countries, and part of the opposition to biotech seed appears to be motivated by opposition to multinational corporations.

Other important factors impacting the structure and performance of the crop production input supply industry in the past 15 years include:

- globalization of markets
- increasing global demand for grain and oilseed production

Markets for crop products have become more global as consumers have sought year-round availability of perishable produce, as regional demand growth has exceeded regional supplies, and as a few large crop producers have expanded their operations to other countries. Markets for crop inputs have become more global because the technologies developed in one country have high value elsewhere and crop input companies have expanded their research and development to multiple countries. For example, most of the insecticides and fungicides used in North America are manufactured by the European companies: Syngenta, Bayer, and BASF, who all have large research units in the United States. Global markets help companies with well-recognized brands grow larger because they can quickly recover the required investments in facilities, personnel, and logistics in multiple countries.

Increasing global demand has outpaced increases in production for grain in 7 of the past 11 years (Potash Corp, 2011) and stocks for corn are forecast to hit their lowest levels since 1974 this year (Wilson and McFerron, 2011). Demand increases are mostly due to the effect of increasing incomes on meat consumption and increasing use of corn for biofuel production. These shortfalls have pushed up grain and oilseed prices, which have increased the returns to crop producers from using the most productive crop inputs. As crop producers have chosen the seed, pesticides, and farm machinery that are most differentiated by product performance, the market shares and profits for the manufacturers of these differentiated products have

climbed. Biotechnology has certainly helped increase production to meet rising demand for grains, but limited resources such as water and high-quality cropland as well as variable weather have constrained the supply response.

### Questions for the Future

The discussion above illustrates a number of ways that product differentiation has shaped the structure and performance of the crop production input supply industry. The Porter Five Forces model includes rivalry through product differentiation, so it is very capable of explaining these important structural changes. New technologies have greatly increased the productivity of pesticides, seed, and farm machinery that manufacturers have patented, branded, and bundled with recommendations, setup, and after-sale services. Government policies have supported the technologies that make products more differentiated in North America and selected other countries, but have restricted biotech seed sales in many European countries. Globalization of crop input markets and rising demand and prices for crop production have increased market shares for differentiated products and profits for their manufacturers.

Changes in technology will continue to differentiate products but the impacts on future industry structure and performance are less certain. A key question for farm machinery manufacturers is whether new information technologies will enable multiple service providers to collaborate in providing setup and after-sale services as effectively as large manufacturers with dedicated dealers do it today. Increasingly capable wireless data systems provide the potential for multiple parties to remotely monitor machinery, adjust settings, and diagnose the causes of breakdowns. ISOBUS standards (Schrimpf, 2006) now allow dealers to create integrated machinery systems from several manufacturers, particularly in Europe. There currently are large gaps in the ISOBUS standards that limit the capabilities of mixed manufacturer systems, but significant efforts are underway to fill these gaps. Pesticide manufacturers may see product differentiation opportunities increase as more weeds show resistance to glyphosate herbicide. Seed companies are trying to bundle precision farming services to further differentiate their products, but growers may be reluctant to give them more influence over decision-making. Product differentiation will continue to grow, but whether it promotes further industry concentration remains to be seen.

### For More Information

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