

Global Competitiveness of the U.S. Pork Sector

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Abstract: What countries will have a competitive advantage in producing pork for international customers in the next decades? We briefly examine the changing competitive structure, emphasizing costs of production and processing, for four major pork exporting countries - the United States, Denmark, The Netherlands, and Canada. Several productivity and cost differences, and their causes are profiled for pork producers and processors in each country. Changing environmental constraints and differences likely to play an important role in affecting exports from each country are summarized. After considering each of the changes occurring and the relative costs in each country's pork sector individually, we conclude that western Canada could develop a competitive advantage if it develops a more competitive processing industry, that the United States' very efficient processing industry and the lower cost hog production should help expand its market share, but Denmark is likely to remain the leading exporter despite their higher cost system.

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Global Competitiveness of the U.S. Pork Sector¹

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Introduction

The global pork market has been changing dramatically in the last five years. Taiwan had a foot and mouth disease outbreak that suddenly stopped all exports to Japan where they had been the primary supplier. The Netherlands had a swine fever outbreak, which stopped part of their exports to western Europe. The swine fever outbreak also initiated a downsizing of the Dutch pork industry by their government. Denmark continued as the major world pork exporter, but the U.S. share of world pork exports rose sharply.

What countries will have a competitive advantage in producing pork for international customers in the next decades? This is a difficult but very important question which can have a big impact on the welfare of the pork producer and related industries here and abroad. International restrictions on trade in livestock and meat products, grains and other agricultural products are easing, and protection for domestic industries is declining in the wake of GATT negotiations and other bilateral or multilateral trade agreements. This opens the door for potentially dramatic changes in trade patterns as industries around the world adjust to the new competitive environment. In general, global competitive advantage of the many industries participating in the world market is determined by numerous factors. The cost and quality of basic resources and their best use in potential producing countries determine comparative advantage in international trade theory. This is usually a concept based on production of a product, and not related to the entire

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value chain (Porter 1986, p. 36). The value chain involves a number of stages (like production, processing, etc.) which conceivably could be performed in more than one location. There may be different preferred locations for those activities, and different ways of performing those value added activities which can contribute to competitive advantage for a particular industry in a particular country. Further, some competitive advantages may be fleeting, while others may be more sustainable. Systemwide advantages may lead to brand identities or reputations of particular firms or countries (e.g. German automobiles, Japanese electronics, Columbian coffee). Sometimes this is sparked by a particular endowment of resources particularly well suited for producing a product (climate, soil, cheap labor, etc.). Sometimes, this is sparked by the size, sophistication, and competition in the local market, which may force innovation, encourage advances in supplier industries, facilitate economies of scale, or provide other advantages in dealing with international customers.

Economists tend to look first at the most significant cost components in producing and marketing a product in international markets. In producing pork for the export market, for example, one cannot simply look at the primary cost components in producing a pig (feed, buildings, and labor), the technology employed and related production efficiency, but they may be quite important. Feed prices will be affected by changing yields, fertilizer and machinery costs, and changing government programs (GATT and budget deficit related, especially U.S., Canada, EU). The economies of size in hog production and the likely size distribution and cost distribution in the industry certainly affect the amount which the industry would be willing to produce at each price level. Location of hog production and feed surplus areas in each country could also have an impact. Changing environmental constraints or internalized costs of reducing effluent are likely to play an important role in affecting supply response within the U.S. and in other producing countries. Genetics change slowly, and seem fairly mobile across borders, but may be a factor affecting a country's productivity at the farm level and product quality throughout the value added chain.

What are the consequent costs for hog production, not just as they are now, but as they are likely to be in the near future? The cost of slaughter and processing could vary a lot across countries, and affect where the combined hog production and processing operation optimally

should be located. The highest cost for the processor will usually be the hog, but labor costs may differ a lot across countries. Processing technologies are probably quite mobile, but the economies of size in slaughtering and processing are likely to be quite significant. Further, economies of scope in having multiple plants and related products (poultry, etc.) in the distribution channel may also play a role in determining competitive advantage.

Differentiated products—in quality, service, and adaptation to idiosyncratic demands—can also significantly affect cost structures and related international demand for your products. The degree of competition at each stage of the system influences the profits at each stage, and related price levels. Barriers to entry into production, processing, or international distribution can have an influence on competitiveness, cost and profit levels.

Distribution cost can be heavily influenced by distance between importing and exporting countries, mode of transportation, and transport rates (influenced by fuel cost and fresh versus frozen shipment). Thus the location of net importers relative to net exporters can be critical in determining competitive advantage through cost differences and speed in responding to changing demands.

Coordination systems and the related transaction costs linking various stages of the input supply, production, processing, distribution process may make small differences in overall cost levels and speed of response to changing customer demands. The ability to trace back product to its original source and insure against liability problems is becoming more important to many export customers.

Production and price cycles can provide windows of opportunity in undercutting other competitors' prices, temporarily, but they can also put you at a competitive disadvantage sometimes. Cyclical production and prices can affect your reliability as a market or low cost supplier, and the related willingness of firms to tool up specifically to serve the export market, especially if different products or services are required to compete.

Exchange rate volatility can buffer or aggravate the cyclical commodity price patterns in exporting countries. The relative price in the importing countries' currency is usually going to be a significant influence on who gets the sale, unless there are overriding governmental, cultural, health and sanitary constraints.

Growth rates in domestic market influence the likelihood of possible exporters to actually make the investment in time and money to enter the export market. If domestic market growth is slow, managers have a stronger incentive to focus abroad.

Demand in importing countries versus the supply there determines their excess demand. And the expected pattern of change in their excess demand, which is affected by the ability of domestic suppliers to compete with imports, determines the potential of that country as an export customer. Then the big question is: Who will be best positioned to supply that customer, prosper and grow in the long run? That is the essence of competitive advantage.

In the following chapters, we briefly examine the changing competitive structure, emphasizing costs of production and processing, for four major pork exporting countries— the United States, Denmark, The Netherlands, and Canada. After considering each of the changes occurring and the relative costs in each country's pork sector individually, we examine whether the United States is likely to expand its share of the world market in the future. In addition to using secondary data from a number of sources, we draw upon the discussions with industry participants and government analysts in Denmark and The Netherlands, significant contributions on Canada from Larry Martin at the University of Guelph George Morris Centre, and the contributions from a large team of economists from Iowa State University on the changing structure of the U.S. pork sector.

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**The Netherlands Pork Industry:
Factors Influencing Export Market Competitive Advantage**

Marvin Hayenga, Mary Jane Novenario-Reese, and Roxanne Clemens¹

Introduction

For many years, the Netherlands was the leading exporter of pork, until Danish pork exports surpassed Dutch exports in 1992. Until the Classical Swine Fever outbreak in 1997, the Dutch continued to be a major exporter within the European market. The swine fever outbreak prompted liquidation of about one-fourth of the Dutch herd in 1997. The Dutch Minister of Agriculture will only allow the industry to operate at 80 percent of prior production levels, with biosecurity zones established for environmental degradation and disease control. The reduction to 80 percent has to be reached in the year 2000. This will result in major restructuring in the pig production, pork processing and input supply sectors serving the pork sector in the Netherlands. Nevertheless, we expect that the material which follows will be useful in analyzing potential implications of these dramatic changes.

In this report, we will examine the costs of the pig production and processing in the Netherlands prior to the swine fever outbreak and evaluate the prospects for regaining export effectiveness in the future. For this report, 1995 is selected as the base year for production cost comparisons because the worldwide surge in feed prices in 1996 was dampened by policy actions in the European Union, and cost comparisons with other countries in 1996 might be misleading. Of course, varying exchange rates may make any individual year comparison misleading as well. Recently, more favorable exchange rates would lower the costs after exchange-rate conversion by 5.25% in U.S. dollars.

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Pig Production

Farm Structure

Dutch pig farms are small, typically housing less than 600 sows. More than 99 percent of all farms are family operations. Fifty percent of the farrowing and 35 percent of the fattening operations are specialized pig producing farms. Full-time specialized farrowing operations average 210 sows per operation, whereas the average capacity of full-time specialized finishing operations is 2,600 head. Most of the farms in the pork sector are diversified, mostly in dairy. The average farm size by area is 17 hectares (42 acres), with very high water tables.

Since 1960, the number of pig farms in the Netherlands has decreased by between 5 percent and 10 percent annually (OECD, 1996). Between 1980 and 1995, the number decreased by 50 percent, from about 44,000 to 22,000 farms (Table 1). On the other hand, the scale of production has increased. From 1980 to 1995, pig supply increased from 10 million to 14 million head (Table 2). Pig farming is concentrated in the eastern provinces of Overijssel and Gelderland, and in the southern provinces of Noord-Brabant and Limburg. These four provinces account for 85 percent of pig farms and at least 90 percent of total pig production.

Table 1. Number of pig farms in the Netherlands, by type, 1980-1995

Type of farm	1980	1990	1995
Number of pig farms	44,127	29,211	22,388
Of which:			
with combined pig farms	9,521	8,683	6,964
with sows > 50 kg.	24,696	13,391	9,623
with pigs for fattening > 20 kg.	28,641	24,281	19,627

Source: Livestock, Meat and Eggs in the Netherlands, 1996.

Herd size has also increased considerably. Over the 15-year period, herd size on breeding farms tripled, while that on finishing farms doubled (Tables 3 and 4). Most farms (less than 100 sows and 500 fattening pigs) are dairy farms or mixed farms (Backus, 1996). In 1995, large

Table 2. Pig supply in the Netherlands, by type, 1980-1995

Type of pig	1980	1985	1990	1994	1995
	(1000 heads)				
Pigs for fattening	5,241	6,332	7,025	7,271	7,124
Breeding pigs	1,403	1,643	1,699	1,694	1,677
Piglets	3,494	4,408	5,191	5,600	5,596

Source: Livestock, Meat and Eggs in the Netherlands, 1996.

Table 3. Farms with breeding sows of 110 lb and over in the Netherlands, by herd size, 1980 and 1995

Size of herd	Percent of all farms		Percent of all pigs	
	1980	1995	1980	1995
1 - 74	78	32	38	6
75 - 149	17	27	35	19
150 & more	5	41	27	75
Total	100	100	100	100
of which > 250 sows		16		43
Total no. of farms	24,696	9,623		
Total no. of pigs			1,212,996	1,502,366
No. of pigs/herd	49	156		

Source: "Emerging Issues in Cereal-Livestock Market Interaction: Impacts of Restructuring in the Pig and Poultry Sector of OECD Countries - Note by the Dutch Authorities," OECD, Oct. 18, 1996.

Table 4. Farms with fathering pigs of 44 lb and over in the Netherlands, by herd size, 1980 and 1995

Size of herd	Percent of all farms		Percent of all pigs	
	1980	1995	1980	1995
1 - 74	71	50	25	10
75 - 149	20	27	35	24
150 & more	9	23	40	66
Total	100	100	100	100
of which > 750 pigs	4		24	
of which > 1000 pigs		8		37
Total no. of farms	28,641	19,627		
Total no. of pigs			5,241,002	7,123,923
No. of pigs/herd	183	363		

Source: "Emerging Issues in Cereal-Livestock Market Interaction: Impacts of Restructuring in the Pig and Poultry Sector of OECD Countries - Note by the Dutch Authorities," OECD, Oct. 18, 1996.

farrowing operations with 250 or more sows accounted for 16 percent of farms and a 43 percent of the pigs produced. Large finishing operations with 1,000 or more pigs accounted for 8 percent of farms and 37 percent of pigs produced. Farrow-to-finish operations, which keep both breeding sows and finishing pigs, have increased in number in contrast to the other two types of pig farms.

The occurrence of very large farms (i.e., 800 or more breeding sows or 10,000 or more finishing pigs) in the Dutch pig industry is rare. Farms of this size account for just 8 percent of breeding sow production and 2 percent of finishing pig production (OECD, 1996).

Environmental Rules in Pig Production

In order to contain the expansion of pig and poultry farms, an Act on Manure and Fertilizers was implemented in 1987. This act assigned a manure quota to individual pig producers that limits manure and phosphate application per unit of land owned (OECD, 1996). Prohibitive taxes apply when the limits are exceeded. In 1993, the Ministry of Agriculture, Nature Management and Fisheries estimated that the pig production sector accounted for 34

percent of Dutch manure production and 58 percent of the manure surplus.

Prior to the swine fever outbreak, industry experts did not expect the Dutch pig industry to expand because of environmental costs and the existing quotas. The allowed limits for ammonia and phosphate in livestock and crop production were declining rapidly. All new facilities were required to have 50 percent lower ammonia emissions than existing standard facilities. The only way a producer could increase the scale of a pig operation was by exchanging manure production rights with other pig producers or shipping farm waste elsewhere. Both methods involve high costs. Sow farrowing operations have greater payoff per unit of production rights, causing a shift away from finishing to farrowing. More feeder pigs were being exported to the nearby countries of Spain, Belgium, Luxembourg, Germany, and Italy, which have less environmental restrictions for pig finishing.

Pig Production Costs and Productivity

Average pig farm productivity in 1995 can be measured in several ways.

- a. Weaned pigs per sow per year = 21; new 600 to 800 sow operations achieve 23 to 24 pigs per sow per year.
- b. Feed efficiency = record-keeping farms average 2.9 pounds of feed per pound of pig produced and marketed for the whole herd; “good” farms must be 2.65 in finishing and 2.75 for the whole herd.
- c. Carcass lean percentage (Hennessey probe) = 55.5, up from 53.2 in 1990.
- d. Average daily gains in finishing are 1.61 lbs. per day.
- e. Estimated labor per pig marketed = 1.42 hours.

The technology in Dutch hog production is fairly advanced. Typical hog farm technology includes nearly 100 percent artificial insemination, all-in-all-out production for disease control, and automated feeders with increased wet feeding for medium- and large-scale operations. Dutch producers typically wean pigs at 27 to 28 days and are not allowed to wean prior to 21

days due to animal welfare laws. Because of environmental concerns in the Netherlands, phytase is now added to much of the pig feed to minimize phosphorus effluent.

The Product Board for Livestock and Meat (PVV) provides a system of coordination and

self-regulation to the slaughter and processing industry in the Netherlands. In 1992, PVV established a system of Integrated Quality Control (IKB) to guarantee the quality of Dutch pork. IKB is an integrated quality program that controls the entire production chain from breeders to slaughterhouses. The program provides guarantees with respect to origin, fodder, hygiene, use of veterinary medicines, and the absence of residues in the pork. Moreover, the program makes possible the exchange of information between the links in the production chain. A slaughterhouse obtains information about the health and origin of the pigs from producers and producers are given the results of examinations performed in the slaughterhouse (Product Board for Livestock and Meat 1992).

In 1995, more than 60 percent of all hogs were produced and processed under the IKB program, which is being required by most retailers and promoted strongly in domestic and export marketing. In late 1996, 70 percent were in the IKB program, and industry leaders expect near 100 percent participation in the IKB program in 1997 or 1998. This program involves implementing the best manufacturing processes in slaughter and processing, using limited pharmaceuticals and extended removal times prior to slaughter, hygiene standards, and incorporating traceability back to the farm of origin, to guarantee no residues in the meat. The program is being extensively promoted in domestic markets and to export customers. By the end of 1995, IKB program coverage was extended to include butchers' shops and supermarkets, allowing consumers to easily identify IKB pork by its logo.

Dutch production costs have historically been slightly lower than many other European countries because of extensive Dutch use of tapioca and grain processing byproducts as energy sources to substitute for grains for which prices were kept artificially high by common agricultural policies. Now that policy liberalization has been achieved with the combination of EU budget pressures and GATT agreements, the relative advantage from these feeding practices may be smaller.

A team of economists from five European pork producing countries conducted a comparative study of production costs in their countries. Backus and Vaessen have summarized the Dutch hog production cost structure, concluding that Denmark and the Netherlands have a

similar cost structure, but that England and Italy have slightly lower costs. Slaughter weights in the Netherlands averaged 87 kg carcass weight (250 lb. live weight) in 1995, close to U.S. levels but significantly higher than Danish slaughter weights. Their 1995 cost analysis found investment costs per sow or pig relatively high in the Netherlands versus costs in other European competitors. Building costs are high to minimize ammonia release, animal welfare problems, worker health problems, and labor use. Estimates of capital needed per pig space include \$412/head finishing, \$3,824/sow farrowing, \$2,940/10 pigs nursery, 1,470/sow gestation buildings. New equipment ads emphasize effects on ammonia release. It currently costs \$56 more per pig space to meet ammonia restrictions now, and this cost is increasing. Partial slats are required to meet welfare regulations. Odor setbacks from other people or hog facilities have been in place since 1970s.

Dutch labor costs are also relatively high--typically \$25,000 per year for animal workers and over \$40,000 per year for specialized workers (including one month of vacation). Feed costs were slightly lower, although feed cost differences are small. Finishing mixed feed costs 12 cents/lb., down 20 percent from typical levels in late 1980s before GATT.

The overall cost differences among the Netherlands, Denmark, France, Italy, and England were small. Total cost of production per pound of live pig produced was 77 cents (3.47 guilders per kg carcass weight), with feed accounting for 46 percent; housing, 16 percent; and labor, 13 percent of total costs. High sow productivity and very good feed conversion rates helped to compensate for the high fixed costs, high feed prices, and high labor rates.

The high costs of acquiring manure rights place a considerable burden on the Dutch competitive position. Waste shipment and handling cost about \$7/head when a producer exceeds the land waste capacity. To buy ammonia and phosphate rights for a new 1,000-hog finishing facility would cost \$367,000, and the government keeps 30 percent of all rights transferred. All producers now have to perform in-and-out manure accounting. In 1998, producers will have to perform in-and-out ammonia and phosphate accounting in livestock and crop enterprises.

Pork Processing Structure

Pig production in the Netherlands is generally independent of slaughter and feed

companies, with few contractual links except short term. Ten to twenty years ago, there was a much higher level of contracting because lenders required it for credit to new or growing operations.

The Dutch slaughter industry was characterized by many small slaughter plants with excess capacity and low profits until they were able to buy out excess capacity in 1995 under the auspices of the Product Board for Livestock, Meat and Eggs, with approval from the European Union. Approximately 20 percent of slaughter plant capacity was closed for five years at a cost (paid by slaughter companies) of US\$70 million. At the same time, two cooperative slaughter operations operating at substantial losses merged with a small private firm. The merger also included a processing company, a cooperative feed company (the largest, with 40 percent market share), two breeding companies, and retailing and wholesaling companies to form Dumeco. In 1995, Dumeco had a 30 percent share of total slaughter volume.

The number of slaughter plants handling more than 25,000 hogs per year in the Netherlands has declined rapidly through the years, falling from 55 plants in 1987 to 27 plants in 1995. These plants accounted for roughly 85 percent of the total number of pigs slaughtered in 1995 (Table 6). The top four firms accounted for about half of the slaughter volume, with the cooperative Dumeco as the largest. As shown in Table 7, slaughter volume in the Netherlands has been slowly declining since 1990 as more live slaughter hogs have been exported, primarily to Germany. This trend will undoubtedly accelerate as swine production downsizes after the swine fever outbreak.

Dutch pork quality is considered to be good by Dutch meat scientists, with very little PSE due to Halothane testing of breeding stock and DNA probes now being used to eliminate heterozygotes. Color tests are good, with only a slight incidence of errant via Japanese color standards. In cutting and deboning plants, pH can be measured if requested by customers. Sanitation standards in Dutch meat processing are considered high. Starting in 1997, GMP codes for hygienic slaughter and processing will be implemented involving microbiological testing,

Table 6. Number of pig slaughterhouses in the Netherlands, by size class, 1995

Size	Number of slaughterhouses	Slaughterings	
		Number	Percent
< - 25,000	571	2,463,647	13
25,000 - 100,000	4	212,615	1
100,000 - 300,000	6	975,148	5
300,000 - 500,000	3	1,138,869	6
500,000 - 750,000	7	4,663,401	25
750,000 - 1,000,000	5	4,282,924	23
> 1,000,000	4	4,879,396	26
Total	600	18,616,000	100

* Self-slaughtering butchers included.

Source: "Emerging Issues in Cereal-Livestock Market Interaction: Impacts of Restructuring in the Pig and Poultry Sector of OECD Countries - Note by the Dutch Authorities," OECD, Oct. 18, 1996.

residue testing, and cleaning and disinfection process certification. HAACP is mandatory for processed meats but not for fresh meats, although this is likely to change.

Packer Cost Structure

Plants are generally operated at 400 head per hour (500 head per hour is the limit due to veterinarian regulations) for 6 to 7 hours per day for 5 days per week. Virtually all plants are single-shift plants. Carcass weights average 87 kg, substantially heavier than Danish pigs. High wage rates are prevalent, with estimated cost per hour of \$23 to \$30/hour, with one month vacation.

Slaughter and processing costs are difficult to estimate, as many slaughter firms do relatively little further processing, and there are some conflicting estimates. Variable slaughter costs were estimated at \$9 per head by a Danish study. Industry sources suggest that fixed and variable costs would be near \$10 per head, and second and third cuts probably add another \$6 to

Table 7. Number of pig slaughtered in the Netherlands, 1980-1995

Year	No. of slaughtered pigs (1000 heads)
1980	13,239
1985	16,718
1990	19,942
1994	19,395
1995	18,650

Source: Livestock, Meat and Eggs in the Netherlands, 1996.

costs. When it is performed, further processing beyond that is the most expensive because labor is quite expensive. A Wageningen Agricultural University study (den Ouden) estimated \$23 per head fixed and variable cost for split carcasses and \$31 per head if the carcass is sold as pieces, using 1992 prices. Industry sources offer a range of estimates for total costs, from \$30 to \$35 per head in 1996 for moderate levels of processing, to \$16 to \$20 per head or less for plants doing little further processing, which may be the majority. With little value-added processing, little product differentiation, and excess slaughter capacity, slaughter firm profitability has been anemic, although capacity buyout improved profits sharply in 1996.

The swine fever outbreak and subsequent production downsizing will likely lead to lower levels of capacity utilization. This would lead to higher costs per unit output temporarily, and further plant and firm consolidation in the long run to remain competitive in EU markets.

Marketing

Dutch pork production and exports have decreased slightly in recent years (OECD, 1996). Despite this trend, self-sufficiency in the pork sector was 276 percent in 1995. Close to 680,000 tons of pork were available for domestic consumption, or 44 kilograms per capita (97 pounds).

As shown in Table 8, the value of the live pig and pork export sector in 1995 was about 4.9 billion guilders (about \$3 billion). Exports of live baby pigs and pigs accounted for 21 percent of this value (up from about 17 percent in 1993). Germany was the largest market for

Table 8. Export value of the Dutch pig sector, 1995

Product	Percent share
Baby pigs	5.6
Pigs	15.5
Pork	59.2
Bacon	11.7
Other pork products	8.0
Total value (1,000 guilders)	4,851,800

Source: "Emerging Issues in Cereal-Livestock Market Interaction: Impacts of Restructuring in the Pig and Poultry Sector of OECD Countries - Note by the Dutch Authorities," OECD, Oct. 18, 1996.

slaughter pigs, purchasing 62 percent of total Dutch exports (Table 9). Dutch pig producers in the border areas have been supplying German slaughterhouses in recent years. Spain was the largest buyer of Dutch feeder pigs, attempting increase its pork product export sector by expanding finishing and processing operations (OECD, 1996). Germany, Italy, and France have been the largest buyers of Dutch pork.

Future Growth and Export Potential

The Netherlands has very efficient pork producers, with high sow productivity, very good feed efficiency, and low labor use. On the other hand, producers face relatively high feed prices and stringent environmental restrictions. Dutch producers benefitted more from EU policies on feed and meat pricing than did other EU producers, which accelerated production growth in the Netherlands. But this advantage has disappeared, and more restrictive environmental limits are clearly likely to reduce swine production by approximately 20 percent after the swine fever outbreak. Before that, the government was discouraging any expansion in the southern region, though some areas in the north could handle great production. Germany, France and Spain may fill in this gap, with many pigs coming from the Netherlands, as the Dutch maximize returns to more restrictive environmental constraints in 1998.

Table 9. Exports of pigs and pork from the Netherlands, by destination, 1995

	Slaughter pigs	Live piglets	Pork (excl. bacon & pork products)	Pork products
Germany	62.4	13.4	41.0	17.3
Italy	14.5	19.0	26.8	
France	9.8	6.8	9.4	
Belgium/Luxemburg	8.5	21.9	4.6	7.9
Spain	2.6	38.2		
Greece			6.6	4.7
UK				35.0
Other countries	2.2	0.7	11.6	19.1
of which USSR				10.9
of which USA				5.1
Total quantity	2,659,423	1,789,141	821,298	80,098

Source: "Emerging Issues in Cereal-Livestock Market Interaction: Impacts of Restructuring the Pig and Poultry Sector of OECD Countries - Note by the Dutch Authorities," OECD, Oct. 18, 1996.

Until recently, the pork slaughter industry has been unprofitable, so technology updating and additional value-added processing has been slow to occur. The IKB program is intended to differentiate the Dutch product in international markets, and make them preferred suppliers at premium prices. PVV initiatives like the IKB program and slaughter capacity buyouts are playing an important role in the Dutch processing industry. The downsizing of swine production by 20 percent will likely lead to corresponding downsizing in the slaughter industry in the near future, and will sharply reduce the volume marketed by the Dutch pork industry in the EU export market.

Currently, the prospects of lower Dutch production and exports appears likely to stimulate growth in adjacent countries with less dense hog production and fewer environmental hurdles. The smaller volume of Dutch pork marketed in Western Europe appears likely to provide Denmark and other European exporters with a greater marketing opportunities close to home, potentially reducing their emphasis on Asian markets.

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**The Danish Pork Industry:
Factors Influencing Export Market Competitive Advantage**

Marvin Hayenga, Mary Jane Novenario-Reese, and Roxanne Clemens¹

Introduction

Denmark has been the world's leading exporter of pork for the past five years. More recently, Danish pork exports have constituted at least 75 percent of production. Denmark's emphasis on exports has been a long-standing tradition, but the factors contributing to this export success are not well understood outside Europe. In this report, we briefly examine Denmark's hog production and processing industries, with emphasis on size, cost structure, productivity, and policies affecting future export potential.

Pig Production

Farm structure

In 1996, there were about 64,000 farms in Denmark; approximately half of these farms were full-time operations with an average size near 85 acres. More than 19,000 Danish farms reported producing pigs in 1996. Half of Denmark's hog farms are farrow-to-finish operations, and the rest are specialized farrowing or finishing operations. Danish pig producers typically have 100 sows or 1,000 finishers and feed their own grain production.

Not much has changed in the last 20 years in terms of the geographical spread of pig production across Denmark. About 76 percent of the country's pigs are located on the mainland of Jutland (up 6 percent from 1975), and the rest are distributed among Denmark's six islands (Danske Slagterier 1996).

But a drastic change has occurred in farm structure and size. The transformation is characterized mainly by specialization, concentration, and larger herd sizes. In 1995, 31 percent

¹ Financial support was provided by MATRIC, National Pork Producers Council, and the Iowa State University Agricultural and Home Economics Experiment Station. We appreciate the contributions of many Danish industry participants and government economists to this study.

of all farm holdings in Denmark raised pigs, compared to 85 percent in 1968 (Table 1). In 1968, 75 percent of the pig farms housed 80 percent of all pigs; in 1995, just 18 percent of the farms house the same percentage. The actual number of farms with pigs decreased by 75 percent during the 20-year period between 1975 and 1995 (Table 2).

Table 1. Trends in pig farm specialization in Denmark, 1968 and 1995

Type of Farm	1968 Percent of		1995 Percent of	
	Farms	Pigs	Farms	Pigs
Without cattle and pigs	9.8		38.0	
With pigs, without cattle	10.7	16.2	18.0	78.4
With cattle, without pigs	5.0		30.8	
With cattle and pigs	74.5	83.8	13.2	21.6

Source: Danish Farmers' Unions 1996.

Table 2. Number of pig farms in Denmark, by type, 1975-95

Type of farm	1975	1980	1985	1995
Number of farms with pigs of which:	84,361	67,708	44,222	21,418
with pigs and sows	38,904	29,708	19,433	9,763
with pigs only	17,197	15,516	10,456	6,909
with sows only	28,260	18,701	11,615	3,712

Source: Danske Slagterier 1994, 1995.

Note: A slaughter pig is defined as a hog of 110 pounds and over. Farms with pig under 110 pounds and without sows are not included; therefore the three types do not add up to the total number of farms with pigs.

As shown in Table 3, average herd size tripled to more than 500 pigs per farm from 1982 to 1995. Almost one-third of pig farms kept at least 500 hogs in 1995. Less than half of all pigs were kept in herds of this size in 1982, compared to 80 percent in 1995.

Table 3. Pig herd structure in Denmark, by size, 1982-95

Size of herd	Percent of all Herds			Percent of all Pigs		
	1982	1994	1995	1982	1994	1995
1 - 49	42.5	25.5	25.9	5.3	1.1	1.0
50 - 199	33.2	26.2	24.0	20.4	5.9	5.1
200 - 499	15.5	18.8	18.6	29.2	12.9	11.8
500 and over	8.8	29.5	31.5	45.1	80.1	82.1
Total	100.0	100.0	100.0	100.0	100.0	100.0
Number of herds	55,023	22,716	21,418			
Total pigs (1,000)				9,288	10,923	11,084
Pigs per herd	168.8	480.8	517.5			

Source: Danish Farmers' Unions (Table 13), 1996.

The Danish pig industry has also evolved into a highly concentrated sector of the Danish economy. More than 24,000 full- and part-time farmers supplied 19 million pigs to slaughterhouses in 1995 (see Table 4). Two percent of these suppliers marketed over 5,000 head. Less than half of all Danish producers are responsible for about 90 percent of total pigs marketed.

Pig production doubled from 1975 to 1995, and much of this increase could be attributed to improved breeding and production technology during this period. A small percentage of all pigs are now produced and processed under an ISO 9000 process quality certification program, but most packers are waiting to see whether the market will pay for the additional effort involved. All hogs are traced back to source.

For many years, EU policies kept grain prices in Denmark artificially higher than world prices, and meat prices were higher by an amount roughly offsetting the higher grain prices

Table 4. Pig supply in Denmark, by number of suppliers and pigs, 1975-95

Pigs per Supplier	1975		1985		1995	
	Percent of Suppliers	Pigs	Percent of Suppliers	Pigs	Percent of Suppliers	Pigs
1 - 200	83.7	37.7	68.1	12.3	49.4	3.7
201 - 500	12.2	32.7	15.1	16.7	14.8	6.3
501 - 1,000	3.2	18.9	8.9	21.7	12.1	11.4
1,001 - 2,000	0.7	8.1	5.8	27.5	12.1	22.4
2,001 - 3,000	0.1	1.9	1.4	11.7	5.5	17.5
3,001 - 4,000	-	0.4	0.4	4.9	2.5	11.3
4,001 - 5,000			0.1	2.2	1.4	7.9
5,001 - 10,000			0.1	2.5	1.8	15.2
10,001 and over			-	0.5	0.2	4.2
Total suppliers (1,000)	78.5		47.9		24.1	
Total pigs (million head)		9.1		14.0		18.6

Source: Danske Slagterier 1995.

(according to OECD, there was an 8 percent difference between world and internal EU prices in 1991-93). In the last few years, EU and GATT reforms have reduced both grain and meat price enhancements to near zero. 1996 EU grain prices were kept lower than world prices temporarily by restricting exports when grain prices spiked up.

Environmental Policies

A number of environmental regulations have been implemented to ensure the preservation of the environment in the face of the continuing expansion and growth in pig production. Farms that store manure are required to have enough storage capacity to conform to rules regarding the spreading of manure and its use as a fertilizer.

The harmonization rule is prescribed specifically for this purpose. To balance herd size with the amount of land available for spreading of manure, a harmony threshold of 1.7 livestock units per hectare (2.54 acres) was established. For pig farms, a livestock unit is defined as three sows and their piglets or thirty fattening pigs (Danish Farmers' Unions, 1996). The spreading of manure from more than 1.7 livestock units per hectare was not allowed, and farms with more than

1.7 livestock units had to find outlets for their surplus manure at other farms. Larger hog operations have to own enough land for all manure, while smaller ones need only own a portion of the land required. This clearly makes large hog operations very capital intensive.

In 1995, more than half of the pig farms in Denmark had more than 1.7 livestock units (Table 5). However, there is variation among regions regarding compliance with the

Table 5. Livestock density^a and harmony threshold on pig farms, 1994-95

	1994			1995		
	< 1.7 LU per ha	>1.7 LU per ha	All	< 1.7 LU per ha	> 1.7 LU per ha	All
Number of Farms	6,488	5,289	11,777	5,707	5,241	10,948
Livestock units	317,767	667,179	984,946	316,461	681,605	998,066

Source: Danish Farmers' Unions (Table 16) 1996.

^aLU = Livestock units.

harmonization rule. Between 40 percent and 70 percent of farms have livestock units below the threshold in the different regions (Danish Farmers' Unions, 1996). Recently, environmental rules have changed; they now establish the limit on hog production per hectare by only allowing 140 kg of nitrogen from pig manure per hectare.

These policies, which favor small farms, restrict the number of farms that can be owned by an individual to three. Farmers with smaller holdings essentially have first option on land that is available for sale. Permits from the local government are required to produce more than 750 sows or 7,500 finishers.

Pig Production Costs and Productivity

Hog production in Denmark is quite efficient, probably stimulated by the high feed prices and environmental policies. Very lean pigs and high levels of sow productivity compensate to a

large extent for high feed prices. Some standard measures for Denmark follow.

- a. Weaned pigs per sow per year = 21.7.

- b. Feed efficiency = 2.72; 2.94 in finishing only. (Feed efficiency of 2.94 is an energy efficiency in the Danish Feed; Units pr. kg live weight gain equals approximately 2.75 kg of feed.)
- c. Carcass lean percentage = 60 percent via 9 probe system, adjusted lean equivalent to Fat-O-Meater is approximately 56.5 percent to 57 percent.
- d. Average daily gain in finishing = 1.64 lb. per day.
- e. Feed cost per pound of feed, finishing ration = 10.7 cents (in 1995).

Production technology employed in Denmark varies from other countries in some respects. Typical pig farm technologies are outlined in the following list.

- a. One or two site, not all-in-all-out (new ones are AIAO).
- b. Grind and feed own wheat and barley, plus soy meal.
- c. Untethered sows in farrowing crates during gestation, fully slatted floors.
- d. Wean pigs at 27 to 28 days.
- e. Wet feeding used by 30 percent, rest self feeders; little split sex, phased feeding.
- f. Artificial insemination prevalent, used all or in part by 80 percent to 90 percent of producers.
- g. Manure must be retained in pits for 9 months and spread in spring. In-and-out manure accounting is required for all producers.
- h. Labor use averages 20 hours per sow per year, 25 minutes per finisher marketed, approximately 1.5 hours per head marketed. (With new production systems the labor input is 10-15 hour per sow, including weaners to 30 kg, and 10-15 minutes per finishing.)
- i. 10 percent of young male market hogs are intact boars.
- j. Low slaughter weights at 214 lb. live weight.

Total cost of production for market hogs averaged \$1.04 per pound carcass weight, or about \$0.75 to \$0.80 per pound, live weight. Some of the components of the 1995 production cost

include:

- a. Feed cost = \$0.35/lb. live weight, mostly self-produced grain on farm plus imported

soybean meal.

- b. Building, machinery, equipment, and interest costs per pig marketed were approximately \$35.00 per pig.
- c. Waste handling costs are primarily nine-month pit storage facilities plus cost of spreading on enough land required by law to support the size of the hog production enterprise.
- d. Paid or family labor costs were approximately \$22.00 per pig marketed. Wages are quite high (near industrial levels), \$35,000 to \$38,000 for animal workers and \$45,000 for specialized workers (including 5 weeks of vacation). 1,700 hours per year is standard, and \$20.00 per hour is used in calculating family labor costs. Students getting on-farm training provide part of the labor force at lower wages. The 1997 labor rates are 110 DDK (\$16.39) per hour for hired labor and 145 DDK (\$21.61) for management labor (the family). (The exchange rate fluctuated greatly in 1997; exchange rate used is October 1, at 1U.S.\$=Dkr6.71.)

Pork Processing Structure

The rapid consolidation that occurred in the pig production sector is also evident in pork processing. Farm cooperatives now dominate the entire breeding, feed, slaughter, and distribution system, accounting for more than 95 percent of the volume of breeding stock and slaughter. Privately owned companies disappeared from the scene starting in the early 1990s, and only four companies have remained in the slaughtering business, compared with 54 in 1970 (Table 6). Membership in the cooperatives depends solely on a producer's contractual commitment to be a member and market all pigs through the cooperative for at least one year (Schrader and Boehlje, 1996). All activities of the cooperatives are coordinated by an umbrella organization called Danske Slagterier (DS, or the Federation of Danish Pig Producers and Slaughterhouses). Pig producers primarily comprise the boards that control and direct the operations of the cooperatives.

Table 6. Number of slaughterhouse companies and plants in Denmark, 1970-95

	1970	1980	1990	1993	1994	1995
Companies						
Cooperative	50	18	5	5	4	4
Privately owned	4	2	1	0	0	0
Total	54	20	6	5	4	4
Slaughter units						
Cooperative	56	34	25	24	24	22
Privately owned	4	2	2	0	0	0
Total	60	36	27	24	24	22

Source: Danske Slagterier 1995.

DS operates 22 slaughterhouses in Denmark. Pigs are priced based on the estimated meat percentage, weight deviation from the standard, and size of load. ESS-Food is a major exporting firm owned by three of the largest cooperatives who use ESS-Food to sell to large report customers collectively, but also use their own sales departments to sell directly. Tulip International is a secondary pork processor owned jointly by Danish Crown and ESS-Food. Thus, there is a mix of competitive and collaborative activities among some of the major cooperatives dominating the Danish pork sector.

Danish Crown is the largest of the four cooperatives, accounting for half of the slaughtered pigs in Denmark (Table 7). Formed in 1990, Danish Crown merged with two other companies in 1994. Vestjsskye, which merged with three other cooperatives in the last six years, accounts for over 30 percent of slaughter in its seven plants. Steff-Houlberg has the largest plant and accounts for 13 percent of slaughter. The smallest of the four cooperatives, Tican, was formed in 1978 and accounts for about 5 percent of pig slaughter in Denmark.

It appears that the pork processing sector, which accounts for 80 percent of total meat production in Denmark, has benefited significantly from consolidation. Table 8 shows that the

Table 7. Number of pigs slaughtered in Denmark by the major companies, 1993-95

	1993		1994		1995	
	Million Head	Percent Share	Million Head	Percent Share	Million Head	Percent Share
Danish Crown	9.35	49.3	9.57	49.1	9.48	49.9
Vestjsskye	5.96	31.5	6.20	31.8	5.85	30.8
Steff-Houlberg	2.78	14.7	2.78	14.3	2.67	14.1
Tican	0.82	4.3	0.89	4.6	0.96	5.1
Silkeborg	0.05	0.2	0.04	0.2	0.03	0.1
Total	18.95	100.0	19.47	100.0	19.47	100.0

Source: Danske Slagterier 1994, 1995.

Table 8. Number of slaughtered pigs and pork production in Denmark, 1970-95

Year	Slaughtered Pigs (million head)	Pork Production (1,000 tons)
1970	10.8	766
1980	13.7	1,020
1990	15.7	1,260
1995	19.0	1,581

Source: Organization for Economic Cooperation and Development 1996.

period between 1970 and 1995 saw greater than 100 percent increase in pork tonnage and a 75 percent increase in the number of pigs slaughtered.

DS, the umbrella organization of pig producers and processing firms, operates breeding, veterinary, pig research, meat research, and marketing programs. Research is funded mainly from producer and slaughter levies, and by the government (Schrader and Boehlje, 1996). The main objective of the Danish Meat Research Institute, established in 1954, is to support the competitiveness of the pork and beef industries. It supplies these industries with knowledge and services gained from its research activities. A large part of its research relates to the improve-

ment of meat quality, which has resulted in a high lean meat content and a low incidence of PSE (Danish Meat Research Institute, 1995).

Slaughter and Processing Costs

Typically, Danish plants run near full capacity, with little seasonal fluctuation in volume. Plants run at slow speeds and focus on hygiene and precision cutting to meet customer specifications. Almost all are single-shift operations, typically slaughtering 350 head per hour (650 head per hour is the fastest line speed in Denmark). The largest plant kills 55,000 head per week with five kill lines. Twenty-two slaughter plants killed almost 19 million head in 1995, an average of 863,000 head. Typical volumes of plant operations range from 10,000 to 30,000 pigs per week. Extensive boning and many small production runs for different customer specifications lead to high processing costs and more differentiated products compared to competitors. Notable features of Danish plant operations follow.

- a. High-cost CO₂ stunning is used in each plant.
- b. Very high temperature singeing of carcass hair for rind-on product marketing.
- c. Test for skatole in automated lab. Only 0.8 percent boar taint in gilts and intact boars tested.
- d. A unique nine-probe 15-measure carcass classification system measures lean meat content in each major cut to facilitate selection of cuts for various customers' needs and provides estimates of carcass lean content used for carcass merit premiums and discounts and feedback to producers.
- e. Blast chill of carcasses is typical to reduce drip loss and PSE.

There is a very low incidence of PSE in Danish pork, perhaps half of levels in EU countries where genetics and chilling systems are different. One cooperative is trying heavier carcasses without high-cost singeing for the European market.

Industry estimates from packers suggest that over half of total operating costs per head are for further processing, boning, and packaging operations performed after the basic kill and initial cutting operations. Basic kill and cut costs may be near \$10.00 to \$12.00 per head. Overall, typical operating costs are expected to be near \$65.00 per head, with extensive boning and export sales and marketing costs included. Depreciation of \$4.00 to \$5.00 per head is based

on book value; replacement costs would probably be double that amount. Danish Crown income statements show total fixed and operating costs near \$76.00 per head, including \$4.23 per head depreciation for all their operations, which includes substantial further processing.

Slaughter and processing wages in Denmark are quite high, averaging about \$37,000 per year with 5 weeks of vacation (over \$20 per hour). Skill levels are quite high.

Exports

Per capita consumption of meat in Denmark in 1995 was about 222 pounds, two-thirds of which was accounted for by pork. On a per capita basis, the Danish are the largest consumers of pork among the EU countries, consuming about 150 pounds in 1995, a 20 percent increase from 1980 (Table 9).

Table 9. Domestic consumption of pork in Denmark, 1980-95

Year	Total Consumption (million pounds)	Per Capita Consumption (pounds)
1980-84	634.9	124.1
1994	783.3	150.8
1995	784.4	150.4

Source: Danish Farmers' Unions (Table 46), 1996.

The pork export sector represents a significant part of Danish agricultural exports. With a value of 3.78 billion U.S.\$ in 1995 (exchange rate October 1; 1U.S.\$=Dkr5.55), Danish pork exports accounted for 43 percent of total agricultural exports. Between 1984 and 1995, pork exports increased by 50 percent, from 800,000 to 1.2 million tons.

1995 pork exports of 1.2 million tons comprised 77 percent of the 1.6 million tons produced in 1995. By destination, other EU countries comprise the largest market for Danish pork. Two-thirds of the 1995 volume went to EU countries, with Germany being the number one destination followed by the United Kingdom and France (Table 10). In the 1990s, Germany

Table 10. Exports of pork from Denmark, by destination, 1974-95

Destination	<u>1974</u>		<u>1984</u>		<u>1994</u>		<u>1995</u>	
	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent
Other EU countries	437	75	527	65	761	60	823	67
United Kingdom	316	54	299	37	238	19	232	19
Germany ^a	57	10	100	12	253	20	270	22
France	24	4	61	8	122	10	125	10
Italy	36	6	51	6	94	7	96	8
Other EU	3	1	16	2	54	4	100	8
Non-EU countries	145	25	284	35	503	40	402	33
USA	65	11	130	16	93	7	58	5
Japan	-	-	80	10	143	11	136	11
Other non-EU	80	14	74	9	266	21	208	17
Total	582	100	811	100	1,264	100	1,225	100

Source: Danske Slagterier 1995.

^a Figures for 1974 and 1984 are for the former West Germany.

replaced the United Kingdom as the single largest importer among the EU countries. The rest of the 1995 export volume went to other European countries (12 percent), Japan (11 percent), and the United States (5 percent).

Pork exports to non-EU countries peaked at 40 percent in 1994. The position once occupied by the United States as the single largest importer among non-EU countries is now occupied by Japan. At least 10 percent of Danish pork exports now go to Japan, virtually all of it as frozen pork.

The composition of Danish pork exports has changed considerably during the last 20 years. In 1974, bacon accounted for 40 percent of Danish exports; at present, this product accounts for just 10 percent of total pork exports (Table 11). Table 12 shows that 90 percent of Denmark's exports of bacon in 1994 went to the United Kingdom, accounting for half of the United Kingdom's pork imports. Exports of live pigs and sows went primarily to Germany.

On the other hand, the share of specialized cuts in Danish exports jumped from 12 percent in 1974 to 60 percent in 1995 (Table 11). Denmark has developed a reputation for very high-quality products and a long history of tailoring production and processing systems to customers' needs. In 1994, these specialized cuts represented 60 percent and 93 percent, respectively, of Germany's and Japan's pork imports from Denmark (Table 12).

Summary

Industry analysts suggest that the very high profits for Danish hog producers in 1996 were attributed to demand shifts due to mad cow disease. In addition, Dutch swine fever problems in 1997 further increased EU import demand for Danish pork. In 1998, hog and pork prices plummeted in response to increased production and the sharp cutback in Asian market demand which hit the export-oriented Danish pork sector especially hard.

The interesting question is the longer term production and export prospects in a policy environment freer from EU grain and meat price manipulation. Industry estimates of likely Danish production range from 23 million to 28 million head per year in the next five to ten years, with the most knowledgeable suggesting that the low end of the range is more likely, or a 1 percent to 3 percent rate of increase. Primary constraints to growth involve land and local government permits necessary for growth, but some areas in Denmark can support growth.

Table 11. Exports of pork from Denmark, by type of product, 1974-95

Type of product	<u>1974</u>		<u>1984</u>		<u>1994</u>		<u>1995</u>	
	Quantity (1,000 tons)	Percent Share	Quantity (1,000 tons)	Percent Share	Quantity (1,000 tons)	Percent Share	Quantity (1,000 tons)	Percent Share
Live pigs and sows	-	-	6	1	22	2	28	2
Sow meat	45	8	20	2	-	-	-	-
Bacon	235	41	173	21	127	10	121	10
Carcasses, fresh/frozen	7	1	0	0	25	2	37	3
Cuts	68	12	298	37	766	61	724	59
By-products	46	8	103	13	124	10	141	12
Canned meat	160	28	174	21	144	11	121	10
Other processed	17	3	36	4	56	4	53	4
Total	578	100	811	100	1,264	100	1,225	100

Source: Danske Slagterier 1995.

Table 12. Exports of pork from Denmark, by type of product and destination, 1994

Destination	Live Pigs and Sows	Bacon	Carcasses Fresh/Frozen	Cuts	Byproducts	Canned Meat	Other Processed	Total
(1,000 tons)								
EU countries	16.11	125.25	21.63	425.75	84.66	63.38	18.07	754.84
UK	-	118.58	-	55.80	24.88	33.21	5.23	237.69
Italy	0.01	0.13	-	85.14	5.94	2.84	0.10	94.16
Germany	12.49	4.01	21.55	152.38	33.26	21.37	2.09	247.15
France	0.01	1.62	0.06	97.95	10.62	2.36	9.23	121.85
Other EU	3.60	0.91	0.02	34.48	9.96	3.60	1.42	53.99
Non-EU countries	0.15	2.34	3.84	339.56	38.71	80.58	37.56	502.74
Japan	0.00	0.03	0.01	133.03	3.35	6.35	0.48	143.26
USA	0.01	0.05	-	50.78	1.33	39.59	1.44	93.19
Russia	-	0.93	1.66	30.22	5.58	14.38	16.38	69.16
Poland	0.01	-	0.50	53.21	0.81	0.17	0.01	54.70
Other non-EU	0.13	1.32	1.68	72.33	27.64	20.09	19.24	142.44
Total	16.26	127.58	25.47	765.31	123.36	143.96	55.63	1,257.58

Source: Danske Slagterier 1994.

A high cost structure characterizes Danish hog production and processing, but much leaner pigs combined with superior processing hygiene and flexibility in providing what each customer wants in EU and international markets offsets the cost disadvantage. Denmark will continue to be an effective exporter. Although export volume was expected to increase more slowly than in the last decade, the recent Dutch disease problems and planned production cutbacks there may allow Denmark to capitalize on EU market demand not filled by the Netherlands, and facilitate further Danish industry growth.

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The Canadian Pork Industry: Factors Influencing Export Market Competitive Position

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Introduction

Canada's pork industry is in a period of great change. The industry is the third largest net exporter of pork in the world, behind Denmark and the United States. Canadian pork has acquired a reputation for high quality. In the past, Canada's pork industry was characterized by a large number of small-scale producers located primarily in eastern Canada. But, between 1970 and the early 1990s, the number of pig farms decreased by over 75 percent, while the average number of pigs per farm in Canada increased sharply.

This report examines factors underlying Canada's prospect for pork export growth. They include a strong infrastructure to support production, availability of essential inputs at reasonable prices, cost competitiveness in production, high-quality pig genetics, and government environmental and regulatory policies conducive to continued expansion. Issues for the future involve: (1) industry growth prospects in western Canada; (2) implications of western Canadian growth on profitability and volume in eastern Canada; (3) costs and competitiveness of Canadian pork processors as a whole; (4) and potential changes in the relationship between Canada's pork industry and the U.S. pork industry.

Exports Overview

In 1996, Canada exported \$806.8 million in pork and pork products to nearly 70 different countries. Canada also exported \$280.1 million in live pigs, almost all to the United States. Pork product exports have increased by more than 45 percent since 1993, now accounting for approximately one-third of Canada's total pork production. Table 1 and Figure 2 show Canada's exports of pork products from 1990 through 1997. Table 3 shows the increases in value of pork products shipped by Canada to its top ten export markets over the period from 1993 to 1996.

¹ Financial support was provided by MATRIC, National Pork Producers Council, and the Iowa State University Agricultural and Home Economics Experiment Station. We appreciate the contributions of many Canadian economists to this study.

Table 1. Canadian Pork Production and Total Exports, 1990 to 1997
(In 1,000 metric tons, carcass weight equivalent)

Year	Production	Total Exports
1990	6,965	108
1991	7,257	128
1992	7,817	185
1993	7,751	197
1994	8,027	241
1995	8,097	350
1996	7,764	440
1997	7,835	474

Figure 2.

Canada's largest export market for pork products is the United States, totaling \$500 million in 1996 exports. Canada's positive net trade balance for pork with the United States in 1996 was \$402 million in exports. Canada also exports feeder and slaughter pigs to the United

Table 3. Value of pork exports to Canada's top ten markets in 1993 and 1996

	1993 Exports (U.S.\$ mill)	1996 Exports (U.S.\$ mill)	Change 1993-96 (%)	Country Share, '96 (%)
Total Exports	587.2	806.9	45.8	
United States	389.1	499.7	36.3	61.9
Japan	134.2	178.5	41.2	22.1
Russia	18.3	32.4	88.1	4.0
Hong Kong	4.7	14.5	230.0	1.8
South Korea	0.7	14.4	2,088.9	1.8
Poland	1.5	11.1	700.0	1.4
Australia	4.7	10.1	127.9	1.2
New Zealand	2.1	8.2	318.5	1.0
Cuba	6.1	5.7	-1.2	0.7
Hungary	2.3	4.2	90.0	0.5

Unless otherwise noted, all monetary figures are in U.S. dollars

Source: Agriculture and Agri-food Canada 1997, p. 8

States. In 1997, Canada exported an estimated 2.09 million slaughter pigs and 1 million feeder pigs to the United States.

Japan is Canada's number two export market for pork products. In 1996, these exports were \$178 million in value, which is more than double the level in 1993. These exports totaled 54,794 metric tons and accounted for 22.1 percent of Canada's total pork exports. Sales to Japan will continue to expand, as long as Canada's processing plants continue to get better fitted with processes and equipment to provide extended shelf-life for pork products. Japanese importers generally require a 45-day shelf-life minimum on imported pork products, and some Canadian firms now guarantee up to a 60-day shelf-life on fresh pork products exported to Japan. However, most eastern Canadian processors still have difficulties meeting this minimum requirement, because shipments from the east generally take about 21 days just to arrive in Japan and clear customs.

Canada sells many kinds of pork products to many other foreign markets as well (see Table 4). After the United States and Japan, Russia is Canada's third largest export market, growing from \$18.3 million in 1993 to \$32.4 million in 1996. Russia's country share of Canada's exports in 1996 was 4.0 percent. By comparison, next in size are Hong Kong, South Korea, and Poland, all with 1996 shares between 1.4 percent and 1.8 percent. Canada's attention to quality and cut specifications combined with a somewhat weak Canadian dollar will help offset the effects of a current economic crisis in Asian markets.

Table 4. Value and composition of 1996 Canadian pork exports, by product

	Value	Percent
	(Million U.S.\$)	
Fresh and chilled	333.5	41.3
Frozen	282.7	35.0
Processed	139.5	17.3
Offal	35.4	4.4
Pork fat	15.8	2.0

Source: Agriculture and Agri-food Canada 1997, p. 9

External conditions look promising for Canada's continued expansion in westbound pork exports. This prospect for increasing pork exports has been boosted by the 1995 implementation of the World Trade Organization (W.T.O.), and this is especially true for western Canada, where production is growing most rapidly. As tariff and nontariff barriers have been reduced by between 30 percent and 60 percent during the W.T.O. phase-in period alone, an increased access to new markets has been a result (Martin et al. 1998, p.3). In addition to the effect of the WTO, Japan has lowered some of its non-tariff protection strategies for domestic producers. Canada's ability to realize its potential for increased pork exports will depend on many factors.

Pig Production: Structure, Costs, and Issues

Between 1993 and 1996, pig production in Canada increased by about 13 percent. Pig farming still is concentrated mainly in Ontario and Quebec, where farms usually are mixed farms. Home

grown feed typically is used and wood barns often are still employed there. It is in western Canada, in Alberta, Saskatchewan, and Manitoba, that the pig population has increased sharply in recent years. This increase in the scale of pig production is taking place mainly on specialized farms which are reasonably efficient according to all standard measures. Canada has high productivity per sow (see Table 5) and comparatively inexpensive feed.

Table 5. Production, 1993-94

	Quebec	Ontario	Alberta
Litters/sow per year	2.07	2.05	1.95
Piglets weaned/sow per year	18.30	18.40	16.50
Feed conversion	3.38	3.30	3.78
Piglets born live/litter	10.30	10.40	9.80
Piglets weaned/litter	8.90	9.00	8.50

Source: Fortin and Salaun 1995, page 41

Canada's pork industry competitiveness has been boosted by its increased number of large, specialized operations. The trend in the structure of production clearly is toward concentration, although the extent of concentration differs across provinces.

Pig raising typically is the main business of Canadian farms that raise any number of pigs at all. Approximately 93 percent of pigs in Quebec and 83 percent of pigs in Ontario are on farms earning 50 percent or more of their income from pig production. For comparison purposes, the U.S. Corn Belt states average 68 percent, which is almost identical to Alberta (Fortin et al. 1995, p. 96). The corresponding percentage in North Carolina is approximately identical to the 93 percent measure in Quebec. Large regional differences (in both countries) exist with respect to this measure.

The fact that Canada's pig industry has been consolidating its production through increased farm size is important because large farms gain advantages over smaller competitors in at least two major ways: More efficient production techniques result in an increase in the unit

returns of the production base and lower unit costs for inputs. Large farms are able to generate economies of scale and greater competitive strength. In a recent study by Brewer et al., pork production costs in Alberta and Ontario are analyzed in detail (1998, p. 5) (see Table 6):

Table 6. Canadian 1995 Pork Production Costs. (U.S. \$/cwt)

	Alberta	Ontario
Variable Cost		
Feed Cost	20.12	27.03
Labor Cost	4.40	3.98
Interest	0.92	1.14
Other Var. Cost	5.41	6.21
Sub-total	30.85	38.36
Fixed Cost		
Housing Costs	8.12	8.61
Total Costs	38.97	46.97

Two important production cost variables influencing Canada's export market competitive position are eastern Canada's capital financing and depreciation costs and western Canada's situation with respect to changing feed costs.

During the early 1990s, the opportunity cost of land use for corn and barley production increased in eastern and central Canada as elevated soybean prices (which are grown largely to meet a demand for human consumption in Asia) drew acreage away from corn and barley production for pig feed. The relative cost of producing pigs in Ontario has increased on balance. Just how this relative cost comparison is to shake out in the future depends largely on what happens with the relative feed cost differences between eastern and western Canada.

The longer established eastern Canadian industry—especially in Ontario—has passed through a period of capital replacement, as many 1960s- and '70s-built barns and other structures became outdated. This fact has led to investment in new structures, such that some producers are prepared for a more modernized industrial organization of pork production. One noteworthy development from this new ability to attain more advanced production systems has been an

increased trade of live pigs from Alberta, Manitoba, and Ontario to the United States for slaughter and finishing.

An important factor influencing cost competitiveness of the Canadian pork industry is that western Canada has a relatively lower feed cost today, as compared to the recent past. This is due to a removal of a rail subsidy policy. When Canada removed its Western Grain Transportation Act on September 1, 1995, this eliminated a substantial subsidy for the transportation of many grains (including feed grains) from western Canada to the east. The overall effect was to boost the competitiveness of western Canada's pig producers through the lowered relative cost of feed with respect to eastern Canada and other countries to which Canada exports feed grains. A result has been an increased incentive for prairie producers to use grain in livestock production, rather than to receive lower grain prices due to the now comparatively higher shipping costs.

The relative price benefit for western Canada with respect to eastern Canada has been estimated to be as high as \$21.9 per metric ton of grain, which reduces the cost of pig production by \$3.65 to \$5.84 per pig produced (Agriculture and Agri-food Canada 1997, p. 25). Another estimate by J.D. Lawrence, using a 250 lb pig and 3.11 feed efficiency, finds a cost reduction of \$6.18 per head.

Pork Slaughter and Processing Issues

In 1996, Canada slaughtered 15 million pigs. This level, down from the 17 million head that were slaughtered in 1994, is in line with a trend toward a decreased percentage of Canada's pig production that is slaughtered in Canada. Approximately 15 percent of Canada's pigs currently are killed in the United States. Some detailed analysis will help in explaining the changing condition of Canada's pork slaughter and processing industry.

Slaughter Industry Structure, Scale, and Ties to the Production Industry

In 1996, Canada had 54 federally inspected pig slaughter facilities. Twenty-six of these plants slaughtered more than 100,000 pigs, accounting for 92 percent of the total national slaughter in 1996. Fourteen plants slaughtered over 500,000 pigs per annum, accounting for 73 percent of total slaughter. The five largest plants all slaughtered over 900,000 pigs, and together accounted for 35 percent of total slaughter. Of these five largest plants, one is located in Quebec, two in Ontario, and two in Alberta. Canadian packers generally are concentrated in areas

of greatest pig production: Quebec, Alberta, Manitoba, and Ontario. When measured by firms, the top three firms, consisting of 8 plants, accounted for 47 percent (7 million pigs) of the total Canadian pig slaughter in 1996.

Canada's slaughtering industry is on a comparatively much smaller scale than the U.S. slaughtering industry. An Appendix Table shows the estimated weekly slaughter capacity of Canada's plants. While many U.S. plants kill up to 1,200 head of 255- to 260-lb. pigs per hour, a typical high-output Canadian plant kills 800 lighter weight, 235 to 240 lb., pigs per hour.

In 1996, Canada's pig processors produced 1.23 million metric tons of fresh and frozen pork. Processing was conducted in 90 percent of Canada's 54 federally inspected pig slaughter facilities. Canada's pork products are marketed either wholesale, as cuts such as loins and bellies, or retail, as cuts such as roasts and chops. A substantial amount of the cuts marketed wholesale are sold to some 350 further processors in Canada, who make these cuts into many cured, smoked, canned, or cooked products, such as hams, bacon, sausages, and delicatessen meats. Pork by-products, including lard and other rendered products, generally are sold to industrial users or to international trade brokers.

Costs and Issues Within Slaughter Companies

At least six major factors affect per unit processing costs in the pork slaughter and processing industry. They are: (1) economies of size; (2) technology of plants; (3) number of shifts; (4) labor costs; (5) carcass size and leanness; and (6) regulatory costs.

Other than the cost of pigs, most pork processing costs are fixed or quasi-fixed. As plants become larger, the quantity of throughput increases faster than does the quantity of inputs. A worker can produce more product per hour in a larger plant than in a smaller one. Investment per a given weight of production is lower in larger plants than in smaller ones; fixed and quasi-fixed costs are spread over more units of output.

Plant capacity essentially equates to line speed, which is the maximum number of carcasses that a production line can process in an hour. Current technology allows many new Canadian plants to operate at line speeds up to about 1,000 carcasses per hour, though only a few Canadian plants are able to operate at line speeds up to about 1,200 to 1,300 carcasses per hour. Most of North America's plants with this kind of a capability are located in the Upper Midwest United

States, where they compete with Canadian plants for Canadian pigs.

Canada has built some new plants in recent years, especially in western Canada. However, to date none of these plants has been built to the scale of the most efficient U.S. plants, although plans for such plants have been rumored. Withstanding the fact that a Taiwanese company (Yuan Li) that is a major pork exporter to Japan recently canceled plans to build a 5,000-head per day pig packing plant in Lethbridge, Alberta, the western Canadian provinces are still expanding in their slaughter capacity. Maple Leaf Meats is converting a Lethbridge beef plant into a pork processing and export facility that will process 5,000 to 6,000 head of 280-lb. pigs per week for the Japanese market. By comparison, the average slaughter weight in Canada as a whole is 237 lbs. in Canada, and is 260 lbs. in U.S. Schneider's new plant in Manitoba. Fletcher's plant in Alberta is completing expansion to handle 2.4 million head per year. Intercontinental Packers in Saskatoon, Saskatchewan, also is expanding slaughter capacity. Maple Leaf closed an obsolete plant in Edmonton, Alberta (after a United Food & Commercial Workers strike) in 1997, and began construction on a plant in Brandon, Manitoba. With one shift and an output of up to 1,200 head per hour, the Brandon plant will slaughter 45,000 head per week.

Labor costs are very important to the competitiveness of the pork processing industry. The highly labor-intensive nature of several aspects of meat processing means that differences in wage rate structures can significantly influence cost competitiveness. In the United States, the processing industry went through a period of change during the late 1980s and early 1990s, when wage rates were cut substantially. The current average total wage cost for U.S. plants is estimated to be \$12.26 per hour, whereas the average wage for Canadian plants is about \$15.91 per hour. In addition, benefits are estimated to average 32 percent to 33 percent of wage rates in the U.S. and 37 percent to 38 percent of wage rates in Canada (Martin et al. 1997, p. 14). Canada's red meat industry as a whole has a 30 percent lower labor productivity than the U.S. industry, due to the combination of higher wages and slower plants.

The number of shifts maintained by a plant is another important cost factor. When a plant moves from one to two or more shifts, fixed costs are able to be spread over more units of output, meaning that average processing costs decline. Whereas a majority of U.S. plants are

double shifted, none currently are in Canada. Some approximation has been made of the effect of multiple shifts on costs. Hayenga (1997) indicates that the range of total variable costs per head for pork slaughter plants in the United States was \$20 to \$25 in 1997, with an average of \$22. Fixed costs per head were \$3 to \$10, with an average of \$6. This study investigated the effect of double shifting on plants and found that variable costs were reduced on average by \$2 per head and fixed costs were reduced on average by \$3 per head.

By extension, some approximation of the potential effect of double shifting on Canadian plants can be made. By first converting to a Canadian carcass basis (with an assumed Canadian carcass weight of 86 kg), estimated savings for a Canadian packer would be in the neighborhood of \$3.61 per 100 lbs. of product by moving to a double shifted plant. Effects of different plant sizes would be another important factor involved here, but they have not been separated out (Martin et al. 1997, p. 16; 1998, p. 21).

Compared to the United States, less flexible allowances usually exist in Canada for the number of hours required per week. U.S. employees generally need to be paid only for the hours that they actually work (although some groups of employees do have 32 or 36 hour per week guarantees), which means that U.S. labor costs are lower during weeks that have seasonally low runs of pigs. By contrast, union contracts in Canada generally require that employees be guaranteed 37 hours of work per week. Therefore, because Canada's employees typically are paid whether or not a plant operates at full capacity, Canada's unit costs are more affected by capacity utilization rates than are unit costs in the United States.

Another minor issue involved in labor costs is that Canada's labor contracts feature some work rules (e.g. workers' compensation) which can further exacerbate the labor cost differential between Canada and the United States. Canada's work rules mandate that processors pay overtime when they have a weekend run and they often prevent processors from hiring additional temporary labor at full-time wage rates in order to staff any temporary increases in workload.

Much of the potential growth in Canada's pork processing industry will continue taking place in western Canada, where pig industry growth is greatest. It happens that this growth also will be taking place where general economic growth is fastest and unemployment rates the lowest.

The Canadian pork processing industry faces the unique challenge of competing with the U.S. pork processing industry internationally while simultaneously facing tough domestic competition for labor with other industries.

Another important cost factor is that Canadian pigs are slaughtered at lower weights than U.S. pigs. The higher the weight of a carcass, the more pounds of pork are produced, and the lower is the associated overhead cost per a given weight of product. Current U.S. slaughter pigs average about 255 lbs. (118 kg) live weight, whereas Canadian pigs average 235 to 240 lbs. (106.5 to 109 kg) live weight. On a carcass basis, the average Canadian slaughter carcass has 15 to 20 lbs. (about 6.8 to 9.1 kg) less pork than the average U.S. carcass. Because plants are set up to process a carcass as a unit, a Canadian plant with capacity of 20,000 to 30,000 pigs per week produces 7,250 to 11,000 lbs. less pork per week simply because of the fact that Canadian pigs are smaller. The slaughter cost per a given weight of product therefore is higher. This weight difference may remain a long-term issue, because the solution is not as easy as to just raise Canadian pigs to heavier weights. As pigs get larger, they have a tendency to get fatter and meat quality declines. Moreover, as carcasses increase in their amount of fat, processing costs may actually rise at some point because more is spent on trimming. Trim also has less value than lean meat. Pig weights must be increased gradually, by altering genetics and feeding programs in order to maintain carcass quality. Canada is recognized for the leanness of its pork products. At present, Canadian pigs average a 56% lean carcass content.

Food inspection procedures promote Canada's ability to export. But although food inspection is a benefit to consumers that the W.T.O. rules deem the cost to be an expense that governments can pay without trade penalties, Canada yet has chosen to pursue cost recovery in this area. Inspection presently increases the relative cost of processing for Canadian processors by about \$0.20 to 0.25 per pig. This is a cost that could increase if more inspection-related regulatory concerns might happen to arise.

Can Canada's pork processing industry get more competitive? Martin et al.'s 1997 work suggests that, to some extent at least, it can. Increasing plant size from a capacity of 20,000 per week to a capacity of either 30,000 or 40,000 per week, and also adding a double shift, can bring

costs per unit down significantly. The estimated benefit of double shifting varies somewhat, depending on the assumed amount of overhead cost to be spread across a greater output. The effects of moving to higher capacities and to double shifts are additive, which means that the total savings attained by moving, for example, from a 20,000 head per week single shift operation to a 45,000 head per week double shift operation is \$5.59 per 100 lbs.

The difference between the United States and Canada in carcass weight has a substantial impact; for by spreading the manufacturing costs over the lower weight of output that Canada's lighter weight pigs represent, Canadian manufacturing costs are increased over U.S. costs by about \$1.70 per 100 lbs. in a 20,000 head per week plant and by about \$.96 per 100 lbs. in a 40,000 head per week plant. The effect of this higher cost is greater in small plants than in large plants (Martin et al. 1997, p. 18).

Some approximation also has been made of the effect of wage differentials. With independent estimates finding that wage costs in Canada are 40 percent higher than wage costs in the United States, reducing wage costs to the level estimated for the United States would reduce Canada's total processing costs by \$3.30 per 100 lbs. of carcass (Martin et al. 1997, p. 18; 1998, p. 21).

All told, most of Canada's pork processing plants are at a significant cost disadvantage. It is estimated that these factors add up to a \$9.08 per 100 lbs. higher cost than what is attainable with modern plants and equipment combined with lower wage costs, double shifts, and larger animals (Martin 1997, p. 21). Assuming that U.S. pork processing plants meet all of these criteria, Canadian costs thus are \$9.08 higher per 100 lbs. than the U.S. cost of \$23 to \$28 per 100 lbs. (Hayenga 1997). This makes Canada's processing costs \$32 to \$37 per 100 lbs., for an average of \$34.50. Putting this into still one more perspective, Canada's processing cost disadvantage represents in excess of 10 percent of the current price of pigs in the 1997 marketplace.

Canada's Marketing System

An important factor to consider is the extent to which marketing strategies might be able to offset some permanent cost disadvantages. Marketing of high-grade pork products in Canada is partly controlled by provincial pig marketing boards, such as the Ontario Pork Producers

Marketing Board, which was developed to protect eastern Canada's industry from vertical integration and to enable market access for smaller-scale producers. Pig producers generally have been obligated to trade their pigs through such boards, though this is changing. These boards often have central selling desks, such that each province has its own system for organizing the centralized purchase and sale of pigs. These "single-desk selling" agencies collect pigs, participate in delivery of pigs to packers, price and settle deals, collect stabilization payments, and conduct lobbying and industry promotion. Pig pricing is based on each province's carcass premium/discount matrix, and grading is done by federal inspectors.

The range of possible futures for Canada's marketing boards is interesting. On the one hand, as these boards have been criticized as less than appropriate for current conditions, "dual marketings" for pigs has been introduced. As a result, many producers now have their choice between marketing their pigs through a provincial marketing board or through private contracts with processors. On the other hand, if Canada wants to emphasize a premium on quality as an angle on attaining a permanent market niche, then such boards likely can be useful. A strong trade association, Canada Pork International (CPI), is getting more involved in working with experienced pork packers and traders in opening new export markets. It is possible that some national-level oversight of quality differentiation of Canada's pork products from other nations' pork products might become more a part of the CPI's focus.

Since 1969, when the Canadian Carcass Classification and Settlement System was established to provide a national standard for weight and leanness categories, meat quality determination and grading has been an important government role. In 1986, Canada became one of the first countries to implement a national pig carcass classification system, employing electronic grading probe technology to value carcasses on the basis of objective measurements of fat and muscle content. Prices to producers were based on the carcass meat yield content. In 1992, the Canadian pork industry and Agriculture and Agri-Food Canada determined that the average meat yield for carcasses and cuts was 6 percent to 7 percent greater than in 1978. The 1992 cutout yield averaged 52.35 percent lean yield. Recently, industry estimates suggest lean

yields are averaging near 56 percent.

Regulatory Issues and Other Policy Rules Affecting Costs

The most fundamental part of the environment issue is the question of how much pig production can be sustainable. In order to be sustainable, the pig production industry must be land based, such that the manure from the animals is used to provide the nutrients for the land that produces the crops that feed the animals. Many regions in central and western Canada and the United States have enough available land to be a sustainable location for pig production. Western Canada, for example, has 86 million acres of land available for crops, which include areas under crops and summer fallow. Only 540 thousand acres of this are presently being fertilized with pig manure (Martin et al. 1998, p. 23).

Canada's pork industry faces others environmental issues as well. For one, while Canada's export of live pigs to the United States for finishing and wholesale cuts for further processing have been increasing over recent years, Canadian packers were not able to buy U.S. pigs, because of Canada's health restrictions to protect against pseudo-rabies, a swine disease that occasionally occurs in the United States, but that Canada does not have. This barrier has been removed for some slaughter pigs that are moved directly to Canadian plants.

New environmental policies appear ready to be implemented at the federal level. The Canadian Pork Council (CPC) has developed an "Environmental Code of Practice" to complement existing provincial codes. The CPC also is developing a Quality Assurance Program to address reduction in physical, chemical, and biological hazards in product quality and production integrity. In regions where a high concentration of pig production already is the case—especially in areas of Quebec environmental standards are increasingly being established to protect streams and ground water from contamination caused by pig manure.

Canada is recognized for having one of the best food inspection and hygiene/quarantine systems in the world. Only meat products that originate at plants inspected by the Canadian Food Inspection Agency can be shipped outside provinces.

Summary

Canada traditionally has been a net pork exporter. In 1993, they shipped \$587.2 million in pork exports, and in 1996 they shipped \$806.9 million in pork exports. Although Canada has

more recently been losing export market share, Canada's pork industry does have a great opportunity in the world market. A growing demand in Asia and a supply of low cost feed in western Canada both contribute to this prospect. Ample grain and low population density provide an especially good prospect for industry expansion in the prairie provinces. However, Canada's pork industry lags the U.S. industry in labor as well as capital productivity in the processing industry. Wage rates are significantly higher in Canada than in the United States, and they are likely to stay higher for the foreseeable future.

The possibility exists that the western Canadian pig industry could double in size of production within a decade (Prentice et al. 1997, p. 1). Processing capacity is increasing there, and it is capable of attaining scales of operation that could bring costs somewhat closer to those in the United States. This change should enhance the long-term ability of Canada to increase pork production and become more competitive in Asian export markets. The prospect for increased international trade for Canadian pork products depends on: (1) western Canada's growth in production; (2) increasing the competitiveness of the processing industry as a whole; and (3) the degree to which consumers in export markets will continue accepting traditional Canadian quality.

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Appendix Table. Estimated weekly slaughter capacity, 1996¹

<i>Province</i>	<i>Plant</i>	<i>Capacity</i>
BC		
	Britco	4,000
Alberta		
	Fletchers	25,000
	Gainers	20,000
Saskatchewan		
	Intercontinental	20,000
Manitoba		
	Moose Jaw Packers	6,000
	Burns	14,000
	JM Schneider	18,000
	Springhill Farms	12,500
	Forgan	4,000
Ontario		
	Maple Leaf Pork	32,000
	Quality Meat Packers	25,000
	Conestoga	2,000
	J.M. Schneider ²	20,000
Quebec		
	Olymel-Valley Junction	27,000
	Olymel-St. Valerien	21,000
	Olymel-Princelville	13,000
	Olymel – Total	61,000
	Brochu	20,000
	Du Breton	11,000
	Trahan	6,000
	St Alexander	5,500
	Laurentide	5,000
	Agromex	5,000
	Jolibel	3,500
Atlantic		
	GPM (Maple Leaf)(PEI)	5,000
	Hub (NB)	5,000
	Larsen (NS)	5,000
	Antigonish (NS)	300
Total Capacity		325,600

¹ There are additional plants, especially provincially registered, whose capacities are not known.

² This plant closed in late 1996.

Source: Martin et al. 1997, page 13.

**The United States Pork Industry:
Factors Influencing Export Market Competitive Position**

Marvin Hayenga, David Seim, John Lawrence, and Roxanne Clemens¹

Introduction

The United States is undergoing major structural change in its pork industry. This transition will affect the ability of the pork industry to compete in the world market. Pig production, slaughter, and processing traditionally have been concentrated close to areas of surplus feed production, which is in the Corn Belt states in the upper Midwest. Recently, growth in production has occurred in areas outside the Corn Belt, especially in North Carolina, Kansas, and Oklahoma, where environmental regulation was less restrictive and labor cheaper, compared to the non-Corn Belt states.

The level of U.S. pork exports and the percentage of production shipped as exports have risen steadily during the last decade. The crucial questions for the future are: (1) whether the trend toward increased exports will be only temporary or the result of a longer-term competitive advantage; (2) what is the U.S. industry doing, and capable of doing, to promote longer-term competitive advantage; and (3) will the relative prices of grains for production and economies of size in the slaughter and processing industry emerge as major factors determining the competitive position of the U.S. pork industry in the global market?

Exports Overview

U.S. pork exports have been on an upward trend since the late-1980s (see Table 1 and Figure 2). Total exports in 1997 were 474,000 metric tons, or about 6 percent of total production. A portion of the recent increase in U.S. pork exports is a result of multilateral trade agreements such as NAFTA and GATT.

¹ Financial support was provided by MATRIC, National Pork Producers Council, and the Iowa State University Agricultural and Home Economics Experiment Station. We appreciate the contributions of many U.S. economists to this study.

Table 1. U.S. Pork Production and Total Exports, 1990 to 1997.
(in 1,000 metric tons, carcass weight equivalent)

Year	Production	Total Exports
1990	6,965	108
1991	7,257	128
1992	7,817	185
1993	7,751	197
1994	8,027	241
1995	8,097	350
1996	7,764	440
1997	7,835	474

Figure 2.

A number of independent estimates agree that U.S. pork exports have a potential to increase significantly during the next 10 years. The USDA projects that U.S. pork exports in the year 2005 will be about double those in the recent past. The Food and Agricultural Policy Research Institute projects an increase to 1.025 metric tons in 2003. An export analysis made country by country, and which takes into account the different cuts that are expected to be preferred for consumption in different export markets, suggests that total U.S. exports will reach

1.8 million metric tons by 2007 (Iowa's Pork Industry 1998, p. 12). This projected level is equivalent to about 24 percent of current production. Trade with China, which is not included in this latter estimate, could even double the level for 2007.

The largest export market for the United States is Asia, especially Japan. In 1997, Japanese pork imports totaled 514,000 metric tons (product weight equivalent). To partially replace a decrease in available fresh and chilled pork after Taiwan ceased exporting pork products because of foot-and-mouth disease, Japan turned to domestic producers as well as to the United States, Canada, and South Korea. The outlook for total 1998 exports to Japan predicts a 5 percent increase in pork shipments, to 540,000 metric tons. Denmark is expected to supply 160,000 metric tons of this, which is up 8 percent from their 1997 exports to Japan. The United States is expected to supply 145,000 metric tons, which is up 6 percent from their 1997 exports to Japan.

The following analysis will address a number of factors affecting the competitiveness of the United States in exporting pork products.

Pig Production: Structure, Costs, and Issues

U. S. pork production is a competitive industry that has long been a profitable farm enterprise. Farms with pigs historically have been profitable relative to other types of farms. On farms in the Corn Belt states, pig production has been a value-adding enterprise, building on available grain supplies and utilizing available labor on a year-round basis.

U.S. pig production operations exhibit wide variation in size. Nationally, in 1996, farms with at least 1,000 head numbered approximately 12,000. The average of all pig-farm states is 67 percent of inventory in operations over 1,000 head. North Carolina has the largest size operations, with 25 percent of the state's operations 1,000 head and over in 1996. Furthermore, 92 percent of the state's inventory was in operations of 2,000 head and over. No Midwest state (including Iowa, Minnesota, Illinois, Indiana, Nebraska, and Missouri) had more than five operations in the 2,000 head-and-over range.

Preliminary results from a recent study show that average size and variation in size of U.S. pig producers both have increased tremendously over the last 10 years (Grimes and Lawrence 1998). In 1988, 32 percent of U.S. total pig marketings were by producers under 1,000 head. At

the other end of the scale, 7 percent were marketed by producers over 50,000 head. In 1997, 5 percent of U.S. total pig marketings were by producers under 1,000 head, while 36 percent were by producers over 50,000 head. In addition, 11 percent of 1997 total pig marketings were by producers over 500,000 head. North Carolina is the leading state in number of large-scale producers.

The changing scale of pig production relates to a change in the location of production operations. Midwest states stretching from South Dakota to Ohio have, in aggregate, lost approximately 20 percent of their pig inventory between 1992 and 1996. The exceptions are Minnesota and Missouri. North Carolina's pig inventory has increased dramatically, and some other states in the southeast and southwest have also experienced significant increases in pig inventories. One major factor involved in the Midwest's inventory decline is a decline in breeding herds. In Iowa, for example, which for nearly 40 years produced approximately one-fourth of all the pigs in the country, the sow herd has experienced a marked decline. While Iowa's pig inventory in December 1996 was 18 percent smaller than in December 1992, the breeding herd was 26 percent smaller. By comparison, over this same period the average decline in pig inventory in the United States as a whole was 3 percent, with an average decline in breeding herd of 6 percent. In the western states of Oklahoma, Utah, and Wyoming, large increases have been posted in breeding herds, as large-scale producers moved to previously pig-sparse regions. North Carolina more than doubled its breeding herd inventory since 1992. In fact, for the period September 1996 to September 1997, North Carolina for the first time farrowed as many pigs as Iowa did.

How and why has so much expansion occurred in corn-deficit regions? Some major elements toward a complete answer include the following: (1) less strict environmental constraints; (2) bulk grain-purchasing ability; (3) technologically advanced production systems; and (4) the construction of high-speed feed mills. Assisted by advantages in all of these factors, producers in North Carolina and some western states have attained an average feed cost per pound that is able to compete with the midwestern pig producer's average feed cost per pound (although it is not yet equal to the Midwest).

The primary remaining comparative advantage for the Corn Belt states is in finishing pigs

that are farrowed in other states. In 1994, Iowa processed approximately 32 percent of the nation's pigs, and by 1996 that share had fallen only to 29 percent. But, while Iowa's pig numbers declined as production facilities expanded and increased outside of the state, feeder pig shipments into Iowa grew rapidly. It is cheaper to ship feeder pigs from the east and west to the Corn Belt for finishing, than it is to ship corn from the Corn Belt states to pigs in the east and west. From January through April of 1998, 2.7 million pigs entered Iowa. Many of them (731,000) came from Missouri, which sent 2 million head in 1997 (which was twice the number of any year in the 1980s). By continuing at the current pace, Iowa will receive more than 8 million pigs in 1998, compared to 6.6 million in 1997. This will equal approximately one-third of all pigs fed in the state. Iowa's pork output from its 11 packing plants that process at least 2,500 pigs per day consequently continues to hold at over one-fourth of the U.S. total.

It makes sense that among the different types of operations monitored by the Iowa Farm Business Association, farrow-to-finish operations in the Corn Belt received the highest net farm income and return on owner equity over the ten-year period from 1986 to 1995. Based on Iowa State University Swine Enterprise Records cooperators, return to operator inputs (family labor, management, and capital) has averaged \$30 per head over the last 10 years. But the average has declined over this time, from about \$35 per head over the first half of the period, to \$25 per head for the last five years in the period that was studied.

An important current trend in pig production is the increased employment of three-site production systems by modern swine operations; sows are located on one site, early-weaned pigs are located on a second site, and finishing pigs on a third site. Larger units are required at all three stages if the benefits of this type of production system are to be maximized. Multi-site production is applied especially by large firms, who often have their own feed mills and trucking fleets as well. A number of the larger pig production operations also have their own rearing farms, slaughterhouses, and packing plants. When analyzed along the three-site division of production systems, approximately 10 percent of the necessary feed to produce a market pig is consumed by the breeding herd, 10 percent in the nursery, and 80 percent to finish the pigs to slaughter weight (Iowa's Pork Industry 1998, p. 8).

One angle on how the Corn Belt states can attain future success in the pig industry

involves a weighing of the price disadvantage in exporting competitiveness resulting from higher center-of-continent transportation costs against the benefits of feeding the grain to Midwest livestock and shipping already-processed, closely-trimmed boneless meat cuts to consumers in other states and countries. The Midwest's clear advantage is in adding value to the raw commodity and producing and shipping the lighter-weight, higher-value finished product, rather than shipping the raw feed-grain commodities. Given comparable investment in technology across U.S. regions, lower feed prices should win out.

Pig farm operations across the United States exhibit a wide variation in costs of production. For one relevant example, the top one-third largest specialized production units in the United States are identified to have a \$3.60 advantage in total cost per hundred pounds of liveweight pigs produced, when compared with an average producer in the Midwest (Iowa's Pork Industry 1998, p. 17).

Approximately 60 percent of the total cost of pig production is feed cost. Corn is the single largest expense in pork production. Corn prices in Iowa, Minnesota, and southeast South Dakota are the lowest among leading pig producing states. A number of soybean processing facilities also are in the region, which provide low-cost access to the second-largest feed expense item. Depending on the size of the harvest in these three states, 50 percent to 75 percent of the corn and soybeans are exported out of state as raw commodities, where much of this grain is used to feed livestock and poultry in other states or countries. However, the combination of a comparatively inexpensive price for feed grains with a competitive pig market does not guarantee success in today's pork industry.

A higher price of an input partly can be overcome by using less of it. Analysis indicates that states with higher feed-grain prices can achieve a feed cost per pound of pork that is comparable to such costs in midwestern states. Research by Good and Hurt showed lower feed cost per pound of gain in North Carolina than in the Midwest, despite \$0.39/ bushel higher corn prices in North Carolina (Iowa's Pork Industry 1998, p. 14). This efficiency gain partly is attributed to high-speed feed mills that lower feed processing costs, pelleted feed systems, lighter pig slaughter weights that improve feed conversion, and increased reproductive performance that

produces more pigs per sow and per pound of sow feed.

Larger production operations that have adopted advanced production and management technologies report higher reproductive efficiency than smaller operations. In 1995, in Iowa, average litters per sow per year was 1.90 for all producers and 2.02 for the top 10 percent of producers in terms of size. For “mega operations,” the measure was 2.31. When looked at in terms of pigs per sow per year, the same basic difference is seen—the averages were 18.71 for the average of all Iowa producers, 20.50 for the top 10 percent of Iowa producers, and 23.47 for mega operations. Mega operations had a 15.76 percent loss to death, while Iowa’s top 10 percent of producers had a 16.67 percent loss to death, and the average of all Iowa producers was at 18.17 percent loss to death (Iowa’s Pork Industry, p. 17). This kind of improvement in production efficiency is used especially by large producers in non-midwestern states to overcome feed price and pig price disadvantages relative to the Corn Belt states. An awareness for the future must be that those firms that combine technology/ management to achieve improved feed efficiency with locations in low corn price regions can likely attain a position of a decided competitive advantage.

The central point is that overhead cost is another important factor determining the degree of productive efficiency in an operation. The major way to reduce fixed cost (such as facility maintenance, feed processing implements, manure handling equipment, property taxes, and salaried employees) on a per unit basis is to generate more throughput from the same assets. A key measure of this relationship is the number of pigs produced per sow per year. A related measure is the number of pigs produced through the system. Increased pigs per litter and increased litters per sow reduce the overhead cost per pig produced. Regional differences in the relationship between pigs weaned per litter and operation size are important. Similar is the relationship between litters per sow per year and operation size. North Carolina leads the Midwest states on these two measures. Of the Midwest states, Kansas leads in these measures.

Climate and soils in the upper Midwest provide advantages as well as disadvantages relative to other states. Midwest facility costs typically are higher compared to those in warmer and drier climates. Buildings must be built with footings below the frost line to insulate better and to withstand heavier snow loads. Also, construction can be performed only during part of the

year, further increasing costs slightly. Seasonal effects on operating costs approximately balance between regions; whereas Midwest operating costs typically are higher in the winter, mostly due to supplemental heating costs, they typically are lower for keeping the building cool in the summer.

In a recent study, Brewer et al. (1998, p. 5) have added up the many costs of production for average Midwest and large Midwest producers:

Table 3. Comparison of Pork Production Costs (U.S. \$/cwt)

	Average MW	Large MW
Variable Cost		
Feed Cost	25.47	22.75
Labor Cost	4.42	3.45
Interest	1.54	1.39
Other Var. Cost	5.63	5.94
Sub-total	37.06	33.53
Fixed Cost		
Housing Costs	6.22	5.50
Total Costs	43.28	39.03

Brewer et al. also identify that U.S. pig leanness is 46.3 percent carcass lean content for average-size Midwest production operations and 50.64 percent for large-size Midwest production operations (Brewer et al., 1998, p. 14).

Overall evidence is strong that the trend toward larger production operations (with larger finishing units) will continue for the foreseeable future. The pig production industry appears capable of attaining increasing returns to scale through all increases in sizes of operations that have been studied so far (Houghton 1998). While large, specialized pork production units have achieved certain production cost advantages over average and smaller-size producers, operations of various sizes can be competitive. Such competitive success will require management approaches that are effective, as well as technologies that are efficient, to an operation's size. Many different technologies have cost impacts that have been quantified, as Table 4 shows. In

addition to technologies, some other adjustments likely will be needed as well, such as networking for smaller operations with 100 or fewer sows to gain marketing advantages (Iowa's Pork Industry 1998, p. 17).

Table 4. Returns for Swine Production Technologies

Rank	Technology	Impact \$/cwt	Impact \$/head	Ease of Adoption
1	SEW/AIAO	4.73	11.59	7
2	Genetics-Production	3.38	8.28	3
3	Throughput	3.09	7.57	8
4	Genetics-Revenue	2.24	5.48	4
5	Split Sex/Phase	1.79	4.39	1
6	All-In/All-Out	0.73	1.79	2
7	Network Selling	0.75	1.83	5
8	Network Buying	0.7	1.72	6

SEW/AIO is "segregated early weaning/all-in, all-out"

Source: Positioning Your Pork Operation for the 21st Century, Purdue University, 1995

Pork Slaughter and Processing Issues

The U.S. pork slaughter and processing industry is rapidly becoming more concentrated. The number of plants involved in pig slaughter is in a long-term decline. From 1980 to 1995, the number of pig slaughtering and processing firms reporting to the USDA dropped from 446 to 209 (Hayenga 1997, p. 4). The top four firms accounted for only 34 percent of pig slaughter volume in 1980, but rose to over 50 percent in 1996 (Hayenga 1997, p. 2).

Slaughter Industry Structure, Scale, and Ties to the Production Industry

Midwestern states have an advantage over other regions in slaughter and packer capacity. U.S. pig slaughter plants generally are located near a large supply of pigs. A 1994 study found that a representative slaughterer in each quadrant of the state of Iowa had five or more different supply companies for pigs within a 50 mile radius (Iowa's Pork Industry 1998, p. 23). This provides a competitive market within close proximity. Because pork prices are set in a global market, an excess capacity of slaughter plants results in pig prices being bid up by the slaughter companies (especially in Minnesota, eastern Nebraska, northwestern Illinois, Indiana, and other

Corn Belt states). An increasing number of slaughter companies are locating in North Carolina and Oklahoma as well.

A major trend in the slaughtering industry is for firms to move into more value-added processing than before. When more deboning, close trimming of external fat, and other processing are performed at the slaughter plant, the slaughter firm captures a larger part of the possible wholesale-to-retail business. In 1987, 81.5 percent of all pork left the plant as primal or fabricated products. By 1992, this level had risen to 92.2 percent. By 1998, this level is estimated to have risen still further.

Many pieces of evidence can be gathered to show that the major trend in the slaughter and processing industry is to increased concentration. The number of plants which slaughtered one million pigs per year accounted for less than 28 percent of U.S. slaughter in 1976, but rose to 87 percent in 1994 (USDA). The ten largest firms now control over 80 percent of the nation's pig slaughter capacity. By comparison, however, the pig slaughter and processing industry four-firm concentration ratio remains considerably less concentrated than the ratio for steers and heifers (at 80 percent) and sheep and lambs (at 74 percent). An implication of this comparison is that the industry might make even more movement toward increased concentration.

A related change in the U.S. pork slaughter and processing sector involves the firms that occupy the top spots in the concentration-ratio index (Table 5; see also appendix table). Smithfield Foods, currently the largest producer, was fourth in 1994 and eighth in 1990. Smithfield expanded by building the largest plant in the world, located in North Carolina, which now processes 26,000 head per day. Smithfield also acquired John Morrell plants in the Midwest. IBP, currently the number two firm, was in the top spot for several years. IBP is continuing its steady growth, for example by recently adding to plant capacity in Indiana, to more than offset the closing of its Council Bluffs plant in April 1997. Farmland (currently number six, at an 8 percent capacity share) has increased in size, whereas Hormel has decreased in size. Seaboard Farms opened an Oklahoma plant during late 1995, and they moved it to a double shift in 1997. Seaboard is planning to build a Kansas plant as well.

Table 5. Plant Capacity of the 5 Largest Pork Slaughter Firms in 1995 and 1997

1995 Rank	Company	Daily Capacity (1,000 head)	Capacity Share (Percent)
1	IBP	70.9	17
2	Smithfield	43.3	11
3	Monfort (ConAgra)	38.5	9
4	Hormel	37.0	9
5	Morell (Chiquita)	30.5	7

1997 Rank	Company	Daily Capacity (1,000 head)	Capacity Share (Percent)
1	Smithfield	80.3	19
2	IBP	72.6	17
3	Swift (ConAgra)	39.4	9
4	Excel (Cargill)	37.8	9
5	Hormel	34.7	8

Source: National Pork Industry Economic Review.

Many slaughter and packer firms are linking more closely with producers, via production and marketing contracts, or via vertical integration. Multiple motivations exist for this increased integration. Economies of size and scope likely are very significant contributors, not only to increased industry concentration, but also to increased integration. Increased volume and consistency of supply are important because of cyclical and seasonal pig production fluctuations—the 3 1/2 to 4 year pig cycle in the U.S. appears to be continuing.

A strong motivation for integration is that contracts provide high-quality pigs that can be given a trademark. As the National Pork Producers Council (Pork Chain Quality Audit) has estimated, the cost of “non-conformities” (quality product that does not attain the precise standard to meet a given product specification for a given buyer’s branding) which originate at the production level is \$10.08 per head. In addition, another \$2.32 per head of non-conformities occurs at the packing and processing levels. An economic incentive of more than 10 percent of

the value of the pig therefore exists to improve on this aspect in the pork production chain. Coordinated or integrated pork production and processing systems are methods to capture this payoff. Smithfield Foods, the largest pork processor, owns a controlling interest in one of the nation's largest pig producing firms, and also is tightly coordinated via marketing contracts with a number of large producers. Smithfield has branded pork in stores, an experienced distribution system, and plans a continued growth in integrated pork production and processing. Seaboard, long a leading poultry producer and processor, and now the seventh largest pork processor, is building a coordinated pork production system around its new processing plant in the Panhandle of Oklahoma. Other recent efforts along similar lines have been made by Tyson Foods and Premium Standard Farms.

A Packers and Stockyard Administration study of pork industry coordination systems found that packers reported buying 87 percent of the pigs they processed in 1993 on the spot market. It has recently been estimated that approximately 70 percent of all pigs actually were committed to packers through long-term contract or direct ownership in 1997 (Lawrence, Grimes, Hayenga, forthcoming). It also was estimated that 33 percent of the pigs that were slaughtered in the United States in 1997 had been produced on a contract basis.

Slaughter and packer capacity is expected to remain in excess of pig supplies in years to come. Partly because of this, even more long-term marketing contracts than most experts have predicted are being made between production operations and slaughter and packer firms. These contracts typically are written for five years or longer and can provide advantages for producers and processors. Contract providers often are processing firms that contract with three parties: sow, rearing, and fattening operations. For contract takers, who take care of labor, barns, land, and technical tools, this contract production is a way to cover price risks.

In the U.S. slaughter and processing industry, the largest contract providers are Murphy Farms, Tyson Foods, Carroll's Farms, and Cargill. Especially outside of the Corn Belt states, contracts help the slaughter industry to survive. The growth of self production, short-term production contracts, and long-term contracts have been much faster in areas such as North Carolina and the western states, where an occurrence of short pig supplies has a much greater opportunity cost than in the Midwest. Large investments and favorable supply contracts with

processors help megafirms achieve higher returns on investment than those achieved by smaller-scale producers.

Costs and Issues Within Slaughter Companies

Another major incentive for integration between pig producers and slaughterers via supply contracts or direct ties of ownership is the need to fill capacity. Capacity utilization rates can have a large effect on slaughtering and processing costs per head, as well as on pricing behavior in the market for pigs. Long-term supply contracts help reduce a packer's seasonal and cyclical variation in pig supply. When the number of pigs purchased is below 80 percent to 90 percent of plant capacity, packers often are willing to bid significantly higher prices for pigs and to haul them further distances; this is because the change in the marginal cost of killing and packing the pigs is quite low relative to expected prices for the end products. A central factor causing this is that between 60 percent to 70 percent of variable costs in the medium run are essentially fixed within the first four days of the week.

Costs of slaughter and processing firms continue to decline. The cost of pigs typically comprises 70 percent of all costs for a slaughter firm. Of the remaining costs, about 70 percent is variable costs, and the other 30 percent is fixed costs.

A survey of managers of the six largest firms and two firms with new plants was recently conducted (Hayenga 1997). For plants involved in the typical range of pork slaughter and processing functions, average estimates of fixed plant and equipment costs were \$6 per head for single-shift plants and \$3 for double-shift plants. Total costs averaged \$23 and \$28 per head for single and double shift plants, respectively. The range in variable cost estimates for individual plants was from \$16-32 per head. Typical average estimates of single shift plant costs from the surveyed firms generally were in the \$20-25 range, averaging \$22 per head. The range of the two shift estimates was \$16-25, with an average of \$20 per head. These estimates included all in-plant costs and allocation of administrative costs from corporate headquarters in multiplant operations (Hayenga 1997, pp. 7-8).

Labor costs typically make up approximately 50 percent of total variable costs in slaughter and processing firms. Approximately 50 percent to 60 percent of labor costs are for

Table 6. Processing Costs

	Variable costs (\$ per head)	Fixed costs (\$ per head)	Total costs (\$ per head)
Single shift average	22	6	28
Double shift average	20	3	23

Source: Hayenga 1997

production workers in the plant, for whom base wages are now in the \$6-10 per hour range. This is substantially lower than the peak wages paid historically, of about \$9 per hour in 1982. Labor costs per head vary in relation to the degree of automation and the extent of further processing that is done.

Fixed costs per head for plant and equipment vary in direct relation to the percent of capacity utilization. When the number of pigs purchased is too small to fully employ the workers for a guaranteed number of hours—typically for 32 or 36 hours per week—packers often are willing to bid significantly higher prices for pigs to increase their capacity and labor force utilization. The marginal costs of purchasing, slaughtering, and processing additional pigs, even at sharply higher purchase prices, can still be lower than the expected prices for the end products.

Slaughter and packer firm margins, which change seasonally as well as cyclically, have remained relatively low in recent years, as firms have fought for market share. The slaughter and packer companies' share of the farm-to-wholesale margin generally is about the same as it was in 1980, reflecting improved slaughter and packer efficiency, stagnant nominal wages, and some remaining excess capacity. For the future, increased slaughter and packer concentration seems likely in response to the economies of size, with overall efficiency likely to be enhanced, but with some potential issues raised regarding market power also likely.

Regulatory Issues and Other Policy Rules Influencing Costs

Pig industry growth adds value to a state's crops, raises farm incomes, and creates local jobs. However, it also brings increases in animal waste and odor, potential health risks and water quality problems, and property value concerns. An increasing number of rural community

development projects are being exposed to occasional major failures of the large-scale waste handling facilities that are connected with the increased scale of modern pig production. With this, public concern over the state of the nation's pig industry has increased accordingly. In fact, in some places the relationship of pigs to the environment has become a hugely controversial issue. In many areas, environmental regulations restrict location and size of pig production operations and packing plants. Both odor and water quality issues, as well as other state and local zoning issues come into play. As a consequence, growth in areas like North Carolina and Iowa is limited, and areas like Oklahoma, Utah, and Colorado are candidates for more growth.

Summary

As the U.S. pig industry attempts to expand to meet its prospect for export competitive advantage, its prospect will depend on how the different participants in pork production—producers, slaughterers, processors, shippers, and wholesalers—are able to sustain profit margins in the international competition with such other nations as Canada, Denmark, the Netherlands, and South American countries such as Brazil, Argentina, and Chile. As U.S. pig production operations attempt to expand, they must compete with producers in other states and countries. As we have seen, many factors affect success in minimizing costs and enhancing competitiveness.

In pig production, large-scale operations—which can spread fixed costs over more output—are able to attain greater feed, as well as leaner pigs. In pig slaughter and processing, economies of size also are significant. More elements in the picture are as follow:

Pork exports are sensitive to internationally implemented sanitary barriers. Recent cases are those imposed in 1997 against the Netherlands (for swine fever) and Taiwan (for foot-and-mouth disease). It has been estimated that the United States was a beneficiary of these problems, temporarily capturing approximately a \$10 per hundredweight advantage (Iowa's Pork Industry 1998, p. 10). In the future, it will remain difficult to predict just where and when disease outbreaks will occur. But these impacts can clearly help or hurt each country's export position dramatically.

The long-term level of pork product exports will be determined partly by the balance

between exports of grain to countries that use it as feed for domestic pigs versus exports of pork products to these countries. The nature of this tradeoff will depend on a comparison of the cost of transporting bulk commodity feed grains against the cost of producing and shipping the meat. If importing grain makes more economic sense for customers like China than importing pork, then U.S. pork exports will not grow as much.

Another key variable is how the strength of the U.S. food transportation sector can boost the prospect for pork export growth. The cost of supplying meat from midwestern states to Asia is now less than 20 cents per pound (Iowa's Pork Industry 1998, p. 11). This is mainly due to the quality of the U.S. center-of-continent to coastal-region transportation system. Low feed costs coupled with some of the highest live pig prices and a first-rate rail system make Midwest states an especially attractive base for new export-oriented pork production.

Finally, a nation's exports always will be sensitive to fluctuations in the value of its currency. Exchange rate movements can greatly alter a foreign importer's decision about whether or not to buy U.S. pork. In the mid-1990s, the weak dollar helped to keep U.S. prices down in most other countries. But these rates are capable of turning around and becoming a significant competitive disadvantage for an extended period of time. Economic downturns in major customer countries (e.g. southeast Asia in 1997 and 1998) can also affect export volume temporarily.

In summary, U.S. pork production has been expanding and becoming more cost competitive. Production and processing costs are low, and lean composition of U.S. pig carcasses has been improving; though it remains significantly behind many competing countries. The present average pig leanness for all production operations is very close to 50 percent, with many large-scale operations between 53 percent and 55 percent lean. While the pork slaughtering and processing is very large scale and efficient in the United States, it is not as export-customer oriented yet as its leading competitors. To assure strong and appropriate patterns for growth, the U.S. needs to: (1) have the relative costs of transporting meat and feed grains remain steady; (2) maintain competitive production and processing costs and quality; and (3) deal with any increasing sanitary requirements or disease outbreaks which might adversely affect U.S. pork exports. In addition, rising social and environmental concerns could make it comparatively more difficult for large-scale U.S. pig production operations to expand in their optimal locations than

for such operations in some other countries. This would reduce the U.S. competitive position in the world market.

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**Appendix Table. Estimated weekly slaughter capacity, 1996-
United States (top 16 companies)**

<i>Company</i>	<i>Plant</i>	<i>Capacity</i>
IBP	Waterloo, IA	85,000
	Logansport, IN	75,000
	Storm Lake, IA	67,000
	Col. Junction, IA	65,000
	Madison, NE	37,500
	Council Bluffs, IA	36,500
	Perry, IA	33,500
Smithfield/ Morel	Tar Hell, NC	120,000
	Smithfield, VA	47,500
	Gwaltney@Smithfield	44,000
	Wilson, NC	10,000
	Sioux Falls, SD	75,000
	Sioux City, IA	75,000
Swift	Worthington, MN	78,500
	Marshalltown, IA	78,500
	Louisville, KY	40,000
Excel/Tyson	Beardstown, IL	80,000
	Ottumwa, IA	50,000
	Marshall, MO	59,000
Hormel	Austin, MN	80,000
	Fremont, NE	58,500
	Rochelle, IL	35,000
Farmland	Crete, NE	41,500
	Denison, IA	37,500
	Monmouth, IL	35,000
	Dubuque, IA	55,000
Thorn Apple Valley	Detroit, MI	70,000
Indiana Packers	Delphi, IN	65,000
Seaboard	Guymon, OK	40,000
Lundys	Clinton, NC	40,000
Sara Lee	West Point, MS	32,500
	Newburn, TN	7,500
Dakota Pork	Huron, SD	38,000
Hatfield	Hatfield, PA	35,000
Clougherty	Vernon, CA	30,000
Iowa Packers	Des Moines, IA	30,000
Premium Std.	Milan, MO	25,000
Total Capacity		1,912,500

Source: Martin et al. 1997, page 13.

Overview and Conclusions

Marvin Hayenga and David Seim

Growth in Global Demand For Pork Products

Global demand for pork products is growing rapidly. Exports of pork products have increased from all four of the countries studied. The Netherlands is focusing on western Europe, while Denmark is focusing on both western Europe and Asia. The United States and Canada are finding Asian countries to be their best prospect. Figure 1 clearly shows the general export trend in all four countries.

Figure 1. Pork Product Exports 1978-1997.

Asia's demand for pork products is quite different than the stable demand situations in North America and Western Europe. Since the implementation of the 1995 World Trade Organization (WTO) agreement, which significantly reduced many tariff and some non-tariff barriers against free trade, pork product exports have increased to many Asian countries. But the large increase in Asian imports of pork products began prior to the WTO agreement, reflecting a rapid real income growth in many Asian countries through the past decade. Withstanding southeast

Asia's current economic crisis, forecasts for future real income growth in Asia still suggest a continued positive rate of change.

Nearly every Asian country has a relative shortage of land and other natural resources. Because of this, Asia's expected continuing increase in demand for pork products will translate into an increased demand for imported pork products.

Four Pork Producing Countries

Many traditional exporters of pork products seem unlikely to be able to meet any large increase in worldwide demand for pork products. In Taiwan, a serious disease problem recently affected pig production, necessitating a cessation of exports of pork products. In Europe, The Netherlands' environmental concerns will limit hog production to approximately 80 percent of previous production levels; this will sharply reduce their exports and stimulate some growth in other European countries. The traditional pork exporting powerhouse, Denmark, is near its capacity to produce for export.

In prior chapters, the focus was to identify factors involved in comparative cost differences in pork production and processing in each country. The most comprehensive analysis to date of productive efficiency in terms of litters per sow and closely related figures may be in Fortin and Salaun, 1995, which is summarized in Table 2.

Table 2. Production - Europe vs. North America, 1993-94

	Quebec	Ontario	Alberta	US Midw.	France	Denmark	Netherlands
Litters/sow per year	2.07	2.05	1.95	1.87	2.06	2.11	2.08
Piglets weaned/sow per year	18.30	18.40	16.50	15.90	18.70	20.10	19.80
Feed conversion	3.38	3.30	3.78	3.72	3.21	3.28	3.11
Piglets born live/litter	10.30	10.40	9.80	9.90	10.90	10.80	10.80
Piglets weaned/litter	8.90	9.00	8.50	8.50	9.50	9.50	9.40

Source: Fortin and Salaun 1995, page 41

Along with relevant data on carcass lean content and average slaughter weight, our

findings are summarized in Table 3.

Table 3. Major Comparative Measures.

	<u>Denmark</u>	<u>Netherl.</u>	<u>Alberta</u>	<u>Ontario</u>	<u>Large US</u>	<u>Ave. US</u>
Total Production Cost \$/cwt.	77.59	74.58	38.97	46.97	39.03	43.28
Average Live Weight	214	250	238	231	239	242
Total Production Cost \$/hd.	166.04	186.45	92.75	108.5	93.28	104.74
Total Processing Cost \$/hd.	71.5	32.5	34.5	34.5	25.5	25.5
Total Cost \$/hd.	237.54	218.95	127.25	143	118.78	130.24
Carcass Lean Content (ave.)	56.75	55.5	56	56	54	49
Total Cost \$/lb. lean	2.64	2.13	1.29	1.49	1.24	1.48

1. Carcass weight as a percentage of liveweight is 74 percent.
2. Some numbers are averages from figures given in text.

The Dutch and Danish pork industries traditionally have been two of the world's most successful exporters of pork products, with almost 80 percent of Danish production and about 75 percent of Dutch production being exported (mainly to other countries in the European Union). Since 1992, however, pork production in these countries has flattened, and even decreased slightly. Because of such limiting factors as a small land base, high wage rates, an already high production density, and necessarily stringent environmental regulations for manure disposal, both of the two countries may be reaching environmental limits in their ability to produce pigs.

Denmark does have some permanent strengths. Denmark traditionally has compensated for its comparative disadvantages in cost of production (in particular a high feed cost) and cost of processing (in particular a high labor cost) with its three well-known attributes: (1) high productivity in hog production; (2) lean pork; and (3) strong export customer orientation. These three attributes relate directly to the fact that Denmark's processing costs are comparatively high: their hogs are lighter weight; they do much more processing than other countries; they produce a much higher proportion of boneless product; and they do much more customized cutting for

smaller export customers. Denmark's exports outside of Europe probably will decline. But, this is not for certain, as it depends on what kinds of products the rest of the world will demand in the long-run.

The Netherlands is in a transition somewhat comparable to Denmark. While their aggregate cost of production and processing may not be as high as Denmark's, their traditional reputation for quality also is not quite as high as Denmark's. Currently, because of the swine fever outbreak in 1997 and subsequent government downsizing of the industry by approximately 20 percent due to environmental concerns, the Dutch industry is undergoing a significant restructuring. This may lead to more Dutch pigs being fed and slaughtered elsewhere in the European Union, and Denmark and other European countries filling in the Dutch export gap.

Canada is recognized for quality and leanness in its pork products. Canada also is rapidly restructuring its pig production and processing industries, as a response not only to changing demand, but also to a government removal of a rail subsidy, which resulted in lower feed grain prices in western Canada. This provided a great incentive for feed lot operations to locate in western Canada. But Canada's processing sector is still small scale, with high cost of operations and high labor cost. Renegotiation of wage structures is taking place in Canada. The future of Canada's pork product exports depends on what kind of growth will continue to occur in the Prairie provinces, whether the wage rates in the processing sector can become more competitive, and whether new, large-scale processing operations are built.

The United States produces pigs at a low cost, and is becoming even more low cost as large-scale operations are rapidly expanding their share of market volume. The United States is solidly established as having the largest scale, low cost processing in the world. Thus the United States might be better prepared currently to meet an increasing global demand for pork products.

Within North America, Canada appears to have some advantage in production costs; specifically, in the feed cost component. Yet the United States has a slight but steady advantage in having the lower slaughter and processing costs. With few border constraints, these costs in the two countries should eventually equalize in the long term. But institutional differences and, more importantly, some inherent differences in culture, climate and geography might say that

these factors could remain unequal for a long time.

However, a nation's exports always are sensitive to fluctuations in the value of its currency. Because exchange rate movements are able to significantly influence an importer nation's decision about whether or not to buy pork products from a particular country, three main factors in the mix become these: (1) the aggregate cost of production and processing; (2) the value that an importing nation places on quality and leanness; and (3) the exchange-rate conditions over time.

Our analysis suggests that North America has a competitive advantage in export of pork products to many parts of the world where relative transportation costs are not prohibitive.