

Structural changes in the pork production and processing industry of the U. S. and other OECD countries: major trends and issues¹

**Marvin L. Hayenga
Professor of Economics
Iowa State University**

1. Introduction

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. This is usually a concept based on production of a product, and not related to the entire 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. The industry's organizational structure linking the input supply-production-processing and merchandising chain can have important influence on the speed and accuracy of response to changing consumer demands and market conditions. The size, sophistication, and competition in the local market at each stage of the food chain may force innovation, encourage advances in supplier industries, facilitate economies of scale, or provide other advantages in dealing with international customers. Processing technologies are probably quite mobile, but the economies of size in slaughtering and processing are likely to be

¹ Presented at the OECD-Ministry of Agriculture Conference on China's Agro-Processing Sector: Developments and Policy Challenges, Beijing, Peoples Republic of China, October 7 - 8, 1999, and previously published in "The Agro-food processing sector in China -Developments and policy challenges", Organisation for Economic Co-operation and Development, OECD, Paris, January 2000.

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. Finally, other important elements include the institutional structure supporting the industry, related infrastructure like roads, telecommunications, and the legal system governing business and contractual systems.

This report briefly outlines some important organizational structure dimensions of the pork chain in the major pork producing and exporting countries in the OECD. These countries provide some interesting contrasts that may be useful in analyzing structural changes in China. References are provided for each country for persons interested in more information.

2. The U. S. Pork Industry

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 was cheaper compared to Corn Belt states.

2.1 Pig Production: Structure, Costs, and Issues

U.S. pig production operations exhibit wide variation in size. Nationally, in 1996, farms with at least 1,000 head numbered approximately 12,000. North Carolina has the largest size operations, with 92 percent of the state's inventory was in operations of 2,000 head and over.

The trend to fewer and larger operations has accelerated in recent years. Over the last ten years the share of hogs produced by large firms marketing 50,000 head or more has increased from 7 percent in 1988 to 37 percent in 1997. This gain has offset a decline in production from operations marketing less than 1,000 head; their share dropped from 32 to 5 percent over the same period. Approximately 24 percent of pigs were marketed by 18 producers selling over 500,000 head.

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. 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.

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 used extensively by large firms, who often have their own feed mills and trucking fleets as well. A few of the larger pig production operations also have their own breeding stock operations, slaughterhouses, and packing plants.

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 very large (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. This performance by large producers in non-midwestern states overcomes feed price and pig price disadvantages relative to the Corn Belt states.

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. 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. Many different technologies have cost impacts that have been quantified; these may be useful for other countries to consider as well.

Returns for Swine Production Technologies -- U.S.

Rank	Technology	Impact \$/cwt.	Impact \$/head
1	SEW/AIA *	4.73	11.59
2	Genetics-Production	3.38	8.28
3	Throughput	3.09	7.57
4	Genetics-Revenue	2.24	5.48
5	Split Sex/Phase Feeding	1.79	4.39
6	All-In/All-Out	0.73	1.79
7	Network Selling	0.75	1.83
8	Network Buying	0.70	1.72

* SEW/AIO is “segregated early weaning/all-in, all-out”

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

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

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 farm-to-retail price difference. 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. Today, this level is estimated to have risen further.

The major trend in the slaughter and processing industry is increased concentration. The number of plants involved in pig slaughter is in a long-term decline, and plants are much larger. From 1980 to 1995, the number of pig slaughtering and processing firms reporting to the USDA dropped from 446 to 209. The top four firms accounted for only 34 percent of pig slaughter volume in 1980, but rose to over 50 percent in 1996. 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. 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).

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 years production cycle in the U.S. appears to be continuing.

Another strong motivation for integration or contract linkages is to provide high-quality pigs that can be given a processor brand. The National Pork Producers Council (Pork Chain Quality Audit) has estimated that 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, has owned a controlling interest in one of the nation’s largest pig producing firms, and recently acquired the two largest U. S. pig production operations; now they own or control approximately 650,000 sows (near 13 percent). Smithfield also is tightly coordinated via procurement (marketing) contracts with a number of other large producers. Smithfield also has branded pork in stores, and an experienced distribution system. Seaboard, long a leading poultry producer and processor, and now the seventh largest pork processor, has a coordinated pork production system involving some of its own production and some long term contract suppliers around its processing plant in the Panhandle of Oklahoma. Premium Standard Farms is a fully vertically integrated pig production and slaughter business in Missouri.

The use of marketing contracts between producers and packers has increased sharply in recent years. Packers reported buying 87 percent of the pigs they processed in 1993 on the spot market. It has recently been estimated that approximately 57 percent of all pigs actually were committed to packers through long-term contract or direct ownership in 1997 (Lawrence, Grimes, and Hayenga). Nearly 47 percent of the 1997 marketings were under some type of prearranged agreement with the packer. This compares to 37 percent in 1994 and 11 percent in 1993. The above 50,000 producer size classes and the outside the Corn Belt operations had 75 percent or more of their hogs under contract with a packer. Since market access is a big issue for large-scale operations and producers in areas without many competing packers, this should not be surprising.

The dominant type of marketing agreement is a formula price contract, especially for the largest producers and other producers outside the Corn Belt. These contracts are

ongoing agreements between the packer and producer that have the selling price based on an observable spot market price report from the government. While 39 percent of all hogs were formula priced, the largest producers marketed 75 percent of their production using that pricing system. Other contracts provided returns based on reasonable production costs, or had limits on market price ranges, sometimes with assurances that the long term price average would not differ too much from spot market price averages. These have had some problems when market prices dropped sharply for extended periods of time in 1998-99, and large debts built up to the other contracting party. Relatively few hogs (3 percent) were priced based on the futures market.

Production contracts are also common, typically with large producers placing pigs in other producers' facilities who raise them. Approximately 40 percent of all hogs marketed in 1997 were by contractors from their own or other growers' facilities. Of those, three-fourths were contractors pigs raised in someone else's facilities under long term production contracts. For contract growers who provide the labor, buildings, land, and utilities, this contract production is a way to market surplus labor, acquire capital more easily and avoid price risks.

2.3 Slaughter plant cost structure

A survey of managers of the six largest processing firms and two firms with new plants found there are economic advantages associated with running two shifts at a processing plant, and running multiple plants. Double shifts enable processors operate at full capacity, reducing both fixed and variable costs per head as a result. The estimates below include all in-plant costs and allocation of administrative costs from corporate headquarters in multiplant operations.

Plant Slaughter and Processing Costs (U.S. \$ per head)

	Variable costs	Fixed costs	Total costs
Single shift average	22	6	28
Double shift average	20	3	23

Source: Hayenga, 1997

2.4 Summary

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 near 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. Producer size is increasing rapidly, and small operations are dropping out or expanding. Large-scale producers have extensive production contracts with other growers to raise pigs for them. Producer-packer linkages are changing dramatically in the last 10 years, with much more vertical integration and long term marketing contracts.

3 The Canadian Pork Sector²

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 the United States and Denmark. 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. Growth of the pork sector is occurring in the prairie provinces in western Canada to take advantage of low grain prices.

The Canadian processing industry has been comprised of many small, high cost plants with few economies of size and high wages. The pork sector is following the lead of the beef processing industry that negotiated more competitive wage and benefit structures to better compete with U.S. packers. New large-scale plants are being planned or built in the prairie provinces in conjunction with increased pig production.

Canadian marketing boards used to dominate the live hog marketing system, with electronic auctions and price premium-discount grids giving significant premiums for lean carcasses for 30 years. More direct sales and contracting with packers is occurring in many provinces, especially in western Canada.

3.1 Pig Production: Structure, Costs, and Issues

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,

² Zana Kruja and Larry Martin, George Morris Centre, Ontario, Canada generously provided updated information.

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 that are reasonably efficient according to all standard measures. Canada has high productivity per sow and comparatively inexpensive feed.

Its increased number of large, specialized operations has boosted Canada's pork industry competitiveness. 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, while Alberta is over 60 percent.

Canada's pig industry has been consolidating its production through increased farm size. Large farms gain advantages over smaller competitors through more efficient production techniques and lower unit costs for inputs. Large farms are able to generate economies of scale and greater competitive strength.

Farm Productivity, 1993-94

	Quebec	Ontario	Alberta
Piglets born live/litter	10.30	10.40	9.80
Piglets weaned/litter	8.90	9.00	8.50
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

Source: Fortin and Salaun , 1995, page 41.

In a recent study by Brewer, et al., pork production costs in Alberta and Ontario are analyzed in detail. Eastern Canada's cost structure is substantially higher.

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

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

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 increased on balance.

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.

3.2 Pork Slaughter and Processing Structure

In 1998, Canada slaughtered 16.7 million pigs. Approximately 15 percent of Canada's pigs currently are slaughtered in the United States. Most Canadian pork processing plants are at a significant cost disadvantage versus U.S. plants.

Processing is conducted in nearly all of Canada's 49 federally inspected pig slaughter facilities. The five largest plants all slaughtered over 900,000 pigs, and together accounted for 35 percent of total slaughter in 1996. The new Maple Leaf plant opening in Manitoba in 1999 will slaughter 45,000 head per week. Maple Leaf, the largest firm with approximately 22 percent of Canada's slaughter capacity, has a new competitor, Smithfield from the U.S., which recently bought one Canadian plant. The top four slaughter firms accounted for 56 percent of Canadian slaughter in 1998; the top eight accounted for 76 percent, according to Agriculture Canada. Canada's slaughtering industry is smaller scale than the U.S. slaughtering industry. 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.

Their products 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.

In the mid-1990s, the average wage for Canadian plants was about US\$15.91 per hour. In addition, benefits were high. Canada's red meat industry as a whole has 30 percent lower labor productivity than the U.S. industry, due to the combination of higher wages and slower plants. No plants are double shifted in Canada.

The higher the weight of a carcass, the lower is the associated overhead cost per unit of product. 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. Consequently, Canadian processing has been more costly than their U.S. competitors, and significant volumes (15%) of live hogs moved south across the border in response to this difference and the strong U.S. dollar.

3.3 Canada's Marketing System

Marketing of high-grade pork products in Canada is partly controlled by provincial pig marketing boards, such as the Ontario Pork Producers Marketing Board. The Board 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, fund research and industry promotion. Pig pricing is based on each province's carcass premium/discount matrix. Grading is done by federal inspectors.

Canada's marketing boards have been criticized as less than appropriate for current conditions. "Dual marketing" for pigs has been introduced. Many producers now have their choice between marketing their pigs through a provincial marketing board or through private contracts with processors. Given that Western Canada represents most of growth potential it is interesting to note that marketing boards in Western Canada have much less influence on hog marketing than Eastern boards.

For example, Alberta began an "open marketing system" for slaughter pigs in December 1996 to replace the compulsory marketing system operated by the Alberta Pork Producers Development Corporation (APPDC). A producer vote in July, 1998 determined this system will continue. The open system allows for other marketing agencies to compete with the Western Hog Exchange (WHE), and for producers to sell directly to packers. The Western Hog Exchange assembles, schedules and sells pigs destined for slaughter on behalf of producers. Agencies involved in the marketing of pigs in Alberta in addition to the WHE include other private dealers and agents, Alberta packer buyers and buyers in markets outside Alberta. The APPDC provides "universal" services for all producers, supporting industry research and conducting pork advertising and promotion to consumers via a compulsory levy on hogs marketed for slaughter. The current levy for their services is \$1.00 per pig.

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. The Canadian grading system discounts heavy carcasses and as a result Canadian carcasses average about 8 kg less than U.S.

carcasses. This results in higher fixed costs (such as sow feed, capital, labor) per market hog in Canada. 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. Recent industry estimates suggest lean yields are averaging near 56 percent.

3.4 Summary

The possibility exists that the western Canadian pig industry could double in size of production within a decade and become the low cost producer of pigs in the world. Processing capacity is increasing there, and it is capable of attaining scales of operation that could bring costs closer to those in the United States. The role of the Marketing Boards is progressively less restrictive, facilitating more flexible linkages between processors and producers. These changes should enhance the long-term ability of Canada to increase pork production and become more competitive in Asian export markets.

4 The Netherlands Pork Sector ³

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 government reaction to the disease outbreak was the liquidation of 25 percent of the Dutch pig herd to eliminate and prevent the spread of the disease. The government also implemented of a number of biosecurity and environmental regulations, resulting in higher production costs without compensation to producers. Recent estimates suggest that only 7,000-9,000 pig operations with the lowest production cost will survive in the next 5-10 years, with 20 percent fewer pigs produced. Total slaughter numbers probably will decrease only 10% due to less cross-border shipping of slaughter hogs (long distance transport of live animals is becoming more difficult due to EU regulations on animal welfare). The competitive position of Dutch pork in the domestic and export markets is being adversely impacted.

³ Recent data was generously provided by Johan Verduijn and J. J. deVlieger to supplement our earlier study.

4.1 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. The farms in the pork sector are typically diversified with a dairy enterprise. Since 1960, pig farms have steadily declined in number, but increased in size. The current structure is shown below.

Size of pig operations, 1998

Farms with sows

Total		1-99 sows		100-199 sows		200 sows and more	
farms	sows	farms	sows	farms	sows	farms	sows
8,303	1,572,524	2,804	125,545	2,654	390,384	2,845	1,056,595

Farms with fattening pigs

Total		1-199 pigs		200-499 pigs		500-999 pigs		> 999 pigs	
farms	pigs	farms	pigs	farms	pigs	farms	pigs	farms	pigs
16,937	6,591,246	46%	10%	29%	24%	16%	28%	9%	38%

Source: Netherlands Central Bureau of Statistics

Large finishing operations with 1,000 or more pigs accounted for 9 percent of farms and 38 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).

4.2 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. In 1997 the government issued stricter rules by prescribing that every pig farm has account for the production and distribution of manure. Fines must be paid for amounts over the amount that can be used on his own land or is sold on long term contracts to others (farmers, exporters, and processors). 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 who stopped or decreased production or shipping farm waste elsewhere. Both methods involve high costs. Sow farrowing operations have had a 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. But the swine fever outbreak temporarily restricted such exports recently, and future exports are likely to be reduced as fewer pigs are produced compared to pre-swine fever levels. Some Dutch breeders have finishing operations in border areas in Germany where environmental constraints are less binding.

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.

Average pig farm productivity measures in 1998 include:

- Weaned pigs per sow per year = 22; new 600 to 800 sow operations achieve 23 to 24 pigs per sow per year.
- Feed efficiency = record-keeping farms average 2.73 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.
- Carcass lean percentage (Hennessey probe) = 55.6 in 1996, up from 53.2 in 1990.

4.3 Production cost

A team of economists from five European pork-producing countries conducted a comparative study of production costs in their countries. Backus and Vaessen 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 89 kg. carcass weights (252 lb. live weight) in 1998, 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 US\$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. Producers have to perform in-and-out ammonia and phosphate accounting in livestock and crop enterprises.

4.4 Coordination mechanisms

The dominant organization form is the private family farm with farmers as the owners of the pigs. Only a very small percentage of the pigs are in vertically integrated operations. 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. With exception of some futures market based contracts, long term contracts hardly exist.

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 and the distribution chain, including the retailers. Consumers buy pork with IKB-logo. The program provides guarantees with respect to origin, feed sanitation, 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. 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. 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. Approximately 80 percent of pigs are produced under this program in 1999. The majority of producers for the export market of live pigs don't produce under the IKB-regime. In the IKB program, farmers can choose to whom they supply their slaughter pigs, and the quality control program has had the added benefits of improving the farmers' technical and financial performance.

4.5 Pork Processing Structure

Many small slaughter plants characterized the Dutch slaughter industry. Excess capacity and low profits were typical until the industry organized 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.

The number of slaughter plants handling more than 25,000 hogs per year in the Netherlands has declined rapidly through the years, stabilizing recently with 25 large plants. In the last few years more concentration at slaughter level took place as capacity utilization dropped sharply. In 1998 three groups slaughtered two-thirds of total slaughter (19.3 million pigs in 1998): Dumeco (cooperative) 35%, Sturko Meat (18%) and Hendrix Meat Group (Nutreco) 12%. A Sturko Meat subsidiary (Zwanenberg) is the biggest producer of meat products (31%), followed by UVG (Unilever) with 16%, Meester (former subsidiary of retailer Ahold, and recently sold to Sara Lee) (11%), Cebeco Meat Products (a farmer cooperative) (10%) and Compaxo (9%).

4.6 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 89 kg., substantially heavier than Danish pigs. High wage rates are prevalent, with estimated cost per hour of \$23 to \$30/hour, with a 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. 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 for moderate levels of processing, to \$14 for plants doing little further processing in 1998, 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.

Frequently 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. If current Government policies continue, the downsizing of swine production by 20 percent, higher production costs associated with environmental regulations, and corresponding downsizing and concentration in the slaughter industry will reduce the export competitiveness of the Netherlands in the near future. However, improved quality

programs may alleviate the effects of some of the cost increases in competing in the domestic and export markets.

5 The Danish Pork Sector

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. We briefly examine Denmark's hog production and processing industries, with emphasis on size, cost structure, productivity, and coordination systems. The cooperative system of organization and the factors leading to such successful export achievements are especially noteworthy.

5.1 Pig Production Structure

The geographical spread of pig production across Denmark has changed little in the last 20 years, but a drastic change has occurred in farm structure and size. More specialization, concentration, and larger herd sizes characterize the transformation. More than 19,000 of the 64,000 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. In 1995, 31 percent of all farm holdings in Denmark raised pigs, compared to 85 percent in 1968. In 1968, 75 percent of the pig farms housed 80 percent of all pigs; in 1995, just 18 percent of the farms had the same percentage. Less than half of all Danish producers are responsible for about 90 percent of total pigs marketed. The actual number of farms with pigs decreased by 75 percent during the 20-year period between 1975 and 1995.

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 quality assurance.

5.2 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. 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.

5.3 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 three companies remain in the slaughtering business, compared with 54 in 1970 (Danske Slagterier, 1995).

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.

Pigs are priced based on the estimated meat percentage (using a very sophisticated measurement system), 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 three cooperatives, accounting for over 80% of the slaughtered pigs in Denmark when factoring in the market share acquired in the recent merger with Vestjskye. Originally formed in 1990, Danish Crown merged with two other companies in 1994. Vestjskye merged with three other cooperatives in the last six years before merging with Danish Crown within the last year. Steff-Houlberg has the

largest plant and accounts for 13 percent of slaughter. The smallest of the three cooperatives, Tican, was formed in 1978 and accounts for about 5 percent of pig slaughter in Denmark.

Number of slaughter companies and plants in Denmark, 1970-99

	1970	1980	1990	1993	1994	1995	1999
Companies							
Cooperative	50	18	5	5	4	4	3 *
Privately owned	4	2	1	0	0	0	0
Total	54	20	6	5	4	4	3
Slaughter units							
Cooperative	56	34	25	24	24	22	22
Privately owned	4	2	2	0	0	0	0
Total	60	36	27	24	24	22	22

Source: Danske Slagterier 1995.

* Recent merger between Danish Crown and Vestjyske

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

5.4 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. However, 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.

5.5 Exports

The composition of Danish pork exports has changed considerably during the last 20 years. In 1974, bacon sent to the United Kingdom accounted for 40 percent of Danish exports; at present, this product accounts for just 10 percent of total pork exports. During that time the share of specialized cuts in Danish exports jumped from 12 percent in 1974 to 60 percent in 1995. 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.

5.6 Summary

A high cost structure characterizes Danish hog production and processing, but they produce much leaner pigs. Combined with superior processing hygiene and flexibility in providing what each customer wants in EU and international markets, the superior end product offsets the cost disadvantages from high labor costs and slow processing speeds. The cooperative system has stimulated uniform genetics tailored for export customers desiring lean pork cut according to the customer's wishes, and marketed that product well. Denmark will continue to be an effective world leader in the global pork market.

6 Summary and overview

The leading pork exporting countries have some very interesting similarities and differences. Producer cooperatives play the dominant role in the organization of the Danish pork sector, from breeding programs to processing and export merchandising. Despite expensive feed and labor, or perhaps because of it, the Danish have developed very lean pigs produced in very efficient production systems. Producers are linked to packing plants via one-year contracts. Processing is very high tech, but slow and costly. Further, they have been quite customer oriented, willing to adjust cutting and packaging to accommodate the different requirements in many countries. They are a leading competitor on the world market, exporting 80 percent of their pork.

The Netherlands has less cooperative influence, and less contracting between producer and packer. Their aggregate cost of production and processing may not be as high as Denmark's, but they do much less processing and their traditional reputation for quality also is not as high as Denmark's. Their new quality assurance program is designed to overcome that. Because of the swine fever outbreak in 1997 and subsequent downsizing of the industry by approximately 10-20 percent due to environmental concerns, the Dutch industry is undergoing a significant restructuring.

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. Marketing boards at the provincial level had a great influence on the marketing system for many years, with grid premium and discount programs rewarding leanness, and electronic auctions as the only producer-packer link in some leading pork producing provinces. Canada's processing sector is still small scale, with high cost of operations and high labor cost. Renegotiations of wage structures are 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, and whether the wage rates in the processing sector can become more competitive as 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. The leading packer is becoming highly vertically integrated, recently acquiring some large production operations. Most large packers are acquiring a majority of their pigs via long term marketing arrangements, a dramatic change from spot market direct sales in the last 10 years.

Is there one best way to organize your pork sector? Clearly, tighter linkages are becoming more important in many countries in response to increased quality demands being placed on the system. Assurance of quality, both in the product and the production process, is becoming increasingly important in the world market. Production and packing operations are expanding to take advantage of economies of size, where environmental limitations permit. But environmental constraints are becoming more pervasive and restrictive in many countries, as air or water pollution issues keep the pork industry from moving into some areas or expanding. These are factors to consider when analyzing which organizational structure would work best in your business environment.

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