

How Has the Structure of Animal Agriculture Changed?

Livestock production has shifted to much larger farms over time. We first describe those changes in size at the aggregate level, by comparing the hog, broiler, dairy, and fed-cattle industries. But each industry has also undergone important changes in how production is organized. Farms, while larger, are more likely to specialize in one stage of production and may be tied to other stages through complex contractual relationships. Size, specialization, and contractual relationships influence the technologies adopted by farm operators as well as the manner in which they are compensated. We describe those elements of structural change industry by industry.

Farm Size

U.S. livestock production features a highly skewed distribution of producers: many small farms raise some chickens, hogs, or cattle, but most production is on much larger farms. As such, simple measures of average size can be misleading. For example, the census of agriculture reports that 105,978 farms sold fed cattle in 2002, and that a total of 28.2 million fed cattle were sold.⁴ The average farm therefore sold 266 cattle—28.2 million divided by 105,978 (table 1). But that average (the mean farm size) isn't very informative, or representative, of farms or of cattle. Most farms were much smaller than the average; 91,000 sold less than 100 cattle, and half of those sold less than 10. But most cattle came from farms that were much larger than the average: over 20 million of the cattle sold in 2002 came from farms that sold at least 5,000 head.

As production is the underlying focus of this report, we measure farm size so as to capture the farm on which the typical hog, steer, dairy cow, or broiler resides. To do so, we identify the farm size that's at the center of the distribution of production, where half of annual production comes from larger farms and half comes from smaller farms.⁵ We call that operation size the locus of production.

The production locus is considerably larger than the average (mean) farm size. While the average seller of fed cattle sold 266 head in 2002, the average animal came from a farm that sold 34,494 cattle—half of all fed-cattle sales came from operations that sold 34,494 or more and half came from farms that sold less (table 1). The production locus is larger than the average farm size in all four commodities.

In each industry, the production locus increased over time, nearly doubling for fed cattle and for broilers between 1987 and 2002 (table 2). The broiler and fed-cattle industries underwent major changes before 1987 (Gee et al., 1979; Lasley, 1983; Hart, 2003), with more recent shifts of production to larger operations occurring while vertical organization remained stable.

Consolidation in the hog and dairy sectors is more pronounced. Half of all 1987 dairy production came from farms with no more than 80 milk cows in the herd. As very large operations (with 1,000 or more cows) grew more

⁴ Fed cattle are usually shipped to feedlots—which consist of many open-air pens—when they are 6-12 months old. There, they are fed a ration of grain, silage, hay, and/or protein supplements before being shipped to slaughter markets, where they account for most beef production.

⁵ Specifically, the median of the farm size distribution, when weighted by production (Hoppe et al., 2007; Key and Roberts, 2007). We define farm size as the number of head in a dairy milking herd, or as the number of head removed (sold) from other farms.

Table 1: Average livestock farm size, 2002

	Mean farm size	Production locus
Fed cattle sold	266	34,494
Broilers sold	265,585	520,000
Hogs sold	2,255	23,400
Milk cows in herd	99	275

Note: The mean farm size is the total number of head sold, divided by the number of farms selling the species. The production locus measures the size of farm at which half of production came from larger farms, and half from smaller.

Source: 2002 Census of Agriculture and Hoppe et al. (2007).

Table 2: Consolidation in livestock production, 1987-2002

	1987	1992	1997	2002
<i>Production locus (head sold/removed)</i>				
Broilers	300,000	384,000	480,000	520,000
Fed cattle	17,532	23,891	38,000	34,494
Hogs	1,200	1,880	11,000	23,400
<i>Production locus (milk cows per farm)</i>				
Dairy	80	100	140	275

Note: The production locus measures the size of farm at which half of production came from larger farms, and half from smaller.

Source: Hoppe et al. (2007).

common, the locus of production grew to 275 cows by 2002. The shifts in hog production were even more dramatic. In 1987, half of all hogs marketed came from farms that sold no more than 1,200 hogs. That locus rose to 23,400 by 2002, reflecting a major reorganization of production into stages, as well as shifts to larger operations in every stage of production.

So livestock production has shifted to much larger operations over time. Other elements of structural change—specialization, contractual relationships, technology—tend to be specific to each commodity.

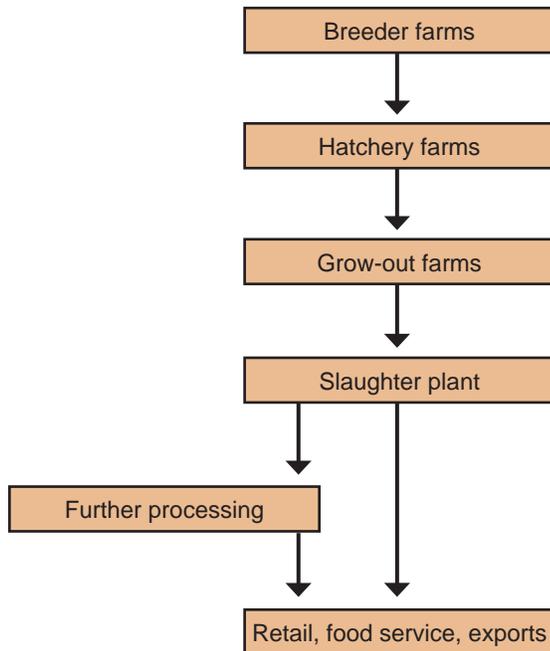
Broilers

Broiler production has a distinctive organization (fig. 1). Firms called integrators own hatcheries, processing plants, and feed mills. Integrators then contract with farmers to “grow out” broiler chicks to market weight, and to produce replacement breeder hens for hatcheries. Under a production contract, the integrator provides the farmer/grower with chicks, feed, and veterinary and transportation services, while the farmer provides labor, capital in the form of housing and equipment, and utilities. The birds are sent to slaughter after 5-9 weeks on the farm, and the farmer is paid for the growing services provided.

The organizational innovations developed in broiler production have been adopted in other commodities, but the methods of grower compensation remain distinctive (MacDonald, 2008). Growers receive a base payment for each flock of birds and an incentive. The incentive payment depends on the grower’s performance, relative to other growers delivering birds to the integrator during the same period. Those growers who can convert feed to meat more efficiently, while having fewer birds die, realize higher payments.

Figure 1

Organization of broiler production



While contracts in other commodities may specify incentive payments, they are set against fixed standards and not relative performance.

The industry’s current form developed during the 1950s and 1960s as integrators devised grow-out contracts, built production complexes, and developed breeding flocks (Hart, 2003; Lasley, 1983). Early grow-out farms weren’t very large, but that changed (fig. 2). In 1959, farms producing at least 100,000 broilers in a year accounted for 28.5 percent of production. That share doubled by 1969 and continued to grow rapidly until the 1990s. Today, hardly any commercial growers produce fewer than 100,000 broilers in a year. The industry’s basic organization remains unchanged, but production continues to shift to larger operations, from a production locus of 300,000 broilers in 1987 to 520,000 in 2002 and 600,000 by 2006.⁶

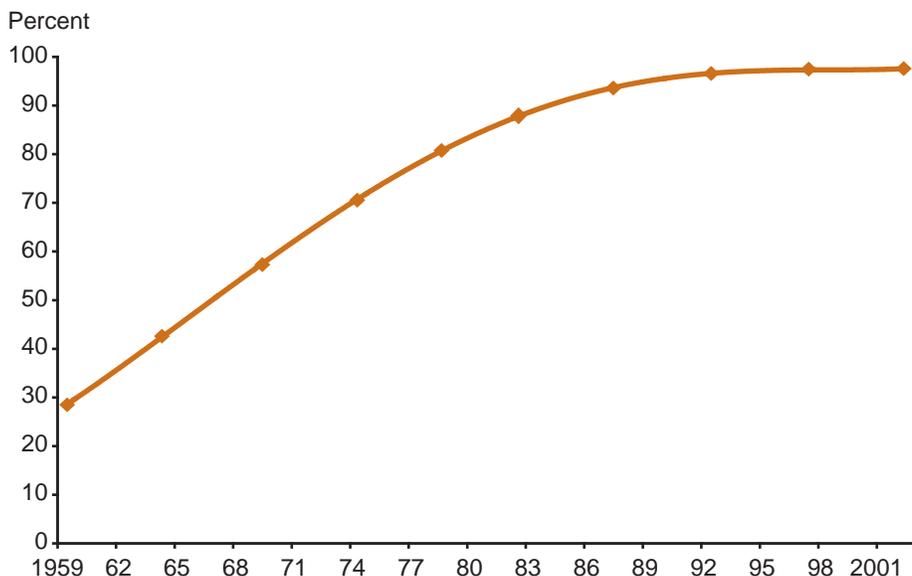
Broiler houses are the grower’s major expense. A pair of new houses can cost from \$350,000 to \$750,000, depending on size and location. Because of the significant initial investment in housing, lenders are important, both for funding and advice. Housing and equipment improvements are an important source of innovation and cost reduction in the industry.⁷

Measured by the gross farm income received by growers, broiler grow-out is still dominated by small farms. A farm at the 2006 production locus (600,000 broilers) would generate fees from broiler production of about \$156,000 if it received the industry’s average payment of 26 cents a head (MacDonald, 2008). Most realize additional farm revenues from crop production, but broilers account for most of gross income, and the production locus farm would likely realize a gross farm income, from all sources, of \$180,000-\$200,000. That is not a large farm—for agriculture as a whole, two-thirds of commodity sales come from farms with at least \$250,000 in gross income.

⁶ Table 2. The 2006 estimate is drawn from the 2006 ARMS broiler version.

⁷ Breeding improvements provide a major source of productivity growth, but improved lighting and climate controls can reduce mortality and improve feed efficiency in flocks.

Figure 2
Share of broiler production held by farms selling at least 100,000 broilers



Source: U.S. Census of Agriculture.

Hogs

Hog production has been transformed in the last two decades. Today, operations tend to specialize in single stages of production and are linked to one another by integrators using production contracts. However, there are some important differences between broiler and hog organization.

Hog production can be described in three stages (fig. 3). In the farrowing stage, sows bred by natural or artificial insemination produce nursing pigs, which are weaned at 2-3 weeks of age, when they weigh 8-12 pounds. In the nursery stage, weaned pigs are fed for about 6 weeks until they weigh 40-55 pounds. Finally, in the finishing stage, feeder pigs are fed for up to 6 months until they reach market weights of 250-290 pounds.

In 1992, most market hogs still came from independent farrow-to-finish operations that combined all three stages of production and that sold their hogs to meatpackers through cash markets (table 3). Today, most production is organized by integrators who coordinate production among growers specializing in separate stages (Martinez, 2002). Some combine farrowing and nursery stages into a farrow-to-feeder operation, and some have broken the nursery stage into two. Most market hogs now come from feeder-to-finish operations that receive feeder pigs from integrators (table 3).

Some integrators organize hog production exactly as broiler integrators do—they own packing facilities and feed mills and they contract with growers to raise hogs. Others focus on organizing contract hog production, while purchasing feed from mills and selling their hogs to packers under cash sales or marketing contracts. About 40 major integrators now coordinate production of 75 percent of the 100 million hogs marketed annually in the United States, with smaller integrators and traditional producers accounting

Figure 3

Organization of hog production

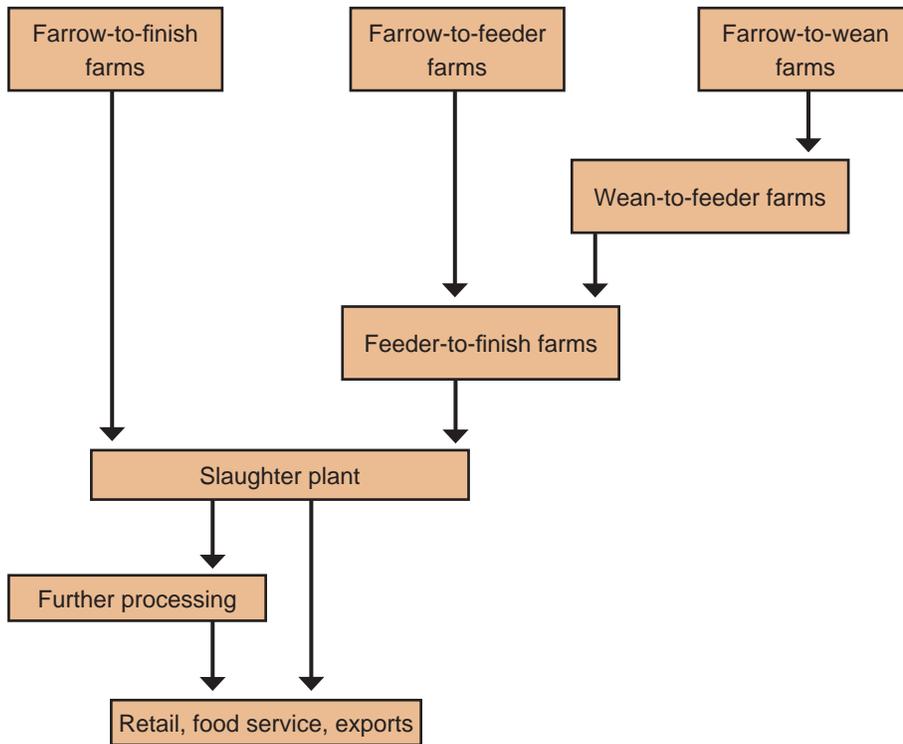


Table 3: Structural change in market hog production, 1992-2004

Type of operation	1992	1998	2004
Farrow to finish			
Percent of operations	54	49	31
Percent of market hogs removed	65	38	18
Percent of feed home-grown	55	51	38
Percent of hogs removed under contract	na	na	na
Market hogs removed (head per farm)	886	1,239	1,472
Feeder to finish			
Percent of operations	19	31	40
Percent of market hogs removed	22	55	77
Percent of feed home-grown	45	22	15
Percent of hogs removed under contract	5	40	67
Market hogs removed (head per farm)	945	2,589	4,656

Note: Other operations, such as wean-to-finish, account for small shares of market hogs.
na = Not available.

Source: Key and McBride, 2007.

for the rest. Major integrators typically contract with providers of genetics services to help improve their breeding herds (Hart, 2003).

Farrowing and nursery operations often specialize, with no commodities other than hogs, and they can be very large. The locus of farrow-to-feeder pig production was 50,000 pigs removed in 2004, and the corresponding production locuses were 25,000 pigs removed on wean-to-feeder operations and 60,000 on farrow-to-wean operations.⁸

⁸ Using data from the 2004 hog version of ARMS. Few of these specialized types existed in 1987, when market hogs accounted for a high share of all hogs and pigs removed from farms. The reorganization of production, and the large numbers of pigs removed from the operations, accounts for some of the dramatic increase shown in table 1. Nevertheless, hog finishing operations have also gotten larger over time.

Hog finishing operations usually operate under a production contract with an integrator, who provides them with feeder pigs, feed, and associated services, while the grower provides housing, labor, management services, and utilities. The grower receives a fee for services, which includes a flat payment for each hog or hog space, and may also have incentive clauses tied to feed efficiency.

Finishing operations have gotten substantially larger—mean annual removals increased from 945 to 4,656 hogs between 1992 and 2004 (table 3). Most hogs come from much larger farms, and the 2004 production locus fell at 12,000 hogs. Finishing operations are usually diversified farming businesses with crop and hog production. Fees from production contracts form a smaller share of gross farm income on contract hog farms than on broiler farms (because of substantial crop production on hog farms), and the hog farms tend to have substantially larger gross farm income than broiler operations (MacDonald and Korb, 2008). While the crops grown on hog finishing operations are not generally fed to the hogs, the hogs' manure is used to fertilize the farm's cropland.

Capital requirements for a large confinement hog enterprise can be substantial. Finishing houses can cost \$100-\$140 per hog space, depending on local construction costs and the nature of the equipment needed. For a 1,100-head facility, that suggests an expense of \$110,000-\$150,000 per house. Most operations have more than a single house, and an operation at the production locus (12,000 hogs) would need 6 houses, and an investment of \$600,000-\$900,000. For operations in the farrowing stage, capital costs can run to \$1,000 per sow (Hart, 2003).

Dairy

Vertical coordination in dairy farming hasn't changed much; most farms still market their milk through dairy cooperatives. But production is shifting to much larger farms, and there have been some important changes in how farms organize themselves.

The production locus on dairy farms rose from 80 cows in 1987 to 275 by 2002 (table 2). That comparison may even understate the nature of the shift because dairy farms cover such a wide range of sizes. Farms with at least 1,000 head in the herd accounted for 10 percent of all cows in 1992, but that share increased to 29 percent by 2002 and to 36 percent by 2007 (table 4). Most of the recent increase has occurred on farms with at least 3,000 head, according to data from the census of agriculture (MacDonald et al., 2007).

The shift toward larger farms is closely associated with some important regional shifts. Very large dairies first appeared in the West, particularly in California but also in Arizona, Idaho, New Mexico, Texas, and Washington. Milk production in those States has increased rapidly, while changing little in the traditional dairy States of the upper Midwest and Northeast, and declining elsewhere in the country. Today, very large farms account for most Western production, while production in all dairy States is also shifting toward larger herds (MacDonald et al., 2007).

Table 4: Size structure of dairy farms, 1992-2007

	1992	2000	2007
	<i>Percent of cow inventory</i>		
Herd size (milk cows)			
1-49	20.4	12.0	7.4
50-99	29.0	22.0	15.4
100-199	19.0	18.0	13.4
200-499	13.7	16.7	14.9
500-999	8.0	12.0	12.5
1,000+	9.9	19.3	36.4

Note: Herd size refers to all dairy cows on an enterprise, including dry cows but excluding calves, heifers, and bulls.

Source: USDA/NASS *Milk Production*, February Issue (1992 and 2000); USDA/NASS *Farms, Land in Farms and Livestock Operations* (2007).

Increased size also led to important changes in dairy farm organization. Whereas traditional smaller dairies relied largely on homegrown feed and pasture forage, large farms purchase a considerable amount of feed—many in Western States purchase all or most of their feed. Some large operations ship their calves to other farms, and contract with those farms to raise them to be returned as replacement heifers. And while most midsize and large dairy farms continue to be owned and operated by a family, they rely extensively on hired labor for milking crews, herdsmen, and cropworkers.

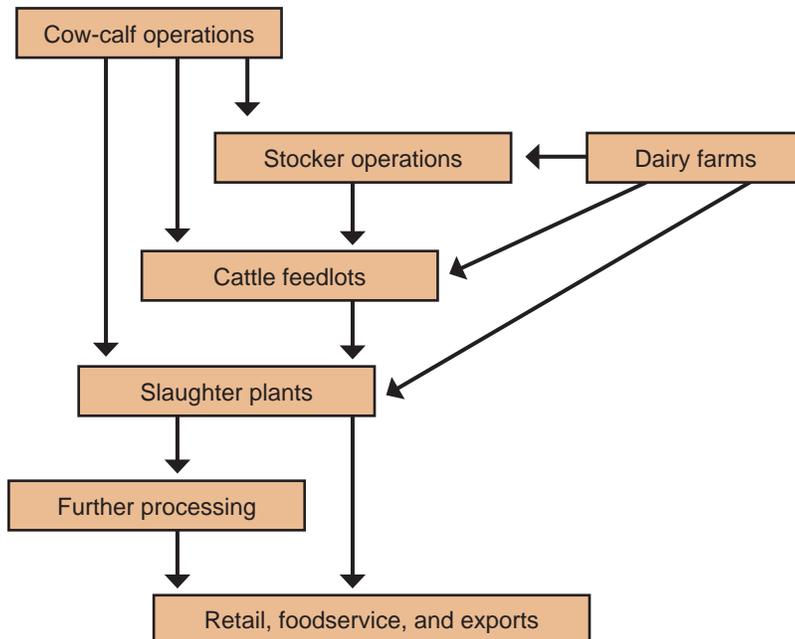
Dairy pricing, and therefore operator compensation, has always been complex, and it remains so today. Farmers are not paid for their services, as broiler and hog growers are under production contracts, but are still largely paid for their products—milk and culled cows. Milk prices can vary, even within regions, with differences in supply and demand for dairy products and because of government policy. But farmers also increasingly receive payments tied to the characteristics of the milk that they produce; most receive premiums for higher levels of butterfat, protein, and other solids, and receive less for milk with high counts of somatic cells, an indicator of bacteria.

Beef

Producers specialize in distinct stages within the cattle industry, and those stages are organized and coordinated differently (fig. 4). The cow-calf stage of beef production includes many farms: 758,000 operations had beef cows in 2007, 10 times as many as had dairy cows. Moreover, there are few really large cow-calf operations. Western cow-calf operations tend to specialize in cattle raising, while those in the Midwest and South tend to combine a cattle business with a crop enterprise. While production has shifted to larger operations over time, cow-calf production is still spread over many modestly sized farms and ranches.

Most calves are weaned between 6-9 months of age, when they weigh 400-700 pounds. They may remain on pasture at the farm or ranch, or be sent to pasture elsewhere. Most move to specialized stocker or backgrounding operations that add 200-400 pounds of weight over 3-8 months. Such operations provide a marketing function by assembling groups of animals of consistent quality, and they can also improve quality through health and nutritional management of the cattle, often with a combination of pasture

Figure 4
Organization of beef production



forage and feed.⁹ Most cattle will eventually be moved to feedlots, where they are confined outdoors in pens with other feeder cattle and fed a high-energy ration (RTI, 2005). Feedlots are the industrialized stage of the sector.

Until the mid-1960s, most feeding occurred in small “farmer-feedlots.” These farmers, usually in the Midwest, raised their own feed for cattle that they purchased and fed to market weight after harvest, when they had spare time. In 1964, feedlots with capacities of less than 1,000 head handled over 60 percent of U.S. fed-cattle marketings.

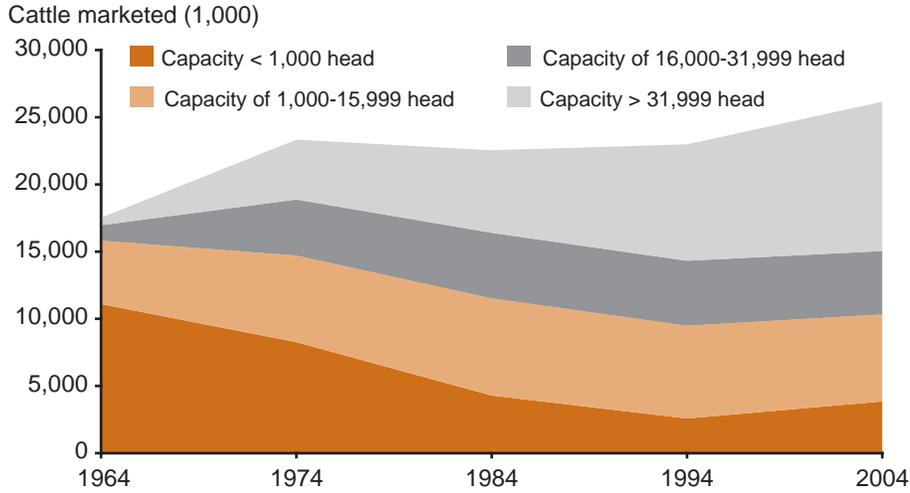
Cattle feeding underwent major changes in the 1960s and 1970s. Production shifted from farmer-feedlots to commercial cattle feeding businesses in the Great Plains and the West (fig. 5). Large commercial feedlots purchase all or most feed ingredients and maintain feedmills, feed delivery systems, and information systems onsite. They employ nutritionists, veterinarians, and sales and management staff, and they buy and sell cattle weekly.

While there are still many farmer-feedlots across the country, such operations feed only one-third as many cattle as they did in the 1960s. Meanwhile, commercial feedlot production has concentrated in larger businesses. In 2007, 262 feedlots had a capacity of at least 16,000 head, and they handled 60 percent of U.S. fed-cattle marketings. The largest can feed 100,000 cattle at a time. Some are owned by meatpackers, some are part of larger diversified firms, and others are specialized cattle feeding businesses, sometimes with a feed production enterprise as well.

Cattle feeders own cattle and market them under their own account, but they also “custom-feed” cattle for others through production contracts. Under those contracts, feeders are paid for their services and an owner may market the cattle or have the feeder handle that service as well. Contractual relation-

⁹ Two-thirds of beef calves are born in February, March, or April, so producers can stretch the beef supply out over the year by varying ages for weaning and backgrounding.

Figure 5
Fed cattle shift to large feedlots



Source: USDA/NASS, *Cattle on Feed*.

ships are becoming more complicated as backgrounders or cow-calf operations enter into joint ownership of cattle with feedlots or with processors. Joint ownership provides more sources of financing, and also ties compensation more closely to cattle quality at each stage of the production process.