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U.S. Hog Production: Rising Output and Changing Trends in Productivity Growth

Christopher G. Davis, Carolyn Dimitri, Richard Nehring,
LaPorchia A. Collins, Mildred Haley, Kim Ha, and Jeffrey Gillespie



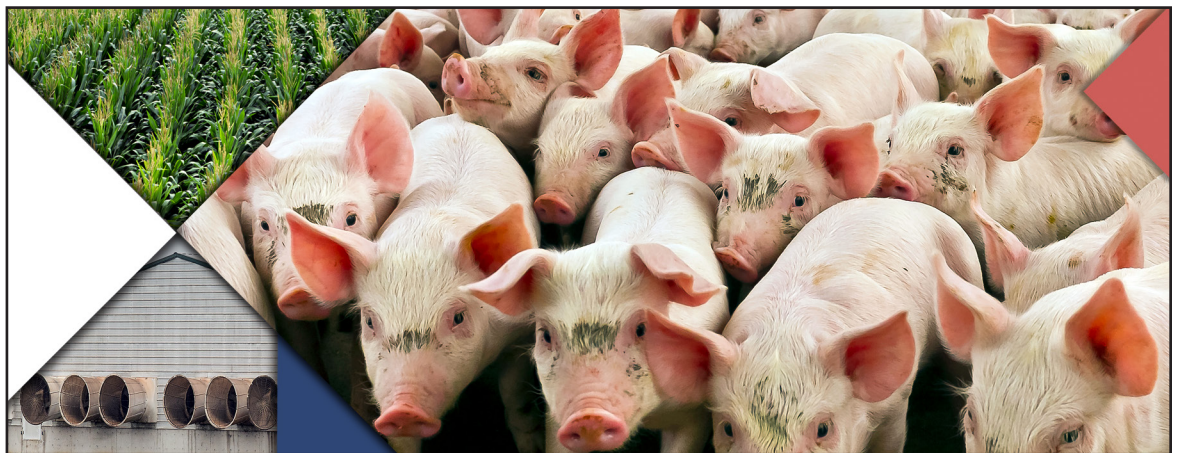


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Christopher G. Davis, USDA, Economic Research Service; Carolyn Dimitri, New York University; Richard Nehring, LaPorchia A. Collins, and Mildred Haley, USDA, Economic Research Service; Kim Ha, United States International Trade Commission; and Jeffrey Gillespie, USDA, Economic Research Service.

Abstract

Since the early 1990s, the number of U.S. hog farms has declined, the size of the typical hog farm has grown, and the regional pattern of hog production has shifted. Spurred by technological innovation and greater use of production contracts, the hog industry has gradually moved to more specialized operations. Rather than raising hogs from birth to slaughter weight, more farms are specializing in fewer phases of production. Production contract use varies across the Economic Research Service's Farm Resource Regions, with contract operations dominating the Southern Seaboard Region, while the Heartland Region includes both independent and contract operations. Greater building capacity has provided the infrastructure that hog farmers need to adopt management practices for improved feed efficiency and reduced disease spread. Most specialized finishing operations have modified hog diets as nutritional requirements change over the life cycle and have commingled hogs of similar ages. Production costs and labor hours to produce a pound of gain have declined. The cost reductions have contributed to an expansion of exports, with U.S. pork improving its competitiveness in foreign markets.

Keywords: hogs, pigs, farm management, production contracts, income statements, specialization, labor productivity, hog building capacity, Agricultural Resource Management Survey, ARMS.

Acknowledgments

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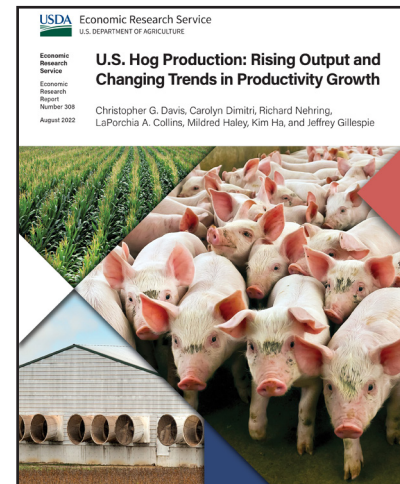
What Is the Issue?

The hog sector began a major transformation in the early 1990s, and since then, it has experienced productivity growth and structural change, increased output, and expanded exports. Although the number of hog farms has declined over time, the typical farm has become larger, and the regional pattern of production has changed. Between 2012 and 2017, the number of hog farms increased after declining for 15 years. During this period, the average size of hog farms grew slightly larger, and the regional distribution of hog production continued to shift. How do these trends relate to the organization of the hog industry, to farmers' production practices and financial outcomes, and to global trade?

What Did the Study Find?

This study examined changes in hog production from 1992 to 2017. The authors find that production contracts have become the dominant business model in hog production, and hog farms have become larger and more specialized.

- In 1992, just 3 percent of operations (5 percent of production) produced hogs under a contractual arrangement. This share increased to just more than half of all operations by 2015 (69 percent of production).
- The scale of operations increased. The average number of hogs sold or removed per farm rose from 945 head in 1992 to 8,721 head in 2015.
- Operations that specialize in fewer phases of production, such as feeder-to-finish operations, became more common.



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Technological advancements improved productivity, though changes in production costs were mixed.

- Greater housing capacity for hogs at all phases of production provided infrastructure for the adoption of all-in/all-out management (commingling hogs of similar ages and weights as they move through different growth stages) and phase feeding (changing diets to meet nutritional needs as hogs age). These innovations were adopted to reduce the spread of disease and improve feed efficiency.
- From 1992 to 2015, real feed costs decreased for feeder-to-finish operations, while they declined on farrow-to-finish operations until 2009 but increased in 2015.
- Real production costs (minus pig costs) decreased as labor productivity increased.
- During 1992–2015, the sector continued to replace unpaid labor with paid labor.

Production contract use and farm practices varied by region, for instance:

- In North Carolina, contract production dominated the hog industry, amounting to 91 percent of hogs sold in 2017;
- Production in Iowa and Minnesota (key hog-producing States in the Heartland Region) was split between independent and contract operations, with about 59 percent of hogs sold under contract in 2017; and
- Hog producers in Iowa and Minnesota were more diversified in production than those in North Carolina and had more acres of cropland.

Manure management is critical for a livestock operation. The average hog farm applied manure to 112 acres in 2015, although the application varied. For example, in North Carolina, manure was spread on an average of 55 acres and on an average of 167 acres in Iowa and Minnesota.

The hog industry exported more pork to foreign markets. In 2020, U.S. companies exported 7.3 billion pounds carcass weight equivalent (cwe) of pork to 118 countries for an export value of \$7.7 billion, an increase from 420 million pounds of pork valued at \$532 million in 1992.

How Was the Study Conducted?

The primary sources were farm-level data from the U.S. Department of Agriculture (USDA), including the 1998, 2004, 2009, and 2015 Agricultural Resource Management Surveys (ARMS), the 1992 Farm Costs and Returns Survey (FCRS) that preceded the ARMS, and the USDA, National Agricultural Statistics Service Census of Agriculture, conducted every 5 years from 1997 to 2017. The ARMS collected data on the financial conditions and production practices of farm businesses and the well-being of farm households. The analysis used the ARMS and FCRS data to describe trends in productivity, costs, contract use, and manure management and the Census data to highlight structural and regional changes in the hog sector over time.

U.S. Hog Production: Rising Output and Changing Trends in Productivity Growth

Introduction

The U.S. hog sector has dramatically changed since the early 1990s, when the sector began transforming from smaller, more diversified independent operations to larger, more specialized operations, some of which raised hogs under production contracts. Technological innovation fueled much of the change, touching every segment of hog production from animal genetics to marketing. At the national level, the industry changes have included increased productivity, with stable hog inventories raised on fewer farms (McBride and Key, 2013). By capturing economies of scale, larger hog operations have become more efficient than smaller ones (Nehring et al., 2019). The trend toward larger and fewer hog farms continued until 2017, when both the hog inventory and the number of operations increased, while the average number of hogs per farm slightly declined (USDA, NASS, 2019b).

Traditionally, hogs were raised on one farm from birth to slaughter, but production has increasingly moved to operations that specialize in just one or two phases of production (Key and McBride, 2007). The shift to specialized operations occurred along with two other developments: the movement to widespread use of production contracts and the emergence of larger operations. With the increased use of production contracts, specialization in later phases of production, such as finishing, has become more common, with the contractor providing feed, feeder pigs, and services. Previous research indicates that feeder-to-finish operations exhibit economies of scale, providing a rationale for why hog farms became larger and specialized in the final phase of production (Parcel et al., 2017).

Technological innovation and increased farm size have contributed to lower production costs per hundred-weight (cwt). In the hog sector, the technological advances have included improvements to animal genetics, housing, feed, and animal management. These advances have led to greater efficiency in hog production, with reduced labor and lower feed requirements per cwt of gain (McBride and Key, 2013). Crossbreeding techniques developed by agribusiness companies and independent breeding companies have also resulted in genetic improvements that have increased feed efficiency, litter size, birth weight, and piglet viability at birth (Moeller, 2000). The use of artificial insemination has increased the speed of bringing genetic improvements to the farm and has reduced the number of boars needed to breed hogs (Narrod and Fuglie, 2000). More recent genetic improvements have targeted qualities that consumers demand, such as leanness, or have reduced undesirable pig behavior, such as ear biting and aggression (Kanis et al., 2005). Increased use of pelleting has reduced feed waste (Miller, 2012). Feed mills, particularly those in the Corn Belt, nearly doubled the feed they produced between 1984 and 2004 (Eversull, 2005).

Other changes that have affected production costs and efficiency are the publication of new guidelines regarding antibiotic use for growth promotion and farmers' responses to growing concerns about local regulations for manure handling and storage (U.S. FDA, 2015; Key et al., 2011). Increased productivity at the farm level has led to a larger supply of pork meat from U.S. hog producers. At the consumption level, domestic loss-adjusted availability of pork has been relatively flat over the last three decades (Bentley, 2019). Global imports of pork have also remained flat. Over time, the U.S. exports have accounted for a decreasing share of global imports—less than 10 percent in 2020 (USDA, ERS, 2021a). However, the export market has become an important outlet for U.S. pork, with exports increasing by a factor of 17 between the early 1990s and 2020 (USDA, ERS, 2021a).

Several key events affected the hog sector during the study period. First, in late 2013, an outbreak of porcine epidemic diarrhea virus (PEDv) affected U.S. herds. PEDv is the most lethal for sows and newborn pigs; by the time it was brought under control in late 2014, more than 8 million hogs and pigs had died (Lee, 2015). Second, China's demand for U.S. pork increased as the country's domestic herds were decimated by an outbreak of African Swine Fever in 2018–19 (Haley and Gale, 2020). Most recently, in 2020, the Coronavirus (COVID-19) pandemic reduced capacity use rates in the U.S. pork processing sector, affecting pork production in 2020 and 2021 (Haley, 2020).

This report examines the hog sector, starting from production and following, when applicable, to the market. The report focuses on structural change in the hog sector, including the shift to specialized hog production and trends in related factors such as production contract use, labor efficiency, feed requirements, housing capacity, and manure management. The report focuses on production contracts and does not consider marketing contracts. The analysis also describes farm finances for different types of operations, focusing on hog farms with an inventory of at least 25 head each year. A detailed comparison of hog operations in Iowa and Minnesota to those in North Carolina shows the importance of advantages specific to each of the two regions and highlights regional differences masked by national-level data. The report relies on data from the USDA, NASS Census of Agriculture and Agricultural Resource Management Survey (see appendix for more information) and supplemental data available on the USDA, Economic Research Service (ERS) website.

The hog production and marketing system

Hog production occurs in four phases:

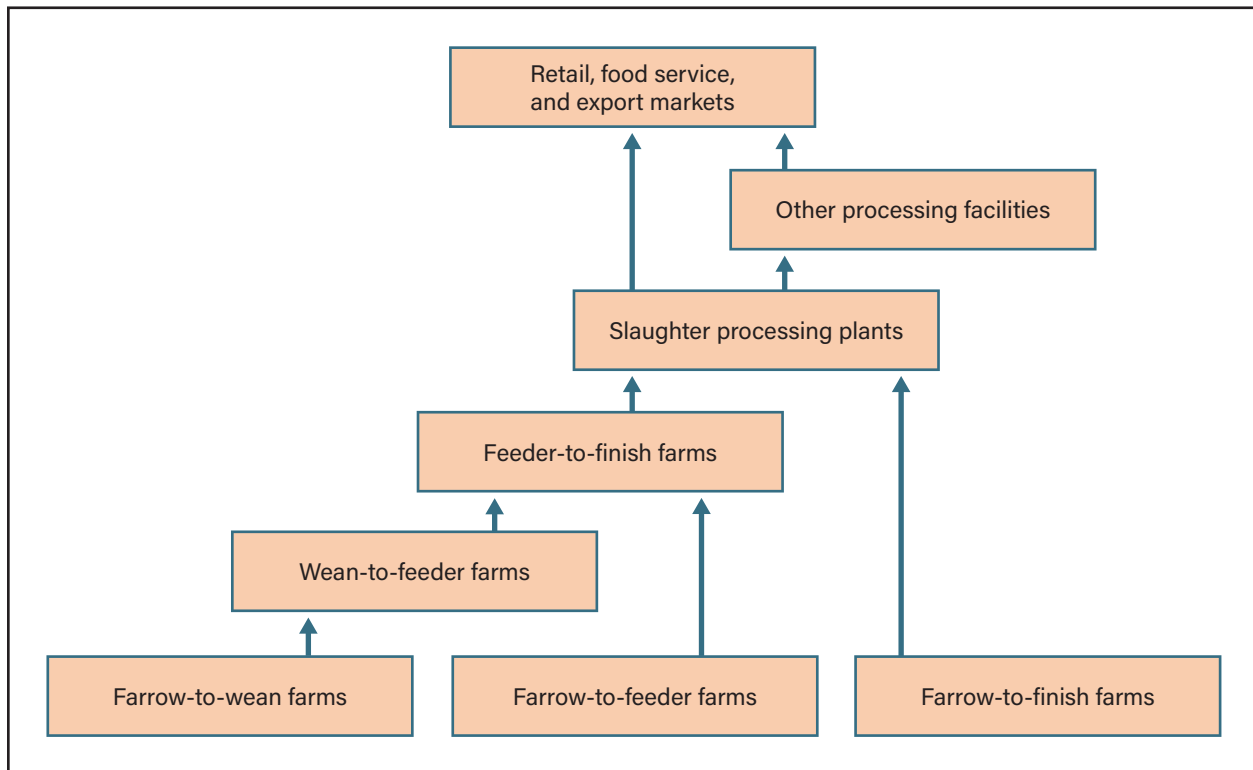
- breeding and gestation (breeding and maintenance of females during pregnancy);
- farrowing (caring for pigs from birth until weaning);
- nursery or feeder (caring for pigs immediately after weaning until they are about 30 to 80 pounds); and
- finishing (raising hogs from 30 to 80 pounds to a slaughter weight of 225 to 300 pounds) (Hoar and Angelo, undated).

The process from birth to slaughter weight takes approximately 6 months (National Pork Board, undated).

Six types of operations produce hogs in the United States. Feeder-to-finish, farrow-to-wean, and wean-to-feeder operations are specialized operations that focus on one production phase. Farrow-to-feeder operations encompass two production phases (farrowing and nursery), and farrow-to-finish operations include all production phases from birth to slaughter. Some operations do not fit into any of the above categories and are categorized as mixed operations.

The production system for hogs follows one of three paths from farm to market (figure 1). The traditional system involves raising hogs on a farrow-to-finish operation, where hogs and pigs remain on one farm from birth to slaughter weight. In a second system, hogs start on farrow-to-feeder operations and then are transported to feeder-to-finish operations, where they remain until they reach slaughter weight. In the third system, hogs begin on farrow-to-wean operations, are moved to wean-to-feeder operations to remain until they reach 30 to 80 pounds, and then are transported to feeder-to-finish operations to remain until they reach slaughter weight.

Figure 1
Organization of hog production systems from farm to market



Source: USDA, Economic Research Service.

Once hogs reach slaughter (or market) weight, they are considered “finished” and are transported to a slaughter processing plant. According to Meyer (2020), U.S. total daily slaughter capacity was approximately 512,000 hogs per day in 2020, with the largest facilities able to slaughter 20,000 or more hogs daily. After hogs are slaughtered, the resulting meat is further processed, either at the slaughter plant or at another facility, and eventually packaged. The pork meat products are then sold to domestic consumers through retail markets and food service providers or to export markets. The primary export markets for U.S. pork are Mexico, Japan, China/Hong Kong, and Canada (Haley, 2019).

Timeline of milestones in the hog sector

Key structural and productivity changes between 1992 and 2015

Farm specialization

Through 1992, most hogs were raised on one farm from birth to slaughter weight (i.e., from farrow to finish). From 1992 to 2004, production continually shifted to specialized operations (such as feeder-to-finish farms). After 2004, the percent of hogs raised on specialized farms remained relatively constant.

Phases of hog production: breeding and gestation, farrowing, nursery, and finishing.

continued on next page ►

Scale of operations

All hog farms

Hog production shifted to larger operations from 1992 to 2015. Between 1992 and 2009, hog farms became larger, and the number of hogs sold or removed per farm increased by more than 8.5 times. Between 2009 and 2015, farm size continued to increase but more slowly.

Feeder-to-finish operations

After increasing 798 percent between 1992 and 2009, the number of hogs sold or removed per feeder-to-finish operation increased only 6 percent between 2009 and 2015.

Farrow-to-finish operations

The number of hogs sold or removed per farrow-to-finish operation rose 349 percent between 1992 and 2009 and then declined 19 percent between 2009 and 2015.

Use of production contracts

The percent of hog operations using production contracts increased by a factor of 16 between 1992 and 2009 but remained relatively constant between 2009 and 2015.

Between 1992 and 2004, the percent of hogs raised under a production contract increased by a factor of 13. From 2004 to 2015, the share of hogs raised under contract remained relatively stable.

Contract production dominates the North Carolina hog sector, while farms in Iowa and Minnesota are operated by independent producers and contract producers. In 2017, these three States produced slightly more than half of all hogs sold in the United States.

Costs of production

Between 1992 and 2015, hog production became more efficient. Inflation-adjusted (real) production costs per hundredweight declined continuously over the period and by 2015 were 41 percent of those incurred in 1992.

Real production costs per hundredweight also declined on feeder-to-finish farms from 1992 to 2015, but costs followed a different pattern on farrow-to-finish farms, declining until 2009 and increasing thereafter.

Labor productivity

Hog operations rely on a mix of paid and unpaid labor, though from 1998 to 2015, paid labor replaced much of the unpaid labor in the sector.

Between 1992 and 2015, both types of labor became more productive. From 1992 to 1998, the total labor hours used to produce 100 pounds of weight gain declined by 58 percent. From 1998 to 2015, labor productivity continued to increase, albeit more slowly.

On farrow-to-finish operations, labor productivity increased between 1992 and 2009, with paid labor replacing unpaid labor as total labor requirements declined from 2004 to 2009. On feeder-to-finish operations, the bulk of labor productivity increases occurred between 1992 and 1998.

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and the USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey and 2017 Census of Agriculture.

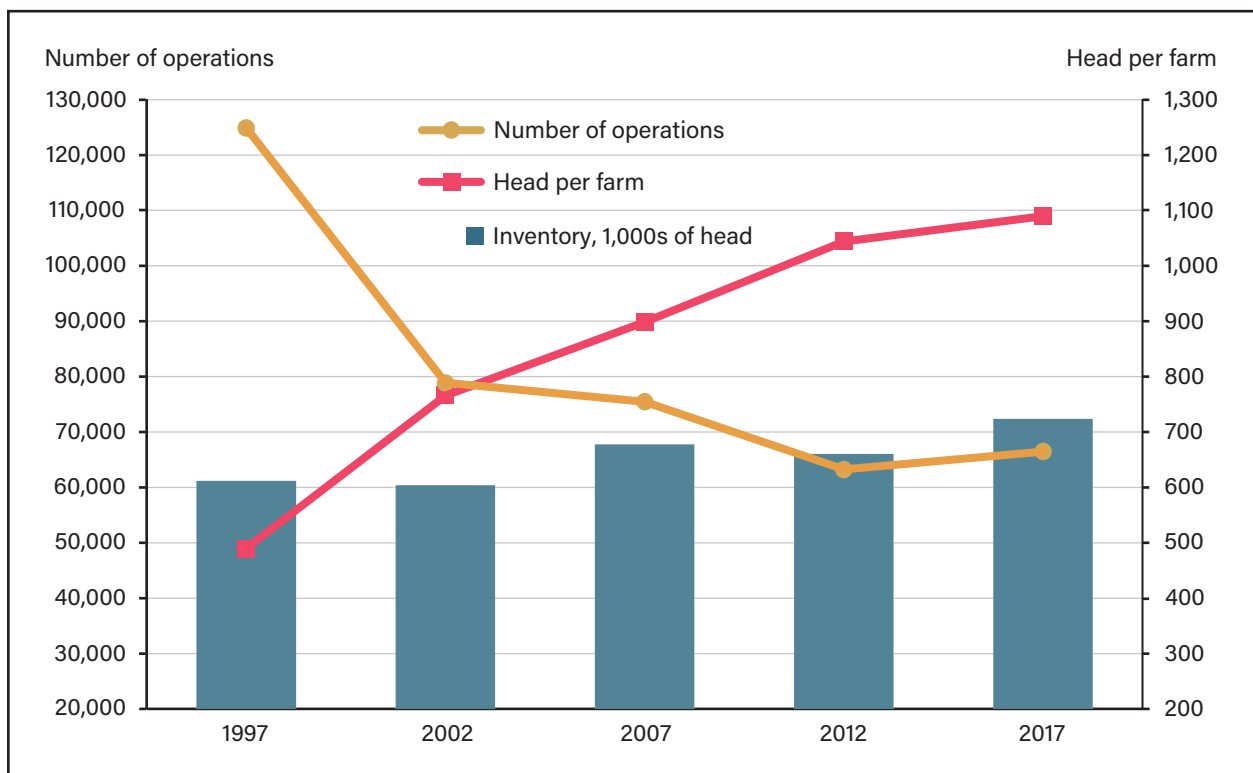
Hog Sector Trends in Production, Producer Characteristics, Specialization, and Contract Use

Hog production trends up while the number of operations declines

According to U.S. Census of Agriculture data, between 1997 and 2017, the U.S. hog sector transformed such that, by the end of the period, production occurred on larger and fewer farms. The number of hog operations with inventory declined by approximately one-third between 1997 and 2002 and then began to level off (figure 2). In contrast, the average farm size, measured by hogs per farm, roughly doubled between 1997 and 2012 but remained relatively stable afterward.

At the same time, sector-wide hog inventory fluctuated little from 1997 to 2017, yet inventory in 2017 ended 18 percent higher than in 1997. Moreover, the average slaughter weight increased from 256 to 289 pounds (USDA, NASS, 2019a). Thus, at slaughter each hog weighed an additional 33 pounds in 2017 compared with 1997, and the overall weight of the hog inventory grew 34 percent. These two factors—more hogs and larger hogs—contributed to an increased supply of U.S. pork.

Figure 2
U.S. hog operations, hog inventory, and head per farm: 1997-2017



Note: Data reported are the number of hogs in inventory, the number of operations with inventory, and the average farm size, measured as the head of hogs per farm.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service (NASS) 1997, 2002, 2007, 2012, and 2017 Census of Agriculture.

Over the two decades from 1997 to 2017, production shifted from farms with fewer than 5,000 head to those with 5,000 or more head (table 1), with the share of inventory dramatically declining on farms with fewer than 2,000 head. As of 2017, roughly 93 percent of hog inventory was on farms with 2,000 or more head, a change largely driven by the increase in the share of inventory on farms with 5,000 or more head from 40 percent in 1997 to 73 percent in 2017.

Table 1
U.S. hog operations and percentage of hog inventory by farm size, 1997 and 2017

Head	1997		2017	
	Operations	Inventory	Operations	Inventory
	<i>Number</i>	<i>Percent</i>	<i>Number</i>	<i>Percent</i>
1–99	74,837	2.2	52,123	0.7
100–499	26,903	10.8	2,671	0.9
500–999	10,378	11.6	1,305	1.3
1,000–1,999	6,597	14.4	2,016	3.8
2,000–4,999	4,323	20.8	4,724	20.6
5,000 or more	1,851	40.2	3,600	72.8
U.S. total	124,889	100.0	66,439	100.0

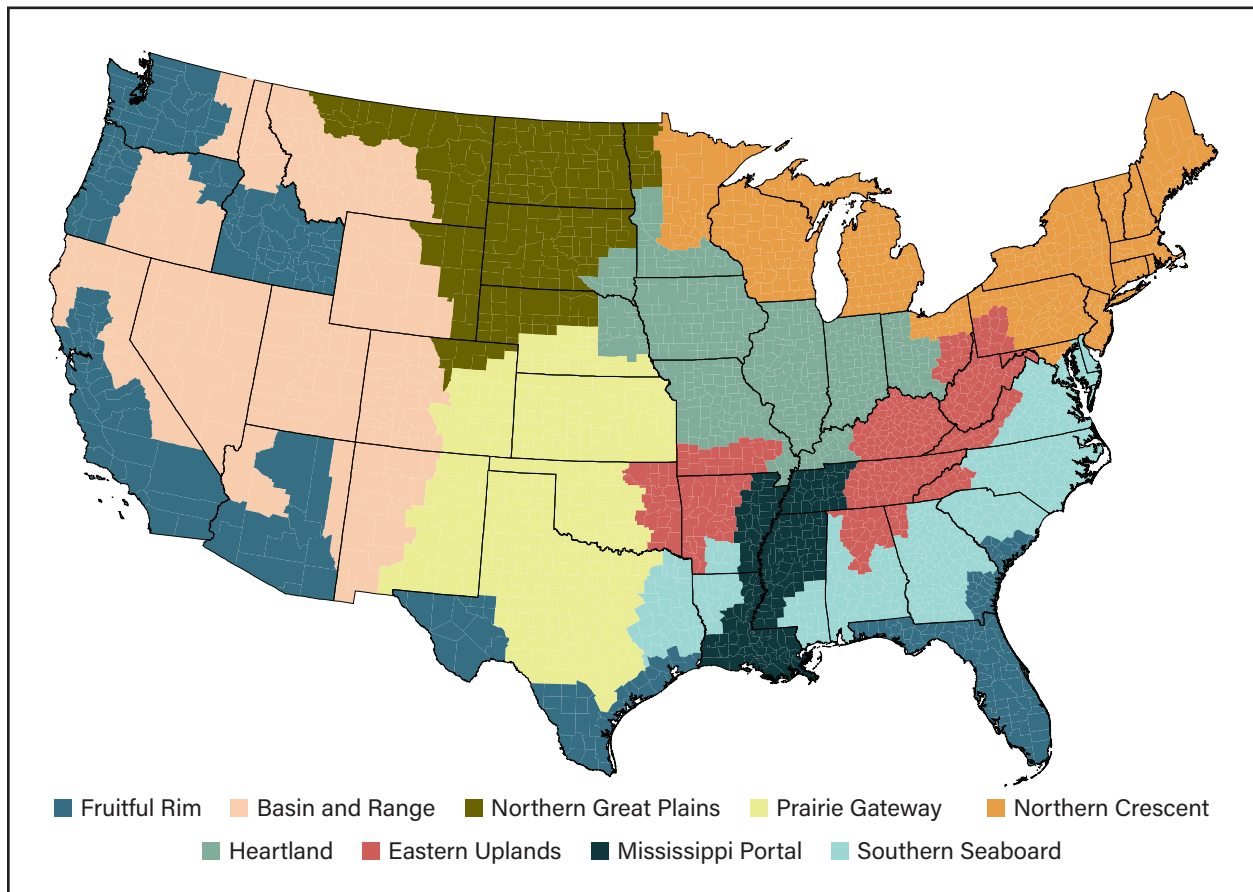
Note: Data are from the end of December in 1997 and 2017.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 1997 and 2017 Census of Agriculture.

Hog production shifts across regions, increasing operations outside of the Heartland

The geographic distribution of hog production differs from the historical production pattern. Figure 3 shows the location of nine USDA, Economic Research Service farm resource regions throughout the United States. Throughout most of the 20th century, hog production was concentrated in the Heartland Region near feed-corn production and interregional transportation systems (Roe et al., 2002). However, during the 1990s, larger numbers of hog farms began locating in the Southern Seaboard Region, primarily in North Carolina, with increased use of production contracts (McBride and Key, 2013). Familiarity with poultry contract production in the Southern Seaboard Region likely contributed to the acceptance of contracts for hog production in North Carolina (Rhodes, 1995).

Figure 3
U.S. farm resource regions



Note: The Western regions include the Prairie Gateway, Northern Great Plains, and Basin and Range regions.

Source: Heimlich, R. 2000. *Farm Resource Regions*, AIB-760, U.S. Department of Agriculture, Economic Research Service, August 2000.

The newly established hog operations in the Southern Seaboard Region were significantly larger than those in the Heartland Region (Rhodes, 1995); however, North Carolina’s 1998 moratorium on new and expanding hog operations limited hog production growth (NCDEQ, undated). The moratorium became permanent in 2007 and requires any new farms or expanded facilities to meet performance standards. The moratorium was partly responsible for the corresponding rapid growth in hog production in the Western regions, a process that began in 1992 (Key and McBride, 2007). Proximity to commercial feed facilities also contributed to the growth of hog production in the Western regions during the 1990s (Roe et al., 2002), though during the same period North Carolina hog operations clustered near slaughter facilities (Roe et al., 2002).

Based on 2015 ARMS data, 67 percent of U.S. hog operations were in the Heartland Region (table 2). The Heartland Region contained the largest proportion of each type of operation and most of the farrow-to-finish and feeder-to-finish operations, primarily because of the large supply of corn and soybeans produced in the region. Farrow-to-feeder operations were plentiful in the Western regions, however, as were wean-to-feeder operations in the Southern Seaboard Region.

Table 2

U.S. hog farm and producer characteristics, by type of producer, 2015

Item	Farrow-to-finish	Farrow-to-feeder	Feeder-to-finish	Wean-to-feeder	All producers
Percent of farms ¹	19	7	60	6	100
Total acres operated	581	120	591	288	527
Operator age (years)	59	55	54	58	55
Age 65 years or older (percent ²)	47	39	14	24	22
College degree (percent ²)	37	33	19	17	25
Region (percent ²)					
Heartland	70	42	73	49	67
Northern Crescent	8	3	4	8	6
Southern Seaboard	0	9	7	31	7
Other regions ³	22	46	16	11	19

Notes: Some producers refused to respond or did not know the answer to a question. The reported data are based on the percent of the total producers who responded to a question.

¹ The sum of percent of farms does not equal 100 because some farms could not be classified by type or were farrow-to-wean operations for which few observations were available.

² Percent of farms.

³ Includes the Eastern Uplands, Prairie Gateway, Northern Great Plains, and Basin and Range regions.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2015 Agricultural Resource Management Survey.

Producer characteristics vary by operation type

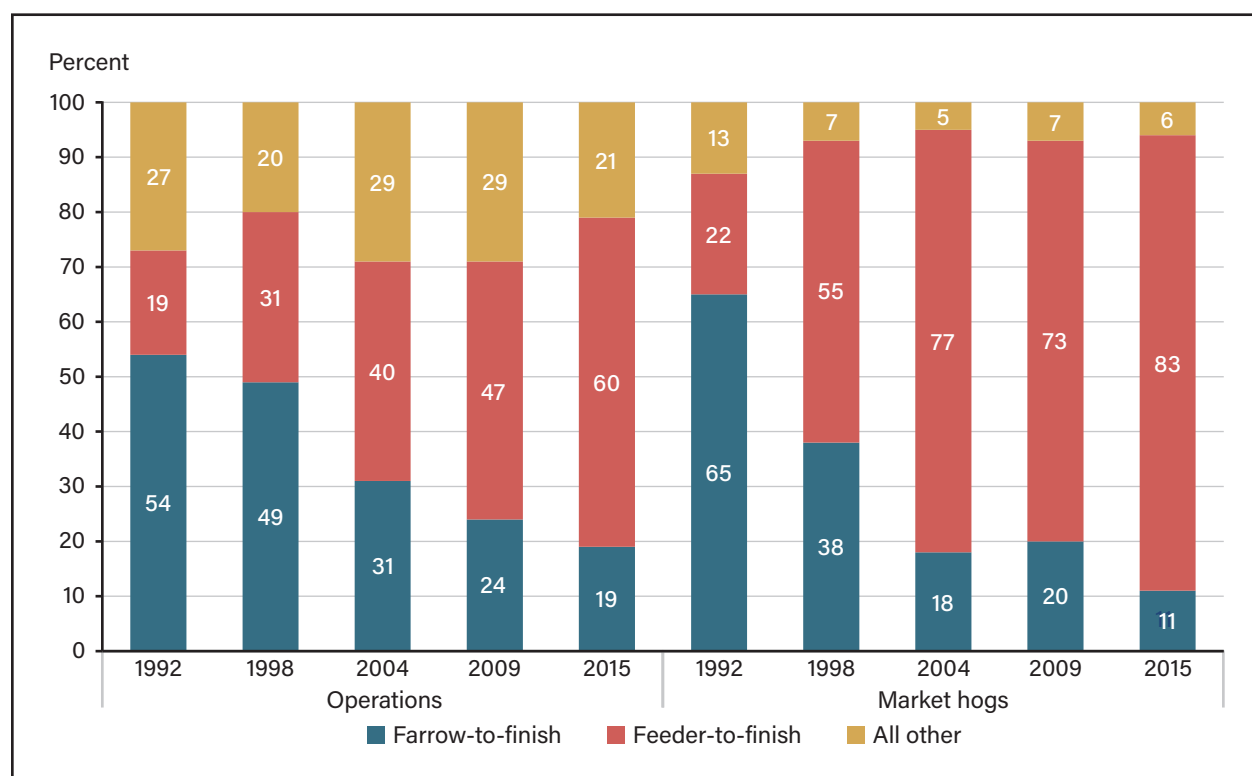
The U.S. Census of Agriculture indicates that the average age for all U.S. producers was 58 years in 2017, and 34 percent of all producers were 65 years or older (USDA, NASS, 2019a). In comparison, the 2015 ARMS data indicate that hog producers were 55 years of age, on average; and 22 percent were 65 years or older (table 2). Farrow-to-finish producers were the oldest with an average age of 59 years, while feeder-to-finish producers were the youngest with an average age of 54 years. The percent of producers 65 years or older was greatest on farrow-to-finish operations at 47 percent, compared to only 14 percent who were 65 years or older on feeder-to-finish operations. Twenty-five percent of all hog producers held a 4-year college degree. Across all producer types, farrow-to-finish producers were most likely to have a college degree.

In addition, the 2017 Census indicates that only 2 percent of farms operated by a beginning producer specialized in hog production (USDA, NASS, 2020), where a beginning producer is one who has spent 10 years or less operating any farm or ranch. The 2015 ARMS data reveal that 17 percent of hog farms were operated by a beginning producer across all regions; 14 percent in Iowa and Minnesota, key hog-producing States in the Heartland Region; and 8 percent in North Carolina, the key hog-producing State in the Southern Seaboard Region. Startup costs for hog production can be significant, particularly for beginning producers. For example, in 2014 Dhuyvetter et al. (2014a, 2014b) estimated that a farrow-to-finish operation with a capacity of 1,200 sows required a new facility investment of more than \$4 million, while finishing facilities with a slatted floor and deep pits for liquid manure handling, such as facilities needed on feeder-to-finish operations, required a cost of almost \$200 per pig.

Hog farm specialization increased over time

As hog operations grew larger, many operations specialized in one or two production phases, shifting from the traditional system of farrow-to-finish operations that raised hogs and pigs on one farm from birth to slaughter weight. The share of producers that raised hogs on farrow-to-finish operations declined from 54 percent in 1992 to 19 percent in 2015 (figure 4; table 3). Over the same period, the share of market hogs raised on farrow-to-finish operations declined from 65 to 11 percent. However, specialized hog finishing operations became more prevalent. Both the share of hog farms that were feeder-to-finish operations and the percent of hogs raised on feeder-to-finish operations increased between 1992 and 2015. The most dramatic shift to feeder-to-finish operations occurred between 1992 and 2004, when 40 percent of hog farms were feeder-to-finish operations producing 77 percent of all market hogs. By 2015, 60 percent of hog farms were feeder-to-finish operations, producing 83 percent of all market hogs.

Figure 4
U.S. hog production shifts to specialized operations, 1992-2015



Source: USDA, Economic Research Service (ERS) using data from the ERS 1992 Farm Costs and Returns Survey and USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.

In addition to raising hogs, some producers raise and sell other livestock or grow crops. Some hog farms that produce corn and soybean crops grow their own hog feed (Key and McBride, 2007). Over time hogs have commanded a larger average share of the value of farm production (table 3). Between 1992 and 2015, the share of farm product value from hogs increased from 46 to 79 percent. Over the same period, the share of farm product value from hogs increased by 17 percentage points on farrow-to-finish operations and more than doubled on feeder-to-finish operations.

Table 3

Selected characteristics of U.S. hog farms by producer type, 1992-2015

Producer/Item	1992	1998	2004	2009	2015
Farrow-to-finish					
Operations ¹ (percent of U.S. hog operations)	54	49	31	24	19
Market hogs sold/removed ¹ (percent of hogs)	65	38	18	20	11
All hog sales/removals (head per farm)	886	1,239	1,472	3,980	3,223
Farm product value from hogs (percent)	48	47	59	58	65
Feeder-to-finish					
Operations ¹ (percent of U.S. hog operations)	19	31	40	47	60
Market hogs sold/removed ¹ (percent of hogs)	22	55	77	73	83
All hog sales/removals (head per farm)	804	2,756	4,730	7,222	7,672
Farm product value from hogs (percent)	35	54	72	71	79
All hog and pig producers					
All hog sales/removals (head per farm)	945	2,589	4,646	8,389	8,721
Farm product value from hogs (percent)	46	56	67	70	79

Note: ¹ The percent of operations and percent of sales/removals will not sum to 100 because not all producer types are shown (see table 2).

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and the USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.

For all types of operations in 2015, the total value of production, which includes hog, pig, and other production, averaged \$1.77 million per farm (table 4). Total acres operated averaged 527 acres per farm, with an average hog production value of \$1.39 million. Feeder-to-finish operations were the largest, with an average of 591 acres and an average farm product value of \$2.22 million. In contrast, farrow-to-feeder operations were smallest in terms of both acreage and sales, with an average of 120 acres and a farm product value of \$693,000. In 2015, most (91 percent) farrow-to-finish operations sold crops or other livestock in addition to hogs, whereas 60 percent of farrow-to-feeder operations were completely specialized in hog production.

Table 4
U.S. farm characteristics by type of hog producer, 2015

Item	Farrow-to-finish	Feeder-to-finish	Farrow-to-feeder	Wean-to-feeder	All producers
Percent of farms ¹	19	60	7	6	100
Total acres operated	581	591	120	288	527
Value of farm production (\$1,000)	876	2,221	693	1,360	1,767
Value from hogs (\$1,000)	567	1,758	653	1,048	1,391
Share of farms with 100 percent of value of production from hogs ²	9	24	60	24	24

Notes: Some producers refused to respond or did not know the answer to a question. The data reported are based on the percent of the total producers that responded, excluding the nonresponse.

¹ The sum of percent of farms does not equal 100 because some farms could not be classified by type or were farrow-to-wean operations for which few observations were available.

² Percent of farms for which all of the value of farm production was from hogs.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2015 Agricultural Resource Management Survey.

Growth in contract production coincides with increased specialization

Another key transformation of the hog sector was the shift from independent hog production to contract production. Nearly all hog operations were independent in 1992 (97 percent); but by 2015, less than half of all operations (47 percent) were independent (table 5). The percentage of hogs produced under contract had an even more dramatic shift—in 2015, 69 percent of hogs were raised on contract operations compared to only 5 percent in 1992.

The extent of production contract use varied by the type of hog producer (table 5). In 2015, wean-to-feeder and feeder-to-finish operations relied the most on contract production, while few farrow-to-finish operations used production contracts. Sector-wide, production contract use increased between 1992 and 2015 (as shown by data for “all hog and pig producers” in table 5), though the share of contract operations grew by a slower rate in each successive period, increasing only 5 percentage points from 2009 to 2015 versus 20 percentage points from 2004 to 2009. The percent of hogs produced under contract also increased from 1992 to 2009 but stayed relatively constant between 2009 and 2015. These data suggest a leveling-off in the share of contract production, driven by slow-to-moderate growth in contract production since 2004 on feeder-to-finish operations, which make up 60 percent of hog farms (table 4).

Figure 5 shows the changes in production contract use, farm specialization, and farm size from 1992 to 2015. “Specialization” reflects the percentage of hogs that were produced on an operation that specialized in one or two production phases rather than on a farrow-to-finish operation. “Contract use” shows the percent of hogs produced on a contract operation across all farm types. “Head per farm” shows the average number of hogs produced on all hog farms. All three measures trended upward throughout the study years, showing how increased use of contracting occurred alongside increased farm size and specialization.

Table 5

U.S. production contract use by type of hog producer, 1992–2015

Producer/Item	1992	1998	2004	2009	2015
Feeder-to-finish					
Contract operations (percent of operations)	11	34	50	74	71
Contract production (percent of hogs)	22	62	73	79	80
Farrow-to-feeder					
Contract operations (percent of operations)	N/A	19	N/A	9	14
Wean-to-feeder					
Contract operations (percent of operations)	N/A	N/A	N/A	98	99
All hog and pig producers					
Contract operations (percent of operations)	3	15	28	48	53
Contract production (percent of hogs)	5	40	67	71	69

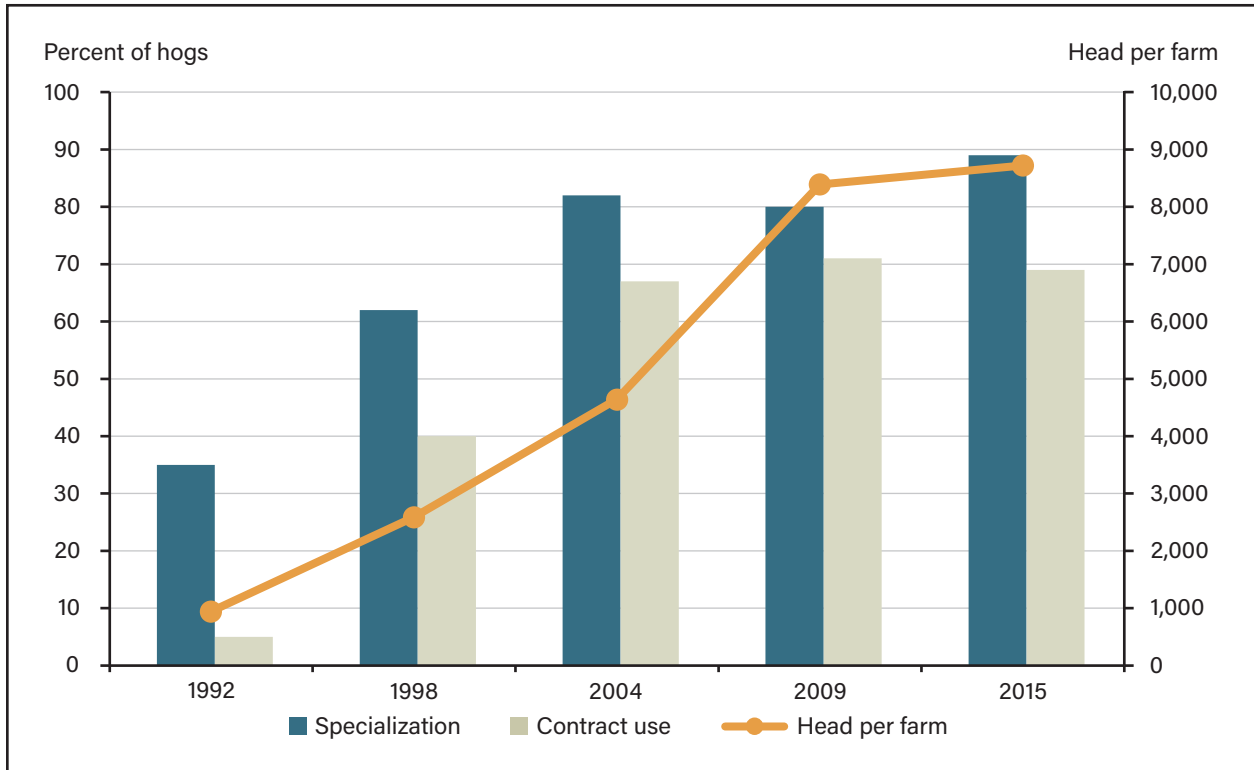
N/A = data not available.

Notes: Data covering farrow-to-wean and wean-to-feeder operations were not collected in 1992. Hogs represent hogs sold/removed from farms.

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and the USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.

Figure 5

Specialization, production contract use, and farm size, U.S. hog farms, 1992-2015



Note: "Specialization" reflects the percent of hogs sold or removed from farms other than farrow-to-finish operations; "Contract use" is the share of hogs raised under a production contract; and "Head per farm" reflects the sector-wide, average number of hogs sold or removed per farm.

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and the USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.

Farm management differs for independent and contract producers

Farm management is affected by the type of business arrangement hog producers have with hog buyers and input suppliers.

Independent producers control all aspects of the operation, own the hogs and feed, and face all market and production risks. Independent producers make all business decisions, including determining the type of animal to raise and which feed to use. They secure the labor and facilities used to produce hogs and then market and transport the hogs. Independent producers generally market hogs locally and/or sell directly to packers (Plain and Mintert, 2006). The risks faced by independent producers include those associated with input procurement costs, hog growth and quality, locating buyers, transportation, and pricing.

Under contract production, some decisions for the hog enterprise are made by the contractor while others are made by the producer, or contract grower. For a typical production contract, the contractor owns the hogs and feed while the grower raises the animals on their farm. The contractor, sometimes referred to as an integrator, may contract with multiple growers. The contractor typically provides some of the inputs, such as feeder pigs, feed, veterinary services, and medicine. The grower receives a fee for raising the hogs, which may include an incentive tied to feed efficiency (MacDonald and McBride, 2009). Many of the management decisions are made by the contractor, who in many cases determines the methods and procedures used to grow, feed, manage, and market hogs. Production contracts generally reduce grower price risks because payments are usually unrelated to input costs or hog prices (Johnson and Foster, 1994; Martin, 1997). Because the contractor provides feed, animals, and other inputs, the contract grower generally has lower credit needs than a similar-sized independent producer (Key and McBride, 2003).

Both contractors and contract growers are subject to certain provisions of the 1921 Packers and Stockyards Act that prohibits contractors from using unfair and anti-competitive practices and provides some recourse for resolving disputes and breaches of contract (USDA, AMS, undated).

More details on production contract use are covered later in this report when we contrast business arrangements used across regions.

Technological Changes and Efficiency Gains Underlie Production Costs, Labor Productivity, and Housing Advances

The primary inputs of hog production are feed, energy, labor, housing, and pigs. Hog farm productivity reflects how efficiently these inputs are transformed into hog weight gain (Key and McBride, 2007).

Technological innovation improves on-farm productivity such that weight gain is higher for a given number of inputs. Innovation covers changes in all aspects of the hog production process, such as genetics, nutrition, housing, veterinary and medical services, and hog farm management technology (Key and McBride, 2007).

Farm-level total factor productivity (TFP) measures the quantity of farm output per unit of inputs. TFP depends on the production technology available, which determines the rate at which inputs can be combined to yield outputs. Other factors influencing TFP are whether farms are operating at an efficient scale of production, how efficiently inputs are combined given the production technology, and how well the producer accounts for the relative prices of inputs. TFP on feeder-to-finish operations increased 6.3 percent per year between 1992 and 2004 (Key and McBride, 2007). During the same period, TFP on feeder-to-finish operations increased 6.7 percent annually in the Heartland Region and 8.6 percent annually in the Southeast region (Key and McBride, 2007).

This study does not estimate TFP but presents alternative measures of productivity, including two single-factor productivity measures from 1992 to 2015. The trends in production costs and input use provide additional insight into gains in production efficiency over time.

Productivity gains lead to lower production costs

Changing production costs reflect the evolution of the efficiency of hog production. As hog operations become more productive, production costs per 100 pounds of weight gain (cwt) decline. Table 6 displays inflation-adjusted (real) feed costs and production costs per cwt, where production costs include operating costs (e.g., feed, fuel, and repairs) and allocated overhead (e.g., hired labor, taxes, and the opportunity costs of land and unpaid labor) but exclude feeder and nursery pig costs, since feeder and nursery pigs are not inputs contributing to weight gain. From 1992 to 2015, real production costs per cwt fell by 59 percent for all hog and pig producers (table 6), with production costs declining 46 percent on farrow-to-finish operations and 54 percent on feeder-to-finish operations. Appendix table A-1 shows feed costs and production costs in nominal terms.

Table 6

Trends in real production costs per cwt by type of hog producer, 1992–2015 (2015 dollars)

Producer/Item	1992	1998	2004	2009	2015
<i>Dollars per cwt</i>					
Farrow-to-finish					
Feed costs ¹	61.70	50.88	48.11	31.20	36.13
Production costs ²	126.18	112.39	98.09	61.82	67.51
Feeder-to-finish					
Feed costs ¹	54.36	43.18	37.94	33.58	31.54
Production costs ²	103.47	73.49	56.33	51.41	47.49
All hog and pig producers					
Feed costs ¹	62.77	48.10	43.79	37.80	32.83
Production costs ²	131.05	99.32	77.11	63.39	53.36

cwt = hundredweight.

Notes: Feed costs are converted to 2015 dollars using the national agricultural feed price index, and total production costs are deflated to 2015 dollars using the national agricultural production items index (USDA, National Agricultural Statistics Service (NASS), Agricultural Prices).

¹ Feed costs are the sum of purchased and homegrown feed costs. Homegrown feed costs are computed using the opportunity cost approach of what the feed items could have earned on the market rather than being fed to hogs. The amounts of homegrown feed items fed to hogs are valued according to annual market prices for each item.

² Production costs are the total production costs (operating and allocated overhead) less costs for feeder and nursery pigs. Pig costs are excluded because pigs are not inputs contributing to weight gain. Production costs are from the USDA, Economic Research Service (ERS) Commodity Costs and Returns data product.

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and the USDA, NASS 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.

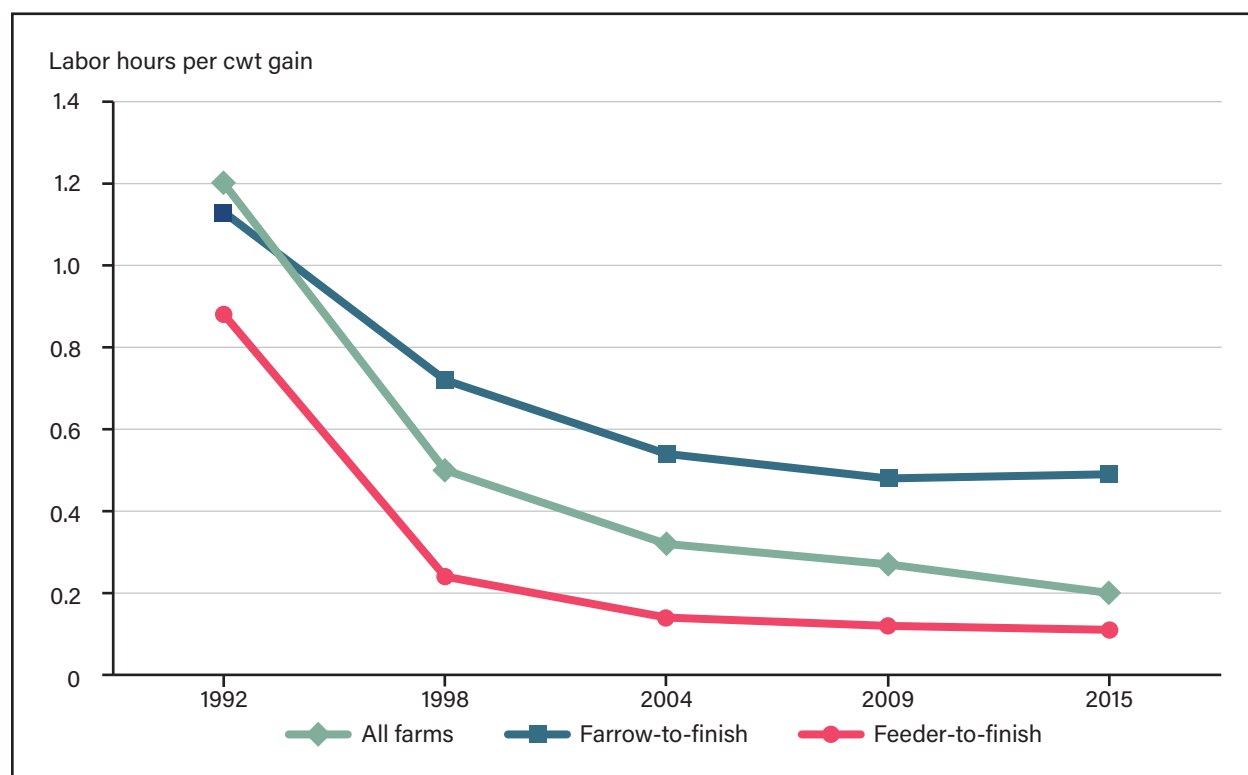
For all hog and pig producers, real feed costs per cwt declined by 48 percent from 1992 to 2015 (table 6), though feed costs vary by the type of hog operation, largely due to differences in feed requirements at different stages of production. For example, farrow-to-finish operations that include hogs on the farm for all growth phases require different feed rations from feeder-to-finish operations that begin the production cycle in the second growth phase (feeding). As a result, the use and cost of feed differ between the two types of operations, and feed typically makes up a smaller share of total operating costs on feeder-to-finish operations (Schnepf, 2011). Nonetheless, both farrow-to-finish and feeder-to-finish operations experienced similar declines in real feed costs per cwt from 1992 to 2015, at 41 and 42 percent, respectively (table 6).

Labor productivity rises over time

Hog operations rely on labor for feeding, watering, and barn cleaning, among other activities (Schlosser, 2001). Operations use hired labor and unpaid family labor. The metric used to examine changes in labor needs on hog operations over time is the number of hours used per cwt of gain. As technology advances and labor becomes more productive, fewer labor hours are needed to produce 100 pounds of weight gain.

Labor use on hog farms declined by 83 percent between 1992 and 2015, as the number of hours required to produce 100 pounds of weight gain shrank from 1.2 hours to 0.2 hours (table 7). For all types of hog farms, 100 pounds of weight gain required 6 times the number of labor hours in 1992 than in 2015. The bulk of the decrease in labor use occurred between 1992 and 2004 (figure 6).

Figure 6
Total labor used to produce 100 pounds of gain, by type of hog producer, 1992–2015



cwt = hundredweight.

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.

Among farrow-to-finish operations, total labor use per cwt of gain declined nearly 57 percent, from 1.13 hours per cwt in 1992 to 0.49 hours per cwt in 2015 (table 7). For farrow-to-feeder operations, labor use per cwt declined by more than 65 percent, from almost 3 hours per cwt of gain to just under 1 hour, whereas for feeder-to-finish operations, labor use decreased 87.5 percent, from 0.88 per cwt in 1992 to 0.11 per cwt in 2015.

In addition to using less total labor, hog operations substituted paid labor for unpaid labor. For all farms, paid labor comprised 34 percent of total labor per cwt in 1992 but 60 percent in 2015. For all farm types, paid labor per cwt declined from 0.41 hours in 1992 to 0.11 in 2004, with small increases in the following years (table 7). Unpaid labor declined throughout the 1992–2015 period, from 0.79 hours per cwt to 0.08 hours per cwt.

For farrow-to-finish operations, the substitution of paid for unpaid labor occurred after 2004, while the substitution took place gradually from 1992 to 2015 on feeder-to-finish operations. These findings about paid labor are reflected in general hog sector employment trends, where both employment and wages increased between 2011 and 2016 (Boessen et al., 2018). Between 1992 and 2007, each additional 1,000 hogs at a large-scale facility was associated with 0.57 hog facility jobs (Sneeringer and Hertz, 2013).

Table 7

Labor hours needed per cwt of gain, by type of hog producer, 1992–2015

	Farrow-to-finish	Farrow-to-feeder	Feeder-to-finish	Wean-to-feeder	All producers
1992					
Paid labor	0.38	1.08	0.17	N/A	0.41
Unpaid labor	0.75	1.73	0.71	N/A	0.79
Total labor	1.13	2.81	0.88	N/A	1.20
1998					
Paid labor	0.17	0.30	0.06	0.12	0.13
Unpaid labor	0.55	0.53	0.18	0.15	0.37
Total labor	0.72	0.83	0.24	0.27	0.50
2004					
Paid labor	0.13	0.63	0.04	0.09	0.11
Unpaid labor	0.41	0.59	0.10	0.20	0.21
Total labor	0.54	1.22	0.14	0.29	0.32
2009					
Paid labor	0.32	0.39	0.04	0.11	0.14
Unpaid labor	0.16	0.64	0.08	0.20	0.13
Total labor	0.48	1.03	0.12	0.31	0.27
2015					
Paid labor	0.31	0.75	0.05	0.10	0.12
Unpaid labor	0.18	0.23	0.06	0.16	0.08
Total labor	0.49	0.98	0.11	0.26	0.20

cwt = hundredweight. N/A = data not available.

Notes: The Agricultural Resource Management Survey (ARMS) data include labor hours supplied by non-paid workers and the hours and wages of paid workers in each survey year since 1992. For each survey from 1992 to 2015, hog producer types included farrow-to-finish, farrow-to-feeder pig, feeder pig-to-finish, and all farms. Beginning in 1998, two additional categories were added to reflect the hog industry's increasing specialization: farrow-to-wean and wean-to-feeder pig operations. Survey responses were used to calculate labor hours per hundredweight of (live weight) gain, broken out into paid and unpaid labor allocations.

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and the USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 ARMS.

Hog farms realized most labor productivity gains by 2004, with gains slowing after that time. Feeder-to-finish operations exhibited increased labor productivity between 1992 and 2009, as labor hours per cwt declined from 0.88 hours to 0.12 hours, with another small decline to 0.11 hours in 2015. Farrow-to-finish operations followed a similar pattern, with large gains in labor productivity between 1992 and 2009, from 1.13 hours per cwt of gain to 0.48 hours, followed by a small increase to 0.49 hours between 2009 and 2015.

The porcine diarrhea epidemic temporarily increased labor requirements

During the porcine epidemic diarrhea virus (PEDv) outbreak in 2013, hog producers controlled the spread of the disease through strict, labor-intensive biosecurity measures that included extensive cleaning and washing of hog facilities to prevent contamination caused by contact with fecal matter. The mitigation of disease transmission was most needed in the farrowing and weaning stage of production. During this stage, disease mitigation included controlling farm access and cleaning anything that touched the animals. For example, farrow-to-wean operations adopted biosecurity practices that included cleaning and disinfecting transport containers before and after delivering pigs (Perri et al., 2020). A literature review conducted by USDA's Animal and Plant Health Inspection Service (APHIS) suggested that contaminated feed might have been another source of disease transmission. The review pointed to the likelihood of multimodal mechanisms for disease transmission and indicated that current biosecurity methods may need to be adjusted to prevent the spread of disease (USDA, APHIS, 2019).

The increased labor needs resulting from the PEDv outbreak eliminated some of the earlier labor productivity gains. Two significant effects of PEDv were fewer piglets per farrowing and more time spent raising and finishing heavier-than-usual hogs as producers tried to offset production losses from PEDv-related deaths (Mathews, 2014). Thus, labor used per cwt increased not only because of labor-intensive, on-farm disease mitigation but also due to changes in both the number of piglets per litter and the length of time producers held hogs on the farm.

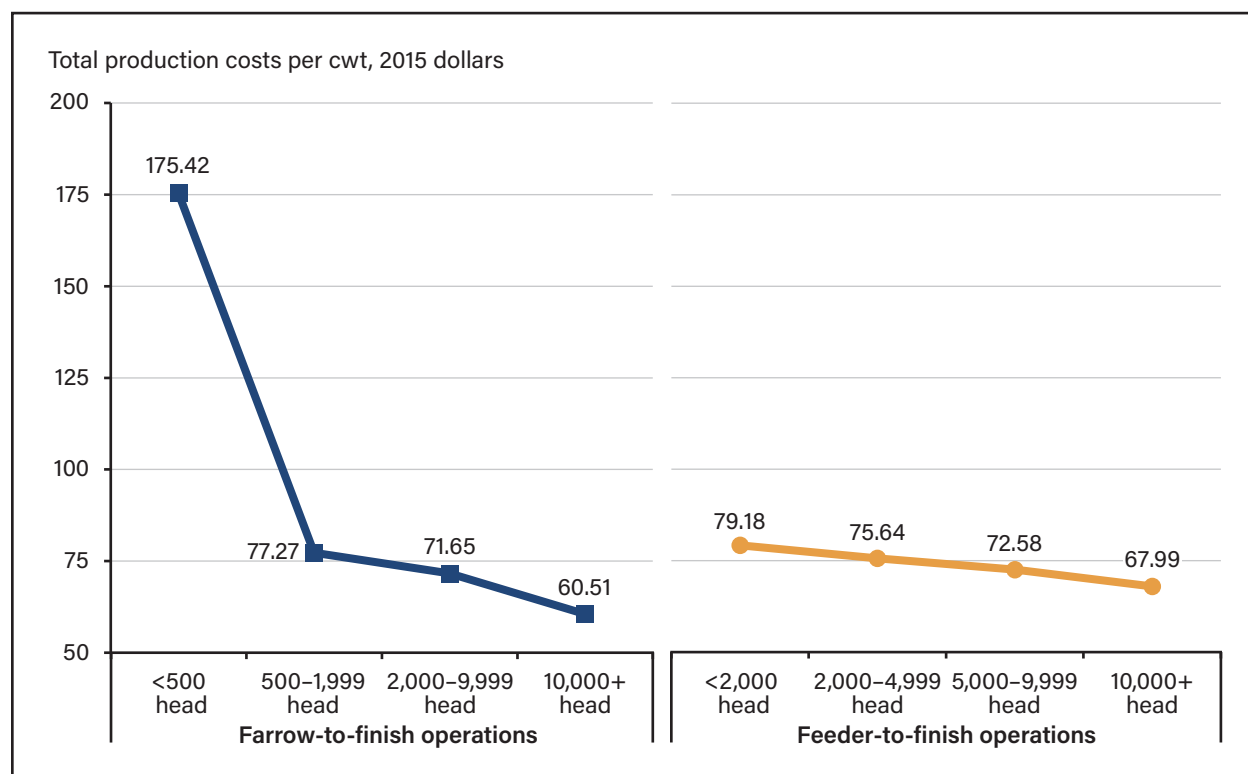
A vaccine for PEDv was developed in the late stages of the epidemic, and USDA authorized its use in 2014 (USDA, APHIS, 2014). Then, other commercial vaccines were developed for use in sows, who pass immunity to their piglets (Gerdt and Zakhartchouk, 2017). Recent research indicates that hog sector productivity has mostly recovered from the PEDv outbreak and by 2017 had returned to 2013 levels (Stalder, 2018). Ongoing research seeks to develop effective vaccines for mutations of PEDv (Won et al., 2020).

Economies of size are evident in U.S. hog production

Costs of production also vary by the size of hog operation. In 2015, total production costs per cwt were lower on operations with more hogs in inventory (figure 7), demonstrating the importance of scale economies for both farrow-to-finish and feeder-to-finish operations. The decline in total production costs per cwt with increasing farm size is especially pronounced among farrow-to-finish operations for which sufficient data were available to estimate costs for small operations with fewer than 500 head of hogs. Farrow-to-finish operations with fewer than 500 head incurred production costs per cwt almost 3 times higher than operations with 10,000 or more head. For feeder-to-finish operations, production costs per cwt were 14 percent higher on operations with fewer than 2,000 head than on those with 10,000 or more head.

Figure 7

Total production costs on U.S. farrow-to-finish and feeder-to-finish operations in 2015, by inventory size class



cwt = hundredweight.

Notes: Size classes are based on highest inventory during a given year. To ensure enough observations in each size class, classes differ between farrow-to-finish and feeder-to-finish operations. Total production costs include operating costs and allocated overhead.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2015 Agricultural Resource Management Survey.

Total production costs also fluctuate throughout the year. From 2004 to 2013, feed costs comprised between 43 and 70 percent of production costs on hog operations (Mintert, 2021). As a result, monthly fluctuations in total production costs since 2004 are largely explained by changing feed costs. Hog cost of production estimates produced annually by the USDA, Economic Research Service show that feed costs constituted 50 to 61 percent of operating costs and 39 to 51 percent of total economic costs during 2011–20. Corn is the largest component of most hog feed in the United States, and prices of other feed grains tend to follow corn prices (Schnepf, 2011). Consequently, corn prices have a sizable impact on feed costs (Langemeier, 2019). From 1992 to 2015, the farm-level corn price declined 27 percent in real terms (USDA, ERS Feed Grains Database), while real feed costs per cwt declined 48 percent (table 6), pointing to higher on-farm productivity.

Trends in farm management practices, feeding systems, and hog housing capacity

As farms became more specialized, hog producers adopted new management practices, feeding technology, and housing types. For example, all-in/all-out housing management commingles pigs of a similar age and weight and keeps the entire group together as it moves through the phases of farrowing, nursery, and growing/finishing (Laurent, 2017). The all-in/all-out system reduces the spread of disease by making it possible to sanitize the entire housing facility after each group of pigs vacates the house (Key and McBride, 2008), improving a hog producer’s ability to manage disease transmission (Owsley, 2012). Phase feeding, another recent management practice, is an age-specific feeding program to meet the varying protein and energy needs of hogs and pigs at different growth phases (Kansas State University, 2020).

The use of all-in/all-out housing and phase feeding may improve feed efficiency and reduce costs (Key and McBride, 2008; Owsley, 2012). When used together, the complementary practices are thought to maximize feed efficiency (Tokach et al., 2012). Using complementary production systems also simplifies record keeping because producers keep records on groups of pigs rather than on individual animals. Decision-making about feeding is also easier because the pigs are in groups with similar needs.

Since 2004, roughly half of U.S. hog producers have adopted phase-feeding practices (table 8). Similarly, hog producers have adopted all-in/all-out housing, though at varying rates depending on production phase. For example, in 2015, 12 percent of hog producers adopted all-in/all-out housing for the farrowing phase, while 50 percent adopted it for the finishing phase.

Table 8
Management practices used by U.S. hog producers, 2004-15

Management practice	2004	2009	2015
	<i>Percent of farms¹</i>		
Phase feeding	50	50	53
All-in/all-out farrowing	25	19	12
All-in/all-out nursery	30	32	24
All-in/all-out finishing	42	54	50

Notes: Data indicate the percent of farms using the listed management practice.

¹ Some producers refused to respond or did not know the answer to a question. These calculations are based on the percent of the total producers that responded, excluding the nonresponse.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2004, 2009, and 2015 Agricultural Resource Management Survey.

Hog housing capacity rises sharply, with large gains in the Southern Seaboard

The total capacity of hog housing for each phase of production reflects the scale of hog operations, which generally increased between 1992 and 2015 (table 9). For each phase of production, the average building capacity per farm more than quadrupled after 1992, with the largest increases occurring for the nursery phase, where building capacity in 2015 was 5 times larger than in 1992, and for the growing/finishing phase, where capacity in 2015 was 6.6 times larger than in 1992. For both the nursery and growing/finishing phases, the largest increases in building capacity occurred between 2004 and 2009.

The increased building capacity provides benefits in farm management. Many facilities with larger building capacities are fitted with feeding, watering, and manure-handling technologies that increase labor productivity by enabling fewer workers to supervise the animals' care. Thus, increases in building capacity point to increases in the scale of production, which likely contributed to reductions in the labor hours required per cwt of gain (table 7).

Table 9

Average building capacity for hog production per farm by phase of production, 1992-2015

Production phase	1992	1998	2004	2009	2015
<i>Building capacity (head per farm)</i>					
Breeding/gestation	104	162	170	401	474
Farrowing	30	73	74	143	132
Nursery	286	563	763	1,392	1,715
Growing/finishing	431	850	1,233	2,349	2,828

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and the USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.

Major shifts in building capacity occurred across key hog-producing regions (table 10). In 1992, the Heartland Region had the largest building capacity for breeding, farrowing, and growing/finishing. From 1992 to 2015, building capacity for each phase of production mostly increased, except in the Western regions, where the building capacity for each phase declined between 2009 and 2015. In contrast, the percent growth in building capacity between 2009 and 2015 for each phase of production was highest in the Northern Crescent Region, where building capacity was relatively low throughout the period and gains from scale economies had not yet been realized.

Between 1992 and 1998, the growth rate of building capacity in the Southern Seaboard Region far outpaced that of other regions for each phase of production (table 10). During the 1990s in North Carolina, the hog sector swiftly transformed from small operations with fewer than 25 head to large-scale, commercial farms (Furuseth, 2001). After 1998, the building capacity for all production phases was largest in the Southern Seaboard Region, where contract production dominates.

Table 10

Average building capacity for hog production per farm by production phase and region, 1992–2015

Year	Region			
	Heartland	Northern Crescent	Western regions	Southern Seaboard
	<i>Breeding capacity (head per farm)</i>			
1992	117	110	126	93
1998	154	113	148	400
2004	192	121	122	428
2009	357	284	207	1,264
2015	559	510	146	1,999
	<i>Farrowing capacity (head per farm)</i>			
1992	36	26	32	31
1998	58	59	58	285
2004	89	52	42	269
2009	104	79	96	664
2015	137	205	32	793
	<i>Growing/finishing capacity (head per farm)</i>			
1992	464	393	431	443
1998	749	511	1,002	2,913
2004	1,310	572	609	3,451
2009	2,484	1,022	1,835	3,895
2015	3,055	2,252	1,274	6,178

Note: The Western regions include the Prairie Gateway, Northern Great Plains, and Basin and Range regions.

Source: USDA, Economic Research Service using data from the 1992 Farm Costs and Returns Survey and the USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.

Antibiotic use to promote growth declines and is now prohibited

While currently prohibited, subtherapeutic levels of antibiotics were used as growth promoters in livestock at both the nursery and finishing stages from the 1970s until 2017 (Sneeringer et al., 2015). The Veterinary Feed Directive (VFD) final rule, enforced in 2017, prohibits the use of antibiotics important to human medicine for the purposes of livestock production (for example, for growth promotion or improved feed efficiency) (U.S. FDA, 2015; Sneeringer et al., 2019). Even before the VFD rule, the use of antibiotics for growth promotion had declined. From 2004 to 2015, the ARMS data show that farrow-to-finish operations reduced the share of hogs receiving antibiotics for growth promotion in the nursery stage from 57 to 28 percent, in the finishing stage from 60 to 27 percent, and in feeder-to-finish operations from 51 to 39 percent. For more information, see the U.S. Food and Drug Administration's 2020 summary report on the domestic sales and distribution of medically important antibiotics approved for use in food-producing animals (U.S. FDA, 2021).

Hog Farm Performance Based on Cash Income Statements and Other Financial Indicators

In this section, we examine the financial health of the hog sector by comparing measures of financial performance using data obtained from the Agricultural Resource Management Survey (ARMS). Key financial indicators include net cash income, net farm income, debt-to-asset ratio, and off-farm income. Note that, except for off-farm income, the financial indicators discussed here are whole-farm and include costs of operating the entire farm operation rather than just those specifically related to hog production. Off-farm income refers to the household of the primary operator. The ARMS Phase 3, Hog Commodity Version collected the data used to assess farm finances, soliciting data covering whole-farm operations and the primary operator's household (USDA, ERS, 2019a).

To provide a perspective on the financial condition of hog farms and hog producers for 2009 and 2015, we looked at farm income, labor and feed costs, the debt-to-asset ratio, interest expenses, and off-farm income. Net cash farm income provides a measure of farm profitability and includes income from cash receipts, cash farm-related income, and Government farm program payments, less cash expenses paid during the year (Key et al., 2019). Changes in farm cash receipts over time occur when farm prices rise or fall. Net farm income is a broader measure of farm profit that also includes noncash income, such as the value of inventory change, economic depreciation, and noncash costs such as capital consumption (Patrick et al., 2016).

The debt-to-asset ratio, measured as total farm debt divided by total farm assets, is an indicator of bankruptcy risk. Farms with a higher debt-to-asset ratio are generally more highly leveraged and are less able to cover potential financial liabilities through the sale of assets, putting them at greater risk of default.

Off-farm income is important to the economic well-being of many U.S. farmers (Mishra et al., 2009). On average, U.S. farm households earn one-third to one-half of their income from farming (Prager et al., 2017). In general, net farm income is volatile from year to year: for the period 1998–2013, the median annual change in farm income between any two consecutive years (\$118,000) was larger than the median farm income over the period (\$73,000) (Key et al., 2018). Thus, off-farm income is important to farm households because it stabilizes farm household income (Chang and Mishra, 2008). Households operating small hog farms in some regions may partially adapt to shortfalls in farm-level performance by increasing their off-farm income (Nehring and Fernandez-Cornejo, 2005; Fernandez-Cornejo et al., 2007).

The discussion below follows three perspectives of the financial health of the hog sector: the aggregate hog sector over time, farm performance by producer type, and comparisons of contract and independent operations in the Heartland Region.

Sector-wide hog farm performance in 2009 and 2015

The income statement shows the flows of income and expenses of the farm operation over 1 year (Williamson, 2017). The income statement for all hog operations (table 11) shows nominal average whole-farm revenues, costs, and farm income during the years 2009 and 2015. The statement points to changes in farm income over those years, which is buffered by off-farm income.

The sales from livestock and production contract income for hogs increased between 2009 and 2015. Livestock sales rose 58 percent, ultimately comprising over half of gross cash income in 2015, while production contract income for hogs increased 9 percent. Crop sales increased 3 percent and comprised one-fourth of gross cash income. Overall, gross cash income increased 33 percent, with the share from crop sales and production contract income for hogs declining between 2009 and 2015.

Total cash expenses also increased in 2015 relative to 2009, with both variable and fixed cash expenses increasing between 20 and 25 percent. Expenses for feed, labor, fuel and oil, repairs and maintenance, utilities, and livestock purchases made up nearly 70 percent of total variable expenses in 2009 and 2015. Feed and livestock ranked the highest among these six expense categories; feed costs alone comprised 30 percent or more of variable expenses in both years. Thus, livestock purchases and feed costs, which increased by 45 and 46 percent, respectively, mainly drove the increase in variable expenses between the 2 years. Feed costs were already relatively high in 2008-09 due to high corn and soybean prices (Giamalva, 2014; Zering, 2009) and further increased between 2009 and 2015. In contrast, variable cash expenses for labor and fuel and oil declined between 2009 and 2015.

In 2009 and 2015, fixed cash expenses accounted for almost one-fifth of total cash expenses. Fixed expenses include those for real estate and property taxes, interest, insurance premiums, and rent and lease payments for land, vehicles, tractors, farm machinery, equipment, and structures (USDA, ERS, 2019c). The rise in fixed cash expenses between 2009 and 2015 was largely driven by a 51-percent increase in rent and lease payments and a 26-percent increase in insurance premiums; combined, these two categories accounted for 70 percent of fixed cash expenses in 2015. Cash expenses for interest payments, the second-largest fixed expense, were between \$20,000 and \$25,000 in both years.

Table 11

Income statements and financial indicators for all hog farms, 2009 and 2015

	2009	2015
Number of observations	1,286	830
Number of farms	24,459	21,856
<i>Dollars per farm</i>		
Gross cash income	593,332	787,629
Production contract income for hogs	68,297	74,740
Livestock sales	289,218	456,262
Crop sales	192,628	197,929
Total cash expenses	456,733	559,451
Variable cash expenses	372,557	454,667
Feed	110,545	161,357
Labor	37,228	34,963
Fuel and oil	24,398	20,333
Repair and maintenance	24,396	28,820
Utilities	12,857	13,405
Livestock purchase	41,495	60,074
Other variable expenses	121,636	135,715
Fixed cash expenses	84,177	104,784
Interest	24,986	21,904
Insurance	14,086	17,811
Rent and lease payments	37,023	55,726
Other fixed expenses	8,081	9,343
Net cash farm income	136,599	228,179
Net farm income	105,522	166,396
Off-farm income, principal operator's household¹	42,430	69,905
Debt-to-asset ratio	19	20

Notes: The number of observations indicates the number of completed questionnaires for which we have sufficient data for analysis. The number of farms indicates the represented number of farms in the target population after applying survey weights to each observation. Gross cash income has sources other than sales of livestock and crops, including contract fees, which are not reported; thus, gross cash income exceeds the sum of livestock and crop sales. Livestock sales include sales of hogs, excluding those produced under contract, and sales of other livestock. For contract operations, feed expenses include those incurred by both the contractee and the integrator.

¹ There were 1,205 and 790 observations for this variable for 2009 and 2015, respectively.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2009 and 2015 Agricultural Resource Management Survey.

In 2009 and 2015, net farm income was over \$100,000 (table 11); however, the year 2009 was challenging for the hog sector, with pressures on farm income coming from the demand and supply sides. Decreased consumer demand during the Great Recession caused hog prices to decline (Widmar, 2016), and the combination of high feed costs and lower prices led to losses for some hog producers (Giamalva, 2014; Zering, 2009). Off-farm income helped buffer on-farm income. Principal operators of hog farms earned \$42,430 in off-farm income in 2009 and \$69,905 in 2015 (table 11).

Despite the help from off-farm income, the 2015 debt-to-asset ratio of 0.20 exceeded the historical average of 0.15 for all farms during the 1970-2017 period (Key et al., 2019). The debt-to-asset ratio of the typical hog operation tends to be relatively high compared to all farms due to the use of capital-intensive production practices and facilities such as hog housing and feeding equipment that are often financed with debt (Key et al., 2019). For example, hog producers may finance buildings this way, usually repaying the debt over 7 to 10 years (Boessen, 2018).

The financial performance of hog farms varies by operation type

The income statements in table 12 reflect the financial condition of four types of hog operations in 2015: farrow-to-finish, farrow-to-feeder, feeder-to-finish, and wean-to-feeder operations. The 2015 ARMS data suggest that feeder-to-finish operations were the most involved in crop production, earning about 32 percent of gross cash income from crops, while farrow-to-feeder operations, which obtain most farm production value from feeder pig sales/removals, were the least diversified, earning only 1 percent of gross cash income from crops.

The number of production phases covered by an operation and the choice of business model both influence the level of cash expenses, where business model refers to whether the operation functions independently or through production contracts. Farrow-to-finish operations include all production phases and mostly operate independently (table 5). In contrast, feeder-to-finish operations and wean-to-feeder operations mostly operate under production contracts, where many of the expenses are incurred by the contractor rather than the grower.

Table 12

Income statements and financial indicators for U.S. hog producers by operation type, 2015

	Farrow-to-finish	Farrow-to-feeder	Feeder-to-finish	Wean-to-feeder
Number of observations	108	52	508	92
Number of farms	4,153	1,576	13,116	1,366
Average number of hogs sold/removed	3,223	13,196	7,672	23,767
<i>Dollars per farm</i>				
Gross cash income	919,961	830,712	773,998	438,968
Production contract income for hogs	N/A	57,633	95,064	108,115
Livestock sales	709,430	715,944	359,268	214,940
Crop sales	163,029	8,442	251,040	73,205
Total cash expenses	663,934	513,124	554,845	320,564
Variable cash expenses	578,171	477,877	428,989	274,568
Feed	279,113	208,257	122,433	72,667
Labor	43,151	68,955	25,531	19,041
Fuel and oil	24,192	11,508	20,481	16,083
Repair and maintenance	31,414	13,960	30,745	22,151
Utilities	15,619	14,071	12,499	12,062
Livestock purchase	28,656	4,534	84,759	39,796
Other variable expenses	156,026	156,593	132,541	92,767
Fixed cash expenses	85,763	35,247	125,886	45,996
Interest	18,174	8,066	25,364	15,669
Insurance	17,597	16,953	17,874	12,344
Rent and lease payments	39,584	5,187	72,670	11,430
Other fixed expenses	10,408	5,041	9,948	6,554
Net cash farm income	256,027	317,588	219,154	118,403
Net farm income	211,951	275,511	143,394	91,436
Off-farm income, principal operator's household¹	52,036	140,307	64,518	61,524
Debt-to-asset ratio	13	20	22	23

N/A = data not available.

Notes: The number of observations indicates the number of completed questionnaires for which we have sufficient data for analysis. The number of farms indicates the represented number of farms in the target population after applying survey weights to each observation. Livestock sales include sales of hogs, excluding those produced under contract, and sales of other livestock.

¹ There were 98, 46, 490, and 89 observations for this variable for the farrow-to-finish, farrow-to-feeder, feeder-to-finish, and wean-to-feeder type categories, respectively.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2015 Agricultural Resource Management Survey.

Variable expenses comprised over 75 percent of total cash expenses for all four operation types, with feed purchases being the largest expense category, comprising between 25 and 50 percent of such expenses (table 12). Labor expenses were the second-largest variable expense for farrow-to-finish and farrow-to-feeder operations, while livestock purchases were the second-largest variable expense for feeder-to-finish and wean-to-feeder operations. For each operation type, feed, labor, fuel and oil, repair and maintenance, utilities, and livestock purchases comprised more than 65 percent of variable expenses. Similarly, interest, insurance, and rent and lease payments comprised over 85 percent of fixed expenses for each operation type, with rent and lease payments being the largest category of fixed expenses for finishing operations.

Net cash income was less than 40 percent of gross cash income for each operation type, and net farm income ranged from 19 percent of gross cash income on feeder-to-finish operations to 33 percent of gross cash income on farrow-to-feeder operations. For all operation types, off-farm income supplemented the farm incomes of principal operators.

The debt-to-asset ratio was less than 0.25 for each type of hog operation, with only farrow-to-finish operations falling below the historical average of 0.15 for all farms (Key et al., 2019).

Comparing independent and contract feeder-to-finish operations in the Heartland

The contract and independent business models have key operational differences, which translate to differences in income and expenses for hog producers. The Heartland Region is the only one where the ARMS data contain sufficient detail to compare the financial performance of contract and independent feeder-to-finish producers within the same region in 2009 and 2015.

Between 2009 and 2015, the estimated number of contract feeder-to-finish operations in the Heartland Region increased, while the average number of hogs sold/removed by these operations was similar in both years (table 13). In contrast, the number of independent feeder-to-finish operations in the Heartland declined slightly between the 2 years, while the average number of hogs sold/removed by these operations increased.

Table 13

Income statements and financial indicators for feeder-to-finish producers in the Heartland Region by business model, 2009 and 2015

	2009		2015	
	Contract	Independent	Contract	Independent
Number of observations	238	93	278	84
Number of farms	6,478	2,240	7,653	1,931
Average number of hogs sold/ removed	7,263	6,728	7,299	7,925
<i>Dollars per farm</i>				
Gross cash income	514,327	1,349,358	653,329	1,867,315
Production contract income for hogs	107,720	0	121,557	0
Livestock sales	81,767	871,435	131,565	1,492,696
Crop sales	273,525	402,641	316,522	286,884
Total cash expenses	343,556	1,024,460	447,503	1,414,197
Variable cash expenses	237,356	857,491	301,555	1,245,721
Feed	27,300	293,263	39,449	491,371
Labor	15,471	33,669	19,553	51,012
Fuel and oil	23,592	40,174	22,639	30,598
Repair and maintenance	24,453	36,045	31,538	44,979
Utilities	10,119	12,953	12,882	14,101
Livestock purchase	29,921	252,194	33,313	377,316
Other variable expenses	106,499	189,193	142,182	236,345
Fixed cash expenses	106,200	166,969	145,948	168,475
Interest	32,455	37,937	29,584	30,358
Insurance	15,043	28,798	19,370	26,175
Rent and lease payments	50,399	91,344	87,066	100,479
Other fixed expenses	8,303	8,890	9,928	11,464
Net cash farm income	170,771	324,898	205,827	453,118
Net farm income	163,632	245,990	129,889	297,602
Off-farm income, principal operator's household¹	42,463	67,735	65,445	52,947
Debt-to-asset ratio	22	21	23	19

Notes: The number of observations indicates the number of completed questionnaires for which we have sufficient data for analysis. The number of farms indicates the represented number of farms in the target population after applying survey weights to each observation. Livestock sales include sales of hogs, excluding those produced under contract, and sales of other livestock. Fees for producing under contract are classified as production contract income.

¹ There were 228, 87, 271, and 77 observations for this variable for the 2009 contract, 2009 independent, 2015 contract, and 2015 independent production categories, respectively.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2009 and 2015 Agricultural Resource Management Survey.

Despite having less than a 10-percent difference in the number of hogs sold/removed, independent feeder-to-finish operations earned over 2.5 times more gross cash income than contract feeder-to-finish operations in both years. In 2015, the average contract feeder-to-finish operation earned \$653,329 in gross cash income, while the average independent feeder-to-finish operation earned roughly \$1.87 million. Fee structures of contract operations generally yield lower revenue per hog to the producer than independent operations, consistent with contract operations incurring less expenses because many of the expenses are incurred by the contractor.

In 2015, independent feeder-to-finish operations specialized in livestock production, garnering \$1.5 million in livestock sales, over 5 times the amount of crop sales. On contract feeder-to-finish operations, hog-related income came from production contract fees, which totaled \$121,557 in 2015—about 8 percent less than other livestock sales and less than half of crop sales.

Independent feeder-to-finish operations in the Heartland Region incurred over 3 times more cash expenses than contract operations in 2015. Contract producers typically receive feed, feeder pigs, and other variable inputs from contractors (McBride and Key, 2013, p. 4) and thus do not incur those expenses. Most cash expenses were variable expenses under both business models, with the bulk attributed to feed and livestock purchases. In 2015, feed and livestock purchases comprised roughly one-fourth of variable expenses for contract operations but 69 percent for independent operations. As many contract feeder-to-finish operations would not be expected to have any feed or feeder pig expenses since the contractor would incur them, these operations may be diversified in other livestock enterprises. Fixed expenses were roughly 15 percent higher on independent operations than on contract operations in 2015, with rent the largest fixed cash expense under both business models, followed by interest.

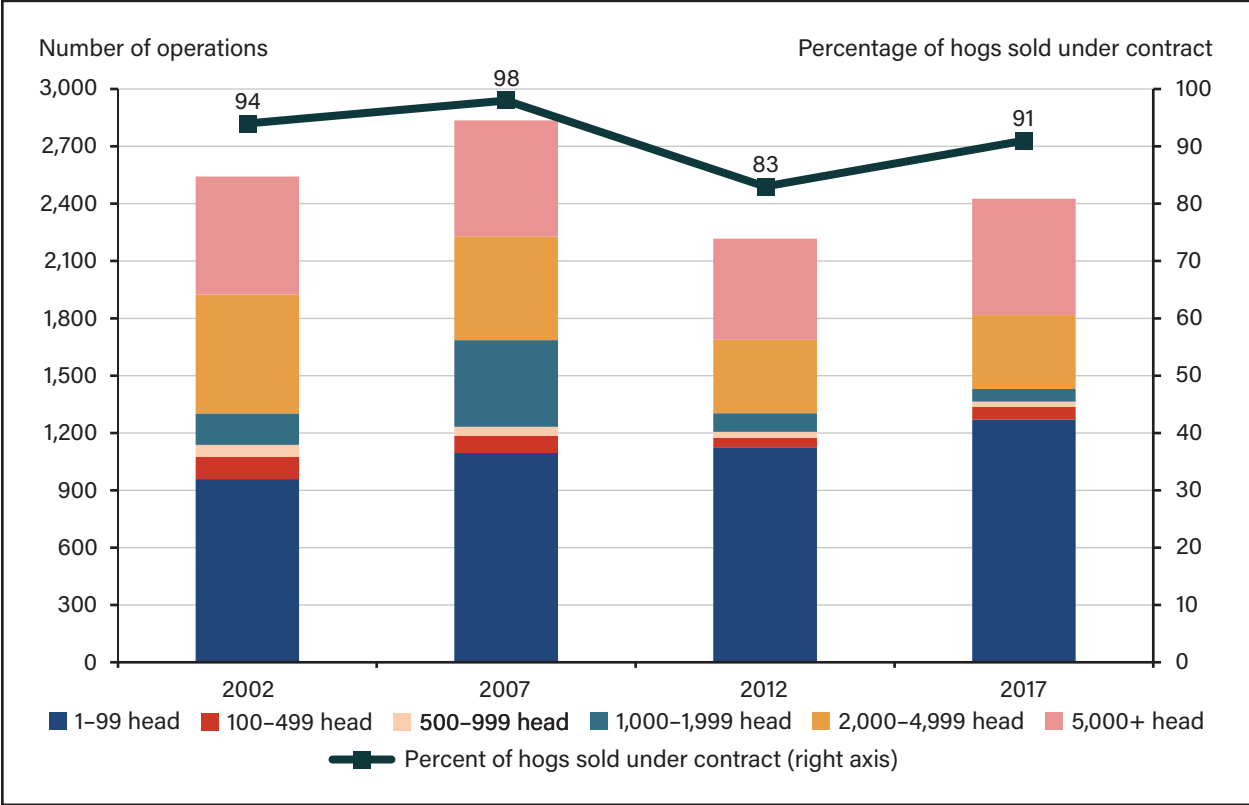
In the Heartland Region, net farm income was higher on independent feeder-to-finish operations than on contract feeder-to-finish operations in 2009 and 2015. Comparing 2015 with 2009, the net farm income of contract operations was 21 percent lower in 2015, while the net farm income of independent operations was 21 percent higher. Contract and independent feeder-to-finish operations had comparable debt-to-asset ratios in 2009 at 0.22 and 0.21, respectively, though the gap between the ratios widened slightly for 2015. For both business models, principal operators earned off-farm income.

Producers in North Carolina and Iowa/Minnesota Use Different Business Models

Hogs are an important part of the economy in North Carolina and Iowa/Minnesota, and the hog sector developed along different trajectories in these regions. Together, the three States housed 60 percent of the ending inventory of hogs in 2015 (ARMS data). According to the USDA, NASS 2017 Census of Agriculture, the three States produced a combined 52 percent of the hogs sold in the United States (USDA, NASS, 2019a), contributing to 57 percent of U.S. cash receipts for hogs that year, based on USDA, ERS Farm Income and Wealth Statistics (2021). Currently, contract and independent hog production coexists in Iowa/Minnesota, while the vast majority of hog production in North Carolina takes place under contracts. Understanding the trajectory of the hog sector in these two regions provides insight into the success of both the contract and independent business models.

Between 2002 and 2017, patterns of hog production in the two regions evolved differently. In North Carolina, the hog sector contracted and expanded during the period, as shown by the fluctuation in the number of hog operations (figure 8). In contrast, the number of hog operations declined throughout the period in Iowa/Minnesota (figure 9), where the bulk of the decrease occurred for operations with more than 100 head but fewer than 2,000 head.

Figure 8
Changes in the North Carolina hog sector: structure and production contract use, 2002-17

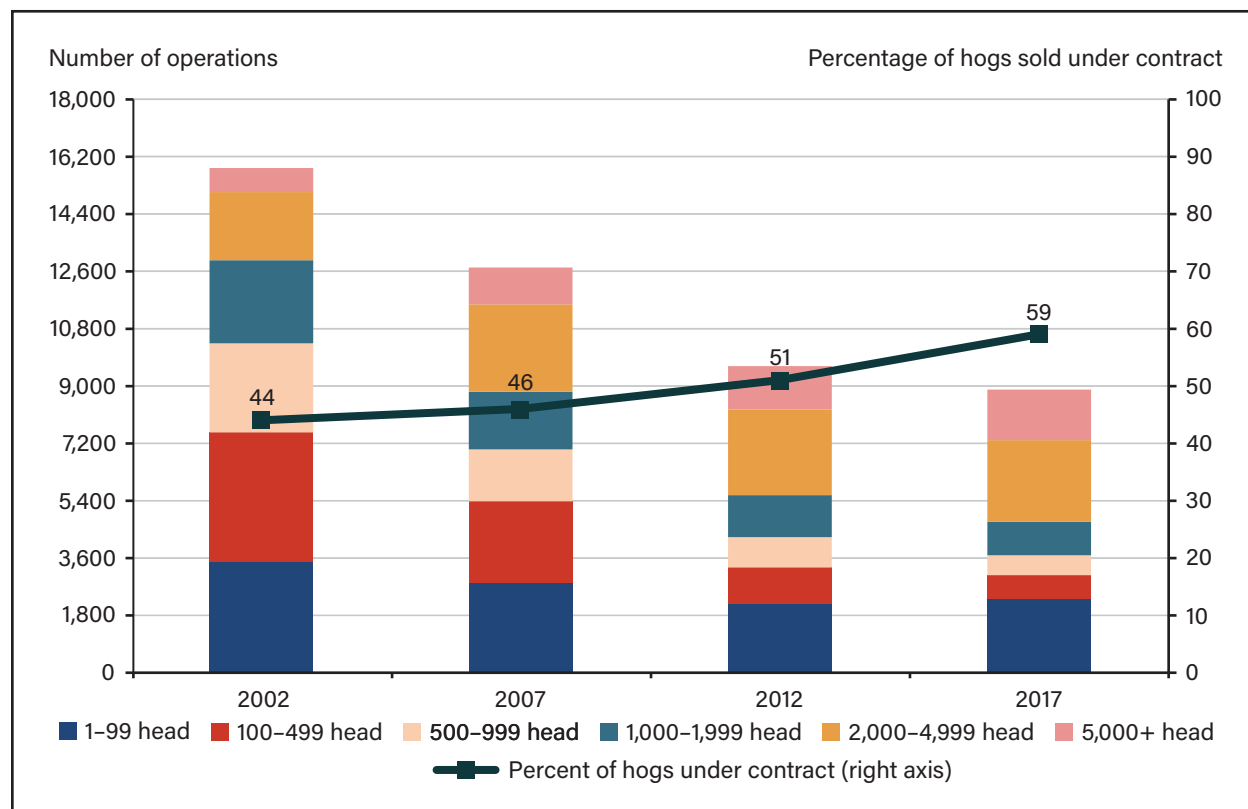


Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2002, 2007, 2012, and 2017 Census of Agriculture.

Contract use also differs between the two regions, with contracting nearly universal in North Carolina. In 2002, the first year for which the Census of Agriculture reported the percent of hogs sold under production contracts, nearly all hogs (94 percent) in North Carolina were sold by contract growers (figure 8). The share of hogs sold under contract remained more than 80 percent during the 4 census years between 2002 and 2017, and the share sold under contract was over 90 percent in all but 1 census year (2012). In Iowa/Minnesota, contracts covered about 44 percent of hogs sold in 2002, a share that increased to 59 percent in 2017 (figure 9). Throughout the period, contract use in Iowa/Minnesota remained well below that in North Carolina.

Cultural differences between the two regions may partially explain the different rates of contract adoption. In the initial expansion of contracting in the early 1990s, new entrants to the hog sector, such as those in North Carolina, may have been more open to using production contracts, while existing producers, such as those in the Upper Midwest, may have been less interested in contracting (Gillespie and Eidman, 1998). In Iowa/Minnesota, scale economies and lower feed costs may also have sustained independent production (Duffy, 2009; Nehring et al., 2019).

Figure 9
Changes in the Iowa/Minnesota hog sector: structure and production contract use, 2002-17



Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2002, 2007, 2012, and 2017 Census of Agriculture.

In addition, North Carolina and Iowa/Minnesota differ in the type of operation most likely to use contracts (table 14). In 2009 and 2015, the ARMS data indicate that in North Carolina contracts were mainly used on feeder-to-finish operations, which held 54 percent of contracts in 2015, and wean-to-feeder operations, which held 32 percent of contracts in 2015. In contrast, feeder-to-finish operations dominated contract use in Iowa/Minnesota, with over 85 percent of the two States' contracts in both years.

Table 14

Distribution of production contracts among types of hog operations in North Carolina and Iowa/Minnesota in 2009 and 2015

Type of operation	2009		2015	
	North Carolina	Iowa/Minnesota	North Carolina	Iowa/Minnesota
	<i>Percent of contracts</i>			
Feeder-to-finish	53	86	54	91
Wean-to-feeder	31	10	32	6
Other or mixed	18	4	13	2

Notes: In North Carolina, nearly all hog operations used contracts. In Iowa/Minnesota, in both years approximately 70 percent of operations used contracts. "Mixed" refers to operations that could not be classified into one type.

Source: USDA, Economic Research Service using data from the 2009 and 2015 USDA, National Agricultural Statistics Service Agricultural Resource Management Survey.

The income statements for feeder-to-finish hog operations in the two regions are shown in table 15. In 2015, the average contract operation in North Carolina sold/removed more than twice as many hogs as contract operations in Iowa/Minnesota and earned almost 1.5 times the income from production contract fees. Note that, relative to operations in Iowa/Minnesota, a higher percentage of operations in North Carolina were selling feeder pigs rather than finished hogs, which may partially account for why the greater number of hogs sold/removed in North Carolina is not proportionate to the greater income from production contract fees. The average contract operation in Iowa/Minnesota had a sizeable amount of sales from other livestock and crops, contributing to a gross cash income double the amount earned in North Carolina. Even so, in Iowa/Minnesota, independent operations earned triple the gross cash income of contract operations due to much greater livestock sales.

In Iowa/Minnesota in 2015, total cash expenses were more than 3 times higher on independent feeder-to-finish operations than on contract operations, with variable expenses making up 89 percent of cash expenses on independent operations and 67 percent on contract operations. In Iowa/Minnesota, feed and livestock purchases combined accounted for 73 percent of variable expenses on independent feeder-to-finish operations but only 25 percent of variable expenses on contract operations. In North Carolina, labor was a major expense on contract feeder-to-finish operations, making up 31 percent of variable expenses compared to less than 10 percent on contract and independent feeder-to-finish operations in Iowa/Minnesota. For contract feeder-to-finish operations, fixed expenses were 69 percent less in North Carolina than in Iowa/Minnesota due to significantly lower interest and rent expenses.

Feeder-to-finish operations in both regions had positive net farm income in 2015. However, independent and contract feeder-to-finish operations in Iowa/Minnesota earned over 3.5 times more net farm income than contract feeder-to-finish operations in North Carolina. This finding is partly because contract operations in Iowa/Minnesota were more diversified than those in North Carolina, with 48 percent of gross cash income from crop sales compared to only 27 percent in North Carolina. Still, principal operators sought off-farm income as a supplement, with off-farm income on independent feeder-to-finish operations in Iowa/Minnesota averaging \$55,444 and off-farm income on contract feeder-to-finish operations averaging between \$70,000 and \$75,000 in both regions.

In Iowa/Minnesota, the debt-to-asset ratio on independent operations (0.17) was below the ratio for contract operations in both regions, indicating that independent operations were not as highly leveraged.

Table 15

Income statements and financial indicators for feeder-to-finish operations in Iowa/Minnesota and North Carolina by business model, 2015

	Iowa/Minnesota		North Carolina
	Contract	Independent	Contract
Number of observations	142	43	62
Number of farms	5,389	1,215	874
Average number of hogs sold/ removed	7,321	8,859	15,730
<i>Dollars per farm</i>			
Gross cash income	664,696	2,020,438	331,796
Production contract income for hogs	124,434	0	190,565
Livestock sales	124,102	1,604,623	13,507
Crop sales	320,657	305,472	90,096
Total cash expenses	453,741	1,519,280	221,771
Variable cash expenses	302,497	1,345,274	175,037
Feed	38,399	521,860	1,520
Labor	19,592	42,886	54,656
Fuel and oil	23,417	29,522	16,656
Repair and maintenance	32,913	49,415	28,865
Utilities	12,625	14,456	15,645
Livestock purchase	35,773	458,725	41
Other variable expenses	139,777	228,410	57,654
Fixed cash expenses	151,245	174,006	46,734
Interest	30,275	32,604	14,615
Insurance	19,849	27,140	12,674
Rent and lease payments	92,081	101,785	10,493
Other fixed expenses	9,040	12,477	8,951
Net cash farm income	210,954	501,158	110,025
Net farm income	134,961	306,841	38,280
Off-farm income, principal operator's household¹	70,027	55,444	74,690
Debt-to-asset ratio	23	17	19

Notes: The number of observations indicates the number of completed questionnaires for which we have sufficient data for analysis. The number of farms indicates the represented number of farms in the target population after applying survey weights to each observation. The 2015 Agricultural Resource Management Survey (ARMS) reports no independent feeder-to-finish hog operations in North Carolina.

¹ There were 140, 40, and 59 observations for this variable for the Iowa/Minnesota contract, Iowa/Minnesota independent, and North Carolina contract categories, respectively.

Source: USDA, Economic Research Service using data from the USDA, National Agricultural Statistics Service 2015 Agricultural Resource Management Survey.

Manure management practices vary across regions

Manure management is a critical aspect of operating a hog farm, and manure is a top contributor to the carbon footprint (greenhouse gas emissions) of U.S. hog production (Thoma et al., 2011). The Environmental Protection Agency (EPA) and many hog-producing States have enacted legislation to mitigate the environmental consequences of poor manure management (Vander Wal, 2001; Chen and Lade, 2018; Metcalfe, 2000). Two main types of storage structures are used to manage manure: lagoon and pit structures (see Key et al., 2011, for more detail on manure handling and storage on hog operations). Lagoons hold liquified manure and wastewater in large earthen containers. Pits are typically placed under hog housing that has slatted floors, so the manure drops into the pits and is stored there as slurry. The slurry has higher nitrogen content and lower volume compared to the manure stored in lagoons (Lory et al., 2018), though pit structures emit less greenhouse gases over a pig’s life cycle than lagoons due to lower methane production (see Thoma et al., 2011, for details on the environmental impact of U.S. hog production).

According to the 2015 ARMS, most operations (91 percent) in Iowa/Minnesota used a pit to handle manure (table 16). Manure pits were used less frequently in North Carolina, with only about one-tenth of the operations using them for manure management. Across all U.S. regions, however, 79 percent of operations used manure pits. Operations in North Carolina were more likely to use lagoons for manure management (84 percent), compared to 3 percent in Iowa/Minnesota and 14 percent in all regions.

The primary use for manure is as a fertilizer on the farm where it is produced or on a neighboring farm (MacDonald and McBride, 2009; Nehring, 2020). A benefit of using manure as fertilizer, in addition to repurposing the waste, is lower fertilizer cost. For example, the price paid by farmers for fertilizer increased sharply during the Great Recession—by 123 percent from 2006 to 2008—and, despite declines, the price in 2018 remained 20 percent above the pre-recession level in 2006 (USDA, ERS, 2019b). Research also indicates that manure nitrogen content (per kilogram of pig weight) is related to feed efficiency, suggesting that higher feed efficiency can be an important manure management strategy (Kanis et al., 2005). Other potential uses for manure include energy generation and biochar (see Pagliari et al., 2020, for details). Of all livestock farms, those raising dairy cows are most likely to generate energy from manure (MacDonald et al., 2009).

Approximately three-fourths of hog operations applied manure on at least part of their farms in 2009, with the largest farms the least likely to do so (Key et al., 2011). According to the 2015 ARMS data, the typical hog operation in the United States applied manure to 112 acres, with farms in Iowa/Minnesota applying manure to more acres on average (167 acres) than those in North Carolina (55 acres).

Table 16

Manure use on hog operations across all regions and in Iowa/Minnesota and North Carolina, 2015

Activity	Iowa/Minnesota	North Carolina	All regions
	<i>Percent of operations</i>		
Manure pit	91	11	79
Manure pond/lagoon	3	84	14
	<i>Number of acres</i>		
Manure applied to fields	167	55	112

Source: USDA, Economic Research Service using data from the 2015 USDA, National Agricultural Statistics Service Agricultural Resource Management Survey.

Market Implications of Structural and Productivity Changes

Pork exports increase while imports remain stable

U.S. hog producers have adopted new technologies, production systems, and business arrangements that have increased productivity and lowered costs over the past 30 years. Higher productivity has contributed to the U.S. pork industry's greater competitiveness in foreign markets; since 1992, the volume of U.S. pork exports has increased significantly (figure 10).

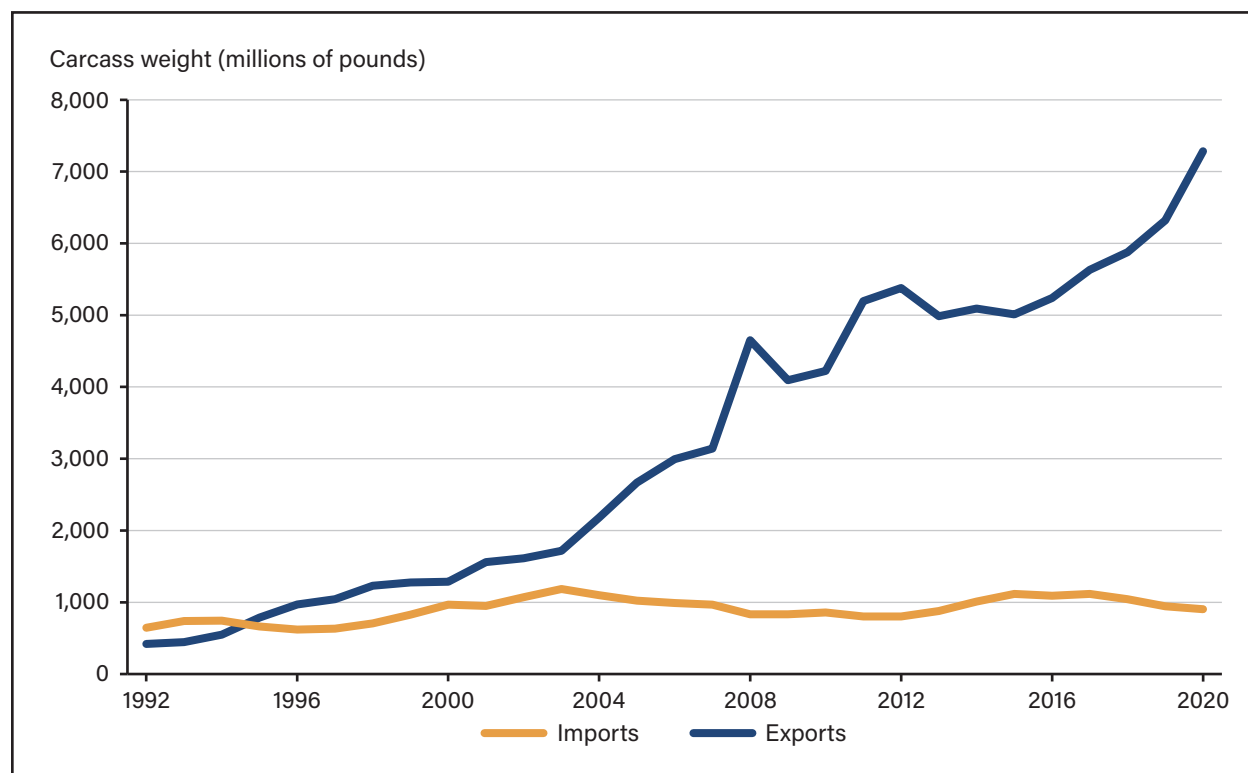
In 2020, U.S. companies exported roughly 7 billion pounds carcass weight equivalent (cwe) of pork, valued at approximately \$7.7 billion, to 118 countries (USDA, ERS, 2021a). Pork exports in 2020, in terms of both quantity and value, significantly increased over the 420 million pounds, valued at \$532 million, exported in 1992. In 2020, U.S. pork exports accounted for 26 percent of U.S. commercial pork production, compared to less than 3 percent in 1992. At roughly 26 percent, the U.S. share of world pork exports in 2020 was much larger than its share of 4 percent in 1992.

The United States remained a net pork importer for the years 1992–94 (figure 10). The United States became a net pork exporter in 1995 and has since ranked as either the world's leading or second-largest pork exporter, at times trailing the European Union. The United States ships most pork exports to Japan and neighboring Mexico and Canada. China recently became an important export market, as the rapid spread of African Swine Fever (ASF) across the country decimated its domestic industry, creating significant export opportunities for the U.S. pork industry. In the United States, recent industry expansion and low prices helped the industry export more pork to China, despite high retaliatory tariffs on U.S. pork. ERS export data show that U.S. pork exports to China in 2020—more than 2 billion pounds (roughly 907,000 metric tons)—were more than 6 times the volume exported in 2018. The increase is notable because China imposed retaliatory tariffs of 50 percent in April and July 2018 on most U.S. pork products. The tariffs, which remained in place through 2019, put U.S. pork at a disadvantage compared with pork from competing countries such as the European Union, Brazil, and Canada (Haley and Gale, 2020). Starting in 2021, the Chinese pork sector began adjusting to African Swine Fever and rebuilding its domestic production capacity, thus demand for U.S. pork began to slow (Haley, 2021).

Pork import volumes remained stable between 1992 and 2020, averaging slightly less than 1 billion pounds (cwe) (figure 10). Throughout the period, most U.S. pork imports originated from Canada—more than three-quarters of U.S. pork imports in recent years.

Figure 10

U.S. pork imports and exports, 1992-2020



Source: USDA, Economic Research Service (ERS) using ERS Livestock and Meat International Trade Data, 2021a.

Despite rising farm-level productivity, retail prices fluctuate with market changes

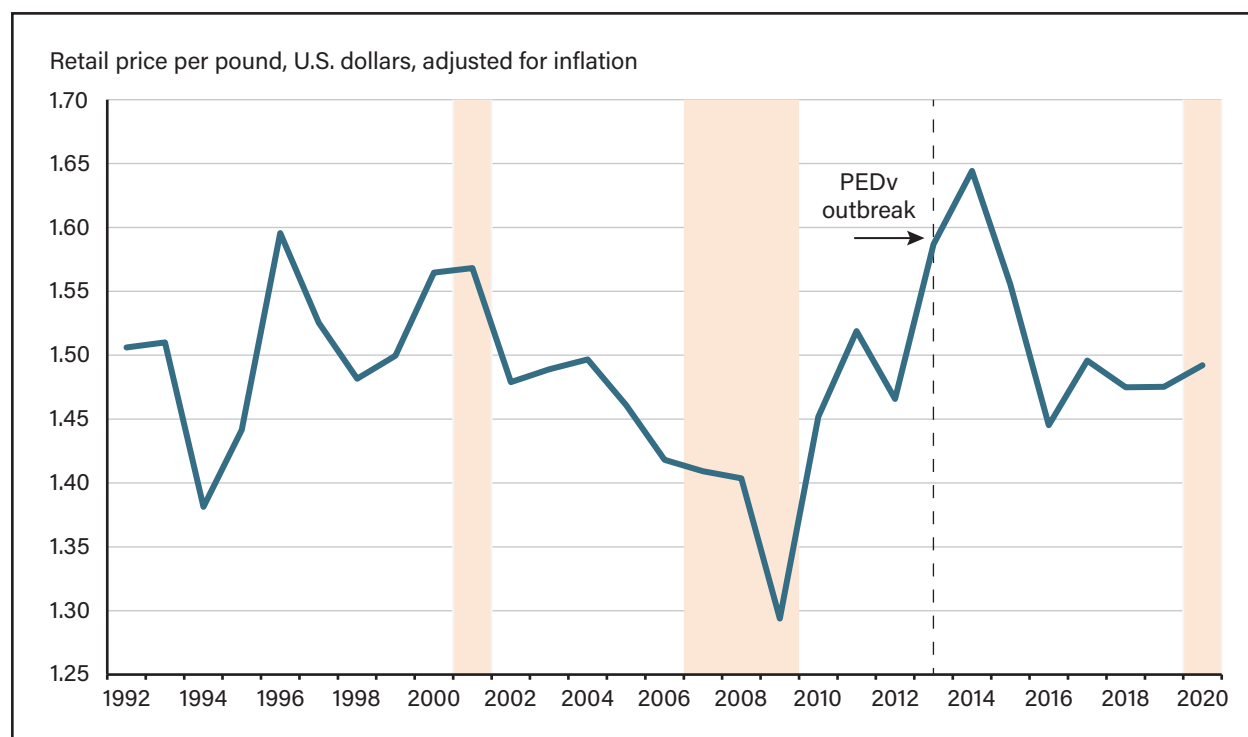
Since 1992, the changing structure of the hog sector has resulted in a sector characterized by larger, more specialized farms. Whether these productivity gains at the farm level resulted in lower retail pork prices is difficult to establish, given the complexity of the pork supply chain. Retail prices depend not only on the supply of pork meat but also on consumer demand for pork and other meat products, as well as net exports. That said, productivity gains and lower per unit production costs at the farm level affected the supply of pork and likely contributed, to some degree, to the retail price competitiveness of pork relative to other meat products.

In the United States, retail boneless pork availability, a measure used by USDA as a proxy for consumption, was about 49 pounds per capita in 2019 (USDA, ERS, 2021b). The per capita availability has ranged from 48 pounds to 52 pounds since the 1980s (USDA, ERS, 2021b). In 2019, boneless chicken retail availability was 67 pounds per capita, while boneless beef retail availability measured 55 pounds (USDA, ERS, 2021b).

Figure 11 presents a series that approximates trends in consumer prices, the ERS Composite Retail Pork Value. The composite retail pork value reflects the weighted average of a hog’s retail meat cuts, measured in cents per pound (USDA, ERS, 2020a). The figure presents the inflation-adjusted retail value of pork, which fluctuated between 1992 and 2020. In 2013, the retail value sharply increased because of PEDv, which temporarily reduced the supply of available pork at the retail level. In 2020 and 2021, market disruptions caused by the COVID-19 pandemic resulted in an increased consumer price index for meats, poultry, fish, and eggs (Mead et al., 2020; BLS, 2021).

Figure 11

Inflation-adjusted, retail value of pork from 1992 to 2020



PEDv = Porcine Epidemic Diarrhea Virus.

Notes: The conversion to real terms uses the Bureau of Labor Statistics food and beverage Consumer Price Index; the base period is 1982–84. Shading denotes years when a National Bureau of Economic Research-dated recession occurred. In 2009, retail prices fell due to the Great Recession. In 2013 and 2014, the U.S. swine herd was infected with PEDv, and retail prices increased.

Sources: USDA, Economic Research Service, U.S. Bureau of Labor Statistics, and the National Bureau of Economic Research.

While validated productivity gains show greater quantities of pork produced from fewer resources, the productivity gains do not necessarily translate to lower prices for consumers. The farm-to-retail price spread represents the difference between the price consumers pay and the price farmers receive, including the amounts paid to the different firms along the supply chain as the animal is transformed into pork and transported through processing stages, to wholesale channels and finally to retail outlets. The farm share of retail pork value in 2019 was 22 percent, with the remaining 78 percent going to retailers, wholesalers, and other marketers along the food supply chain (USDA, ERS, 2020b). This distribution of the retail price indicates that marketing services and other factors constitute an important share of the value of retail, unbranded cuts of pork.

The farm-to-retail price spread for pork, after adjusting for inflation, has remained relatively constant over time (Pouillot and Schulz, 2016). However, during the COVID-19 pandemic, retail pork prices rose even as farmers received lower prices for their hogs, which suggests that the price of hogs is a relatively small component of the price that consumers pay for pork in the supermarket; and the difference between retail and farm prices is influenced by many external factors (Lusk et al., 2021).

Conclusion

The hog sector began a major transformation in the early 1990s and since then has experienced productivity growth, structural change, increased output, and expanded exports. From a broad perspective, the number of hog farms declined over time, the typical farm became larger, and the regional pattern of production shifted. Yet for the first time in many years, the number of hog farms increased between 2012 and 2017; and during this period, hog inventory increased, and the average hog farm became slightly larger.

Hog farm specialization became common, and in many cases, hog farms adopted production contracts as the business model. Rather than raising hogs from farrow to finish on one farm, farms that specialize in fewer stages, such as feeder-to-finish operations, became more common. Much of the shift to specialized operations took place from 1992 to 2004. As the scale of operations increased between 1992 and 2015, so did the number of hogs produced on the typical farm. However, the increase in scale was smaller from 2009 to 2015, partly due to declines in head per farm on farrow-to-finish operations between those 2 years.

Productivity increases in the U.S. hog industry since 2004 can be partially attributed to improvements in labor productivity. In addition to requiring less labor to produce 100 pounds of weight gain, the hog producers substituted paid labor for unpaid labor starting in 2009. Real production costs per cwt declined between 1992 and 2009 for all types of operations. Between 2009 and 2015, real production costs increased on farrow-to-finish operations while they continued to decline on feeder-to-finish operations.

Technological innovations improved feed efficiency and reduced the spread of disease. Genetic improvements contributed to reduced feed requirements and higher hog weight gain. Greater building capacity for hogs at all stages of the production cycle provided infrastructure for the adoption of all-in/all-out management and phase feeding of hogs.

From 1992 to 2015, the share of hog operations using production contracts increased significantly, though the percent of hogs produced under production contracts has been relatively stable since 2004. Still, regional differences in contract use exist. In Iowa/Minnesota, contract and independent producers coexist, while in North Carolina, contract production dominates. Hog producers in Iowa/Minnesota are more diversified than those in North Carolina and have more acres of cropland. Off-farm income provides an important source of income for farm households in both regions.

Manure management is critical for livestock operations. In Iowa/Minnesota, manure management methods differ from methods used in North Carolina; operations in Iowa/Minnesota typically use manure pits, while operations in North Carolina rely more on lagoons. Operations in Iowa/Minnesota also apply manure on a greater number of acres than operations in North Carolina.

By 2017, the industry was producing more and larger hogs and generating more pork. In the face of flat demand from U.S. consumers, export markets have been able to accommodate the increased pork production. However, the hog sector faced many challenges from external factors, such as the 2008-09 recession, the PEDv outbreak, export tariffs, and COVID-19, each requiring hog producers to adapt to changing conditions.

Glossary

All-in/all-out housing commingles pigs of a similar age and weight and keeps them together as they move through each production phase. Marketing is done one house at a time, and houses are washed and disinfected after each group of pigs leaves to decrease the spread of infectious diseases.

Biosecurity plans usually specify strict isolation and sanitation programs to prevent the introduction and spread of disease.

Commercial seed stock producers specialize in the production and sale of breeding hogs.

Contract hog production is typically described as an arrangement in which a hog owner who acts as a contractor engages a producer (grower) to take custody of the hogs and care for them in the producer's facilities, with other inputs often furnished by the hog owner. The producer is paid a fee for the service provided.

Farm resource regions represent the geographic distribution of U.S. farm production in areas where similar types of farms intersect with areas of similar physiographic, soil, and climatic traits (Heimlich, 2000).

Hog operations included in the Agricultural Resource Management Survey (ARMS) are defined as farms that had a hog inventory of 25 head or more on the farm operation at any time during the survey year. Hog operations include independent and contract operations.

Hundredweight gain refers to the weight (in hundredweight, cwt) of hogs sold or removed under contract less the hundredweight of hogs purchased or placed under contract, plus the hundredweight of inventory change each year, expressed as:

$$\text{CWTGAIN} = (\text{CWTSR} - \text{CWTPP}) + (\text{CWTEINV} - \text{CWTBINV})$$

where CWTGAIN is hundredweight gain, CWTSR is hundredweight of sales and contract removals, CWTPP is hundredweight of purchases and contract placements, CWTEINV is hundredweight of inventory on December 31, and CWTBINV is hundredweight of inventory on January 1.

Operating costs are the costs for purchased input items consumed during one production period. These include feed; feeder pigs; veterinary and medical services; marketing; custom services and supplies; fuel, lubrication, and electricity; repairs; and operating capital.

Phase feeding is a production system where hogs or pigs are fed diets of varying protein and energy content at different stages, or phases, of their life to match diets more closely with their changing nutritional requirements.

Phase of production refers to one of four commonly used categories that describe stages in the hog-production process: (1) breeding and gestation—the breeding of females and their maintenance during the gestation period, (2) farrowing—the birth of baby pigs until weaning, (3) nursery—the care of pigs from immediately after weaning until about 30-80 pounds, and (4) growing/finishing—the feeding of hogs from 30-80 pounds to the slaughter weight of 225-300 pounds.

Porcine Epidemic Diarrhea Virus (PEDv) is a coronavirus that affects swine, causing diarrhea and vomiting, and death of 50-100 percent of infected piglets. USDA first approved conditional use of a vaccine in 2014.

Subtherapeutic antibiotics are antimicrobial drugs fed to hogs at low levels (i.e., levels less than prescribed for therapeutic use) to prevent disease, promote growth, and improve overall animal health.

Total economic costs are the full ownership costs (cash and noncash) associated with producing a commodity. These include both operating and ownership costs, plus opportunity costs for unpaid labor and land, and costs for general farm overhead items.

Type of hog producer defines the hog operation according to the phases of production it conducts and the type of product produced. Most hog producers can be classified into one of the following types:

- **Farrow-to-finish operations:** Pigs are farrowed and then finished to a slaughter weight of 225–300 pounds. For purposes of this study using ARMS data, these operations were defined as farms on which more than 75 percent of pigs came from on-farm farrowing, and more than 75 percent of the value of hogs and pigs left the operation through market hog sales or contract removals.
- **Farrow-to-feeder operations:** Pigs are farrowed and then sold or removed under contract at or after weaning at weights of about 30–80 pounds. For purposes of this study using ARMS data, these operations were defined as farms on which more than 75 percent of pigs came from on-farm farrowing, and more than 75 percent of the value of hogs and pigs left the operation through feeder pig sales or contract removals.
- **Farrow-to-weanling operations:** Pigs are farrowed and then sold or removed under contract after an early weaning at weights of about 10-20 pounds. For purposes of this study using ARMS data, these operations were defined as farms on which more than 75 percent of pigs came from on-farm farrowing, and more than 75 percent of the value of hogs and pigs left through weanling sales or contract removals.
- **Feeder pig-to-finish operations:** Feeder pigs are obtained from outside the operation, either purchased or placed under contract, and then finished to a slaughter weight of 225–300 pounds. For purposes of this study using ARMS data, these operations were defined as farms on which more than 75 percent of pigs came from feeder pig purchases or contract placements, and more than 75 percent of the value of hogs and pigs left through market hog sales or contract removals.
- **Weanling-to-feeder pig operations:** Weanlings (10–20 pounds) are obtained from outside the operation, either purchased or placed under contract, and then fed to a feeder pig weight of about 30–80 pounds. For purposes of this study using ARMS data, these operations were defined as farms on which more than 75 percent of pigs came from weanlings purchased or placed under contract, and more than 75 percent of the value of hogs and pigs left through feeder pig sales or contract removals.

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Appendix A

A note on the data used in this report

This report relies on two primary data sources. The first is the USDA Census of Agriculture, conducted every 5 years, with the most recent Census covering 2017. Census data from 1997 to 2017 are used to understand broad structural changes in the hog sector. The second data source, which is much more detailed, consists of hog producer survey data collected by USDA through the USDA, National Agricultural Statistics Service Agricultural Resource Management Survey (ARMS). Hog producer survey data for 1992 come from the USDA's Farm Costs and Returns Survey (FCRS) that was replaced with the ARMS phase 3 hog version in 1998. Hog producer data cover the years 1992, 1998, 2004, 2009, and 2015. The Census data and ARMS data cover different years.

The ARMS data cover a cross-section of U.S. hog operations, which includes farms that had at least 25 head of hogs in inventory each year. Multiple farms operated by the same producer are included as part of one farm or operation unless they are operated separately and distinctly from each other. Data collected from producers include farm size, production costs, business arrangements, production facilities and practices, technology use, and producer and financial characteristics. Major hog-producing States are included in each of the five hog-producer surveys and include North Carolina, Arkansas, Missouri, Illinois, Kansas, Nebraska, Iowa, Minnesota, Indiana, Wisconsin, Michigan, Ohio, and South Dakota. These 13 States represented nearly 90 percent of U.S. hog and pig inventory in each survey year. States that were included in the hog surveys for only some of the 5 years are Colorado, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, and Utah.

The ARMS is a repeated cross section where producers are chosen randomly to participate in each survey; thus, the same producers are not surveyed in each of the years. For this reason, some of the differences across time in average producer and operation characteristics result from the fact that different producers were selected for each survey, rather than from actual changes in average characteristics. When differences across individuals are large and the sample is small, surveying the same operations over time may have greater statistical power to identify changes over time than repeated cross sections. However, in the past decades, many operations have exited and entered the hog business; and these operations differ substantially from continuing operations. For example, new entrants tend to be larger and exiting operations smaller than continuing operations (Key, 2013).

Unlike the ARMS, the Census does not exclude the smallest operations (those with less than 25 head of hogs in inventory). The distinct methodologies can yield differences in estimates produced using the two sources. We used the ARMS data to describe trends in productivity, costs, contract use, and manure management and the Census data to highlight structural and regional changes in the hog sector.

Data from the 2020 ARMS Phase 3, Hog Commodity Version were not available for analysis at the time of producing estimates for this report. For more information on the technical and statistical properties of the ARMS data and to obtain the most up-to-date data as they are released, see the ARMS documentation and tailored reports on farm financial and crop production practices posted on the USDA, ERS website.

Table A-1

Real and nominal production costs per cwt by type of hog producer, 1992–2015

Producer/Item	1992	1998	2004	2009	2015
<i>Dollars per cwt</i>					
Farrow-to-finish					
Feed costs, nominal ¹	25.53	23.45	24.26	24.26	36.13
Feed costs, 2015 dollars	61.70	50.88	48.11	31.20	36.13
Total production costs, nominal ²	52.98	52.81	52.19	47.78	67.51
Total production costs, 2015 dollars	126.18	112.39	98.09	61.82	67.51
Feeder-to-finish					
Feed costs, nominal ¹	22.49	19.90	19.13	26.11	31.54
Feed costs, 2015 dollars	54.36	43.18	37.94	33.58	31.54
Total production costs, nominal ²	43.40	34.37	29.41	39.81	47.49
Total production costs, 2015 dollars	103.47	73.49	56.33	51.41	47.49
All hog and pig producers					
Feed costs, nominal ¹	25.97	22.17	22.08	29.39	32.83
Feed costs, 2015 dollars	62.77	48.10	43.79	37.80	32.83
Total production costs, nominal ²	55.04	46.62	40.70	49.05	53.36
Total production costs, 2015 dollars	131.05	99.32	77.11	63.39	53.36

cwt = hundredweight.

Notes: Feed costs are converted to 2015 dollars using the national agricultural feed price index; and total production costs are deflated to 2015 dollars using the national agricultural production items index (USDA, National Agricultural Statistics Service, Agricultural Prices).

¹ Feed costs are the sum of purchased and homegrown feed costs. Homegrown feed costs are computed using the opportunity cost approach as what the feed items could have earned on the market rather than being fed to hogs. The amounts of homegrown feed items fed to hogs are valued according to annual market prices for each item.

² Production costs are the total production costs (operating and allocated overhead) less costs for feeder and nursery pigs. Pig costs are excluded because pigs are not inputs contributing to weight gain. Production costs are from the USDA, Economic Research Service (ERS) Commodity Costs and Returns data product.

Sources: USDA, ERS using data from the 1992 Farm Costs and Returns Survey and the USDA, National Agricultural Statistics Service 1998, 2004, 2009, and 2015 Agricultural Resource Management Survey.