



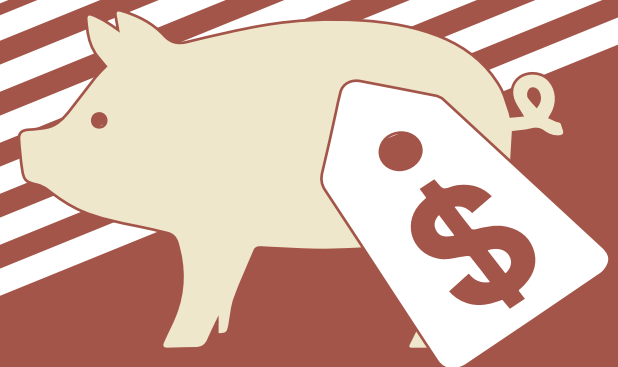
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# The U.S. Hog Industry: Structural Change, Production Systems and Costs, and Manure Management

Jeffrey Gillespie, Zach Raff, Monte Vandever, Jennifer Kee, Mildred Haley, and Danielle Ufer





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# The U.S. Hog Industry: Structural Change, Production Systems and Costs, and Manure Management

Jeffrey Gillespie, Zach Raff, Monte Vandever, Jennifer Kee, Mildred Haley, and Danielle Ufer

## Abstract

The hog production segment of the U.S. pork industry has experienced significant structural change over the past four decades. This study examines changes in the U.S. hog farm structure, using USDA's Agricultural Resource Management Survey (ARMS) hog version data; USDA's Census of Agriculture data since 1997; and the U.S. Department of Commerce's Census of Agriculture Data from 1982 to 1992 (focusing more heavily on the most recent USDA data). The 2020 ARMS hog version data are used to examine differences in costs and returns by farm size; hog management practices, housing types, and manure management practices used on hog farms; and the impact of the Coronavirus (COVID-19) pandemic on hog farms in 2020. Results show continued trends toward fewer farms producing more hogs, greater specialization in hog production, increased use of contracts, shifts in location of production, and increased hog farm productivity. Economies of size are found in U.S. hog production. In 2020, most U.S. hog farms used biosecurity practices, enclosed confinement housing, a deep pit manure system, and spread manure on cropland. About 6 percent of U.S. hog producers euthanized hogs in response to COVID-19 slaughter plant closures.

**Keywords:** hog production, contracting, costs and returns, manure management, biosecurity

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A report summary from the Economic Research Service

# The U.S. Hog Industry: Structural Change, Production Systems and Costs, and Manure Management

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## Key Points

- Over the past 40 years, the U.S. hog inventory increased, the number of U.S. hog farms has decreased, the average inventory of hogs and pigs per farm increased, and the use of production contracts increased.
- Over the past 27 years, the gross value of hog production, including the value of hogs produced and the value of byproducts (manure), has covered total costs in about half of the years; larger-scale hog operations have experienced lower per-unit production costs than smaller-scale hog operations; and production efficiency on U.S. hog farms has increased.
- In 2020, most U.S. hog farms used deep pit manure handling systems for manure management, but manure storage systems varied by production region. Methods of removing manure from storage systems have impacts on air and water quality.

## Why Does This Matter?

Over the past four decades, the structure of the U.S. hog industry has evolved substantially, with fewer farms producing more hogs. This raises questions about how hog farms have changed in size (hog inventory, acres operated), diversification, use of contracts, location, and production efficiency. Questions also arise about the extent of economies of size in hog production and the use

of various production practices by farm size. Recent animal welfare legislation in some U.S. States has implications for the types of housing and equipment that are used in hog production. Manure management systems used in U.S. hog production have environmental implications. This report addresses how hog farm structure has changed over the past four decades, how cost of production varies by farm size and production type, and the types of production practices currently used on U.S. hog farms.

## Highlights

*Structural change in the U.S. hog industry:*

- From 1982 to 2022, the U.S. hogs and pigs inventory increased by 37 percent while the number of U.S. farms with at least 1 hog or pig in inventory decreased by 82 percent.
- From 1982 to 2022, the number of hog farms with between 25 and 999 hogs and pigs sold decreased. The number of hog farms with between 1,000 and 4,999 hogs and pigs sold increased from 1982 to 1992 but declined thereafter. The number of hog farms with 5,000 or more hogs and pigs sold increased from 1982 to 2002 but leveled out thereafter.
- From 2002 to 2022, the hog farm production types with the largest increases in numbers of hogs and pigs sold were farrow-to-wean and finisher operations.

- From 2002 to 2022, the share of the U.S. hog and pig inventory under production contract increased.
- From 1998 to 2020, the average age of hog producers increased, the percentage of hog producers with a 4-year college degree increased, and hog farms became more specialized in hog production.
- Of the top five U.S. States by hog and pig inventory in 2022, the State with the highest percentage of inventory under production contract was North Carolina, and the State with the lowest percentage was Illinois.
- For each of the years 1998, 2009, 2015, and 2020, the total cost of hog production per 100 pounds of gain decreased as farm size increased.
- During the 27 years from 1998 to 2024, the gross value of production associated with 100 pounds of hog weight gain exceeded operating costs in all years, operating and ownership costs in 19 years, and total costs in 13 years.
- Inflation-adjusted hog production costs per 100 pounds of gain decreased from 1998 to 2020, indicating increased production efficiency in U.S. hog production.

*Manure management practices, hog production facilities, and Coronavirus (COVID-19) pandemic impacts on hog farms in 2020:*

- In 2020, the majority of U.S. building capacity for all hog and pig production phases was enclosed confinement with no outside access.
- In 2020, roughly half of U.S. hog farms used deep pit manure handling systems, which collect slurry manure in a deep pit underneath the barn.
- Manure storage systems varied considerably by region. In the Heartland Farm Resource Region, 94 percent of hog operations used a pit or tank to store manure while 86 percent of operations stored liquid manure in lagoons or ponds in the Southern Seaboard.
- With much manure produced in small geographic areas, the removal of manure from storage structures on U.S. hog farms and its application to cropland are important for both air and water quality.
  - Sixty-eight percent of U.S. hog farms applied manure to nearby cropland in 2020. The average hog farm in the Heartland applied manure to 214 cropland acres, while the average farm in the Southern Seaboard applied manure—primarily lagoon effluent—to 56 cropland acres.
  - The incorporation of liquid manure directly into the soil, rather than spreading manure on top of cropland, was practiced on 21 percent of U.S. hog farms in 2020.
- About 6 percent of U.S. farms euthanized animals in 2020 in response to the closing of hog slaughter facilities due to COVID-19.

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# The U.S. Hog Industry: Structural Change, Production Systems and Costs, and Manure Management

## Introduction

The U.S. hog production sector has experienced extensive structural change over the past four decades, with hog farms becoming larger with more hogs per farm, more specialized in specific phases of production, and increasingly dependent on production contracts for the production and marketing of hogs and pigs.<sup>1</sup> Because of the rapid change experienced by this industry, especially over the last four decades, and its importance to the U.S. agricultural economy, USDA, Economic Research Service (ERS) has tracked this structural change through a series of research reports. These reports have utilized data from USDA, ERS and USDA, National Agricultural Statistics Service's (NASS) periodic hog versions of the Agricultural Resource Management Survey (ARMS), and the Census of Agriculture (McBride & Key, 2003; Key & McBride, 2007; McBride & Key, 2007; McBride & Key, 2013; Davis et al., 2022). In this report, we use 2020 ARMS hog version data and 2022 Census of Agriculture data, as well as previous years of both datasets, to show the current structure of the U.S. hog production segment and track how today's hog production segment compares with hog production over the past several decades. Looking over the previous four decades, we examine changes in hog farm size (hog and pig inventory and acres operated per farm); hog farm specialization; location of hog farms; and the use of production contracts on hog farms. We also focus on the 2020 ARMS hog version data to examine the use of selected technologies, management practices, production systems, and manure management on hog farms; the costs and returns associated with U.S. hog production; and hog production characteristics by farm size.

## Data Used in the Study

Data used in this study are from the hog version of USDA's ARMS; USDA, NASS, Census of Agriculture (1997–2022); U.S. Department of Commerce, Bureau of the Census (1982–1992); and other USDA sources. ARMS is conducted annually by USDA, ERS and USDA, NASS to gather information on farm business and farm household economic indicators and farm production practices. Targeted ARMS questionnaires have been sent to U.S. hog producers every 5–6 years to collect information specific to hog farms. These data allow for the development of hog commodity costs and returns estimates and analyses of the characteristics of U.S. hog farms. Hog farms were targeted in the 1998, 2004, 2009, 2015, and 2020 ARMS. The States included in each ARMS hog version have changed based primarily on shifts in the location of hog production, with hog producers surveyed in 23, 19, 19, 13, and 13 U.S.

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<sup>1</sup> In this report, when we discuss hogs, we are referring to older, larger swine that are approaching slaughter weight. When discussing pigs, we are referring to younger, smaller swine that are being raised to eventually be sold for slaughter as hogs.

States in 1998, 2004, 2009, 2015, and 2020, respectively.<sup>2</sup> For each year, these States together included at least 90 percent of the U.S. hog production. To be eligible for survey participation, a farm must have had at least 25 hogs or pigs in inventory at some point during the year. Sampling weights included in the dataset allow the sample to be extended to represent at least 90 percent of U.S. hog production on farms with at least 25 hogs and pigs.

Criteria for inclusion in ARMS differs from other surveys conducted by USDA, NASS. The U.S. Census of Agriculture is conducted every 5 years and reports farm numbers, characteristics, and production levels, with the most recent Census of Agriculture conducted in 2022. We also use previous Census of Agriculture data going back to 1982. USDA, NASS collects additional information on U.S. agriculture via various other surveys. Most USDA, NASS datasets include farms with at least \$1,000 in sales, some of which may have fewer than 25 hogs and pigs. According to USDA, NASS, Census of Agriculture data, of the 60,809 hog farms with inventory of hogs and pigs in 2022, 17,319 (28 percent) were farms with 25 or more hogs and pigs. Because many of the farms with fewer than 25 hogs and pigs likely had only a few hogs and pigs, those with 25 or more hogs and pigs accounted for 99 percent of the total inventory of hogs and pigs. Throughout this report, the terms “operations” and “farms” are used interchangeably. The Census of Agriculture commonly refers to farm operations as “farms” while the ARMS questionnaire commonly refers to farm operations as “operations.” A “farm” is considered as one of the types of “operations” that might include farms, ranches, or greenhouses—hog operations are generally farms. For both Census of Agriculture and ARMS farms, the “operation” includes any hogs or pigs present on the farm. Contractors or integrators report only the hogs on the land they operate; they do not include any hogs grown or fed by someone else on a custom or contract basis.

In examining results for each of the Census of Agriculture and ARMS hog survey years, it is important to recognize that all years have unique production and market characteristics that are likely to impact costs, returns, and production. For example, in 1998, a year when the ARMS hog version was administered, the hog price reached a low of \$15 per hundredweight in December for an average annual price of \$34.40, compared with annual average prices that had ranged from \$39.90 to \$53.70 during the previous decade, according to the USDA, NASS *Agricultural Prices* report. In 2020, the most recent year of the ARMS hog version, the Coronavirus (COVID-19) pandemic resulted in the closure of some U.S. slaughter plants during April and May, impacting hog markets. Some producers opted to euthanize hogs in cases where nearby slaughter plants had closed and there was no market for the producer’s hogs. The impact of COVID-19 on hog production is more extensively explored using 2020 ARMS hog version results later in this report, where we find that almost 6 percent of U.S. hog producers reported euthanizing hogs. Given that any particular year has unique characteristics that impact hog production, we provide results from multiple years and/or refer to other studies conducted in previous years to further contextualize our results.

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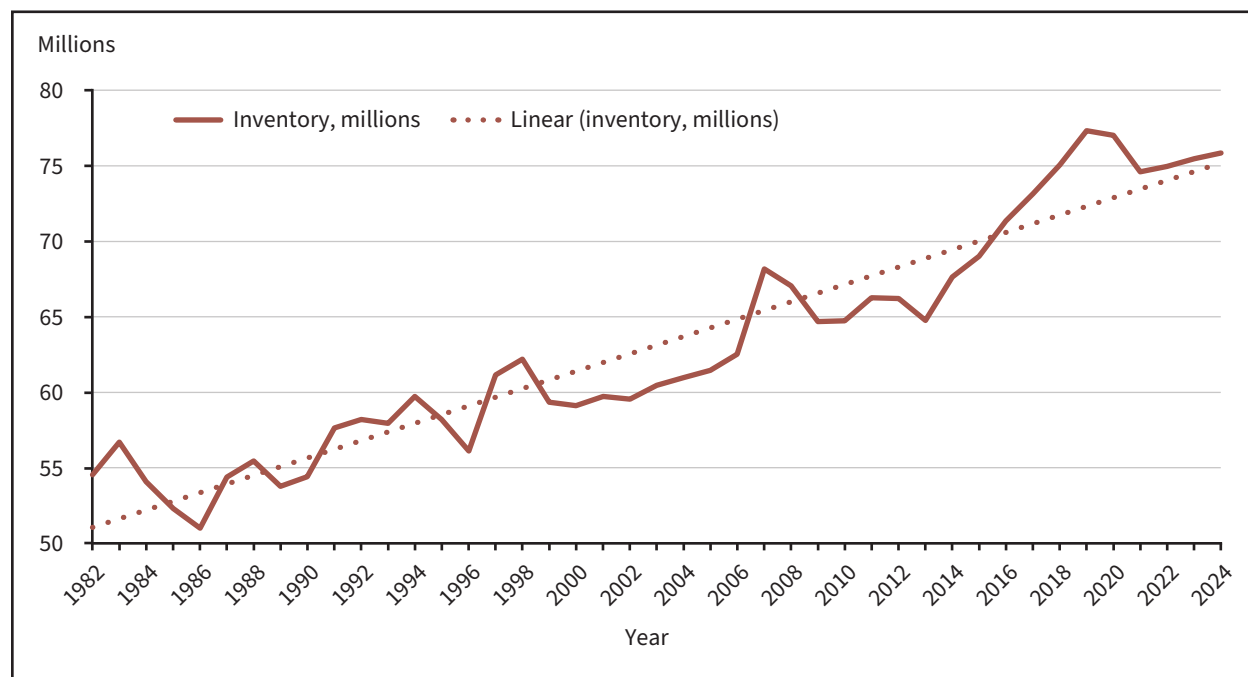
<sup>2</sup> States surveyed in 1998 included Alabama, Arkansas, Colorado, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Utah, Virginia, and Wisconsin. In 2004 and thereafter, Alabama, South Carolina, Tennessee, and Utah were not included. In 2015 and thereafter, Arkansas, Colorado, Georgia, Kentucky, Virginia, and Wisconsin were not included.

# Structural Change in the U.S. Hog Industry

## More Hogs Are Being Produced on Fewer Farms

The use of USDA, NASS *Hogs and Pigs* reports allows for the tracking of hogs and pigs inventories over time, and the use of multiple years of U.S. Census of Agriculture (USDA, NASS 1997–2022; USDC, BC 1982–1992) data allow for the tracking of hog farm numbers. The total U.S. hogs and pigs inventory on December 1 increased from 54.5 million in 1982 to 75.8 million in 2024, an increase of 39 percent (figure 1).<sup>3</sup> While the inventory increase has fluctuated through those 42 years, a linear increasing trendline over the period can be used to approximate the growth in inventory. On the other hand, the number of U.S. farms with at least 1 hog or pig in inventory on December 31<sup>4</sup> decreased from 329,833 in 1982 to 60,809 in 2022, a decrease of 82 percent (figure 2). The largest decline in farm numbers occurred from 1982–2002, with a lower rate of decline thereafter. By simply dividing December 31 hog and pig inventories as reported by the Census of Agriculture by hog farm numbers, the average farm with at least 1 hog or pig on December 31 increased in size from 168 hogs and pigs in 1982 to 1,214 in 2022.

Figure 1  
**December 1 U.S. inventory of hogs and pigs, 1982 to 2024**



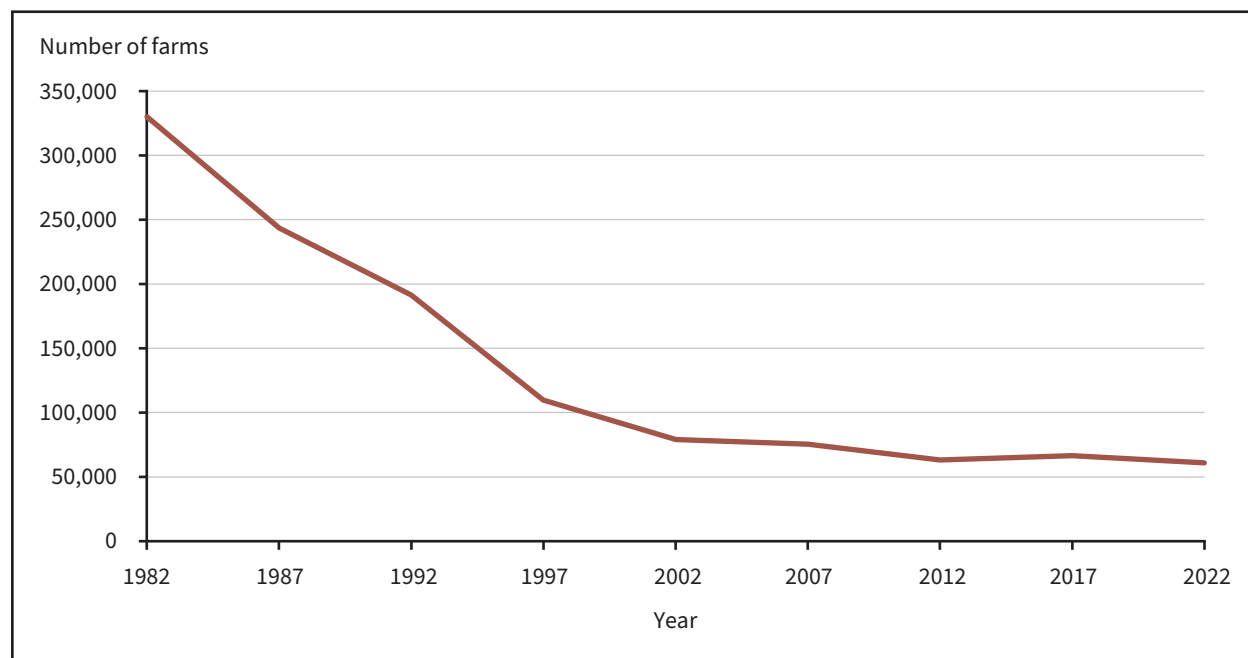
Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service *Hogs and Pigs* reports, 1982–2024.

<sup>3</sup> Likewise, hog slaughter (as reported in the USDA *Livestock Slaughter* report) increased from 82.8 million hogs in 1982 to 129.7 million hogs in 2024, an increase of 57 percent.

<sup>4</sup> The hogs and pigs inventory (as reported in the USDA, NASS *Hogs and Pigs* report) is shown for December 1, while the inventory as reported in the USDA, NASS Census of Agriculture is shown for December 31.

Figure 2

**December 31 number of U.S. farms with hog inventory, 1982–2022**



Note: Numbers shown represent those provided every 5 years in the Census of Agriculture. Estimates for years between Census of Agriculture years are not provided in the chart.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service (NASS), Census of Agriculture, 1997–2022; U.S. Department of Commerce, Bureau of the Census, Census of Agriculture, 1982–92.

While charts showing the total U.S. hog and pig inventory and total number of farms with hogs and pigs are informative, they provide limited information on hog farm size trends in terms of hog and pig inventory per farm. While some farms with inventories of less than 25 hogs and pigs may be considered “commercial” hog farms in the sense that they are raising and selling hogs for the purpose of eventually entering the slaughter market,<sup>5</sup> the ARMS hog version surveys only farms with inventories of 25 or more hogs and pigs since they are the most likely to be engaged in commercial hog production. If only farms with inventories of at least 25 hogs and pigs are considered using the Census of Agriculture data, the number of farms declined from 194,086 in 1982 to 17,319 in 2022, and the total inventory of hogs and pigs on these farms increased from 55.4 million to 73.6 million over the period. The average number of hogs and pigs per farm increased from 280 to 4,248 for those 2 years, respectively.

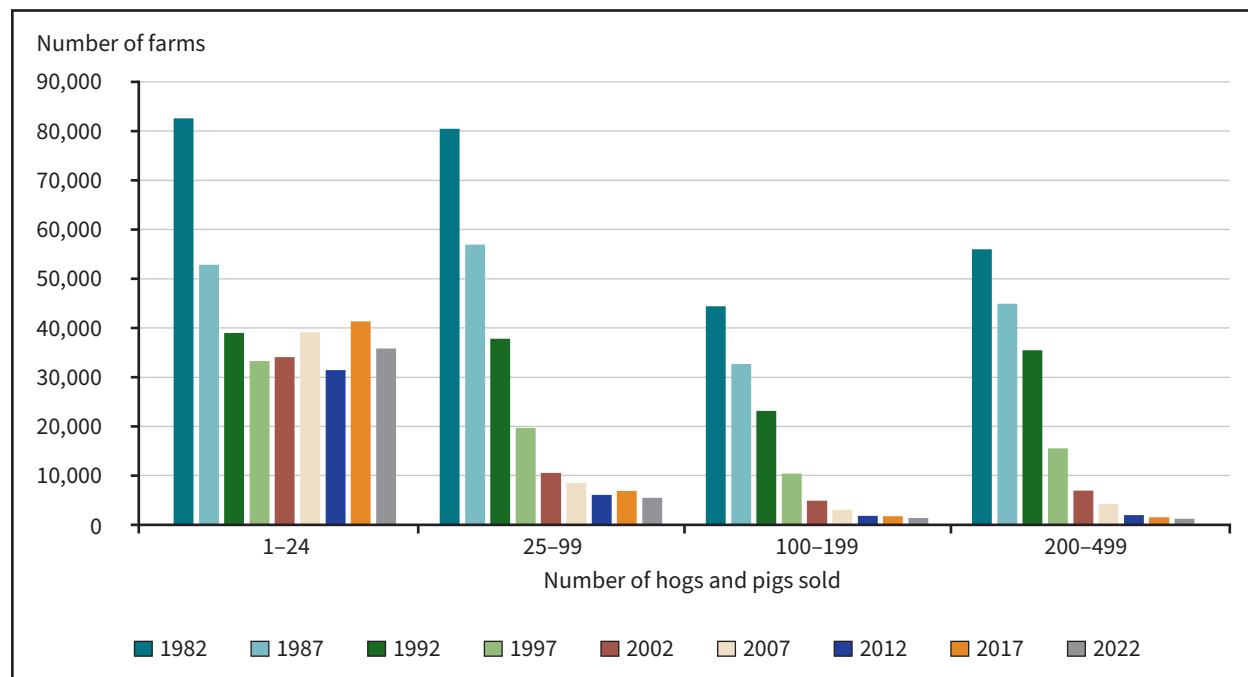
The distribution of hog farms by sales class is shown in figures 3 and 4. Between 1982 and 2022, farms with sales of between 1 and 24 hogs and pigs have consistently constituted the highest number of farms with hog and pig sales, with 82,608 farms in 1982 declining to 33,266 farms in 1997. The number of farms in this size class then ranged from a low of 31,399 in 2012 to a high of 41,320 in 2017, with fluctuations indicating no obvious upward or downward long-run trend from 1992–2022. Downward trends in farm numbers are noted for each of the other farm sales classes except for the 5,000 or more hogs category, which increased from 1,199 farms in 1982 to 7,210 farms in 2002, and has remained in the 7,000–8,000 farm range in successive Censuses of Agriculture since, with 7,636 farms in 2022.

<sup>5</sup> Some farms with fewer than 25 hogs and pigs in inventory on December 31 may be considered commercial farms, for example, those farms with outdoor systems serving primarily local markets and those that have recently sold or removed most of their hogs prior to December 31 for cleanout prior to the next group. However, many of these farms may also include only one or a few hogs for home use, for youth livestock show purposes, or other non-commercial purposes.

Numbers of farms in two sales classes, 1,000–1,999 hogs and pigs and 2,000–4,999 hogs and pigs, increased from 1982 to 1992, but declined thereafter.

Figure 3

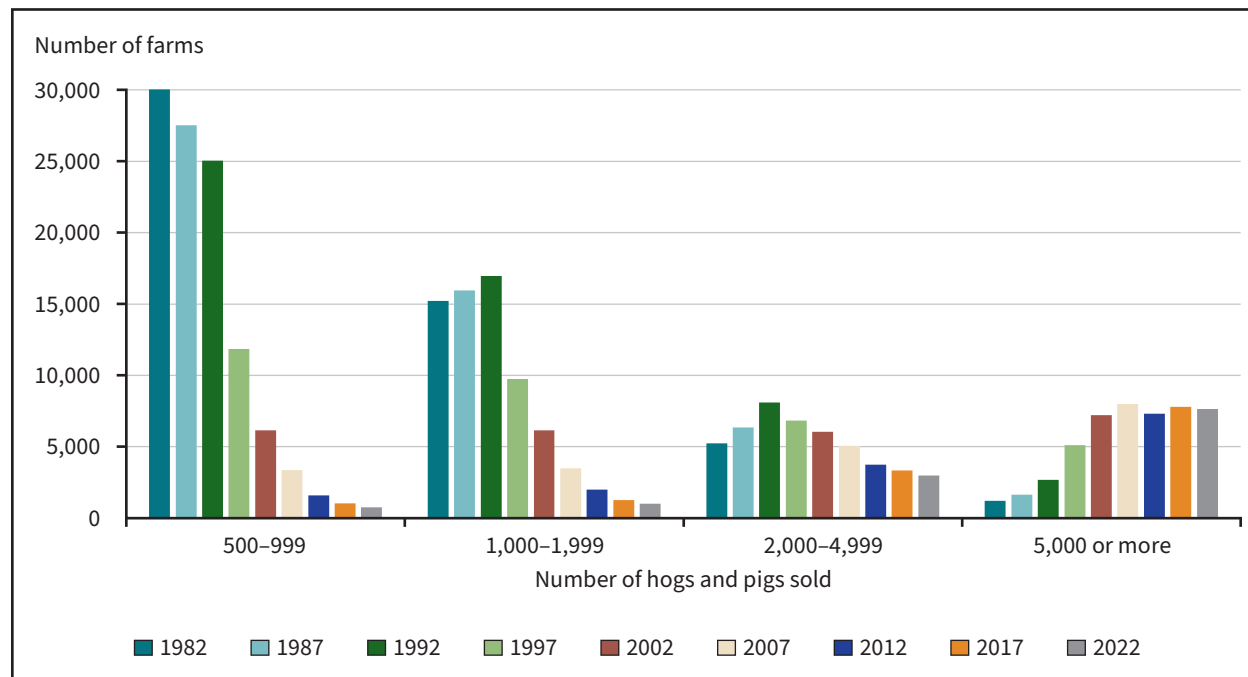
**Number of U.S. hog farms by sales class, categories with sales of 1–499 hogs and pigs, 1982–2022**



Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture, 1997–2022; U.S. Department of Commerce, Bureau of the Census, 1982–92.

Figure 4

**Number of U.S. hog farms by sales class, categories with sales of 500–5,000 or more hogs and pigs, 1982–2022**



Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture, 1997–2022; U.S. Department of Commerce, Bureau of the Census, 1982–92.

## Hog Production Trends by Production Type

U.S. hog farms differ by the phases of production in which they are involved. There are four major phases of hog production (table 1): (1) breeding and gestation, where sows (adult female breeding swine) are bred and maintained during the gestation (pregnancy) period; (2) farrowing, which involves the birth of baby pigs and continues until the pigs are weaned; (3) nursery, which involves the care of pigs from weaning until approximately 30–80 pounds;<sup>6</sup> and (4) finishing, which involves feeding pigs from between 30 and 80 pounds to market hog weight of approximately 225–300 pounds. Hog producers are commonly classified into various hog production type categories, depending upon which of the phases of production they are involved (table 1): (1) farrow-to-finish, which involves all four production phases; (2) farrow-to-feeder pig, which involves production phases 1, 2, and 3; (3) finisher, which involves production phase 4 and in some cases production phase 3; (4) weanling-to-feeder pig (also called nursery), which involves only production phase 3; and (5) farrow-to-weanling, which involves production phases 1 and 2. This classification of various production types indicates the possibility that a pig may be sold multiple times—for example as a weanling, as a feeder pig, etc.—before finally being sold as a market hog. Over the past couple of decades, an increasing number of farms have been involved in production phases 3 and 4 and are considered weanling-to-finish farms. For the purposes of our analysis using ARMS hog version data, these farms are included in the finisher group.

Table 1

### Production phases and hog production types in U.S. hog production

Production phase	Description
1. Breeding and gestation	Sows are bred and maintained during the gestation (pregnancy) period.
2. Farrowing	Sows give birth to baby pigs and nurse the pigs through weaning.
3. Nursery	Pigs are raised from the time they are weaned until they are about 40 pounds, though the range can be roughly 30–80 pounds. These animals are feeder pigs.
4. Finishing	Pigs are fed after the nursery stage from about 40 pounds to market hog weight of 225–300 pounds.
Hog production type	
Farrow-to-finish	Involves all four production phases: breeding and gestation, farrowing, nursery, and finishing.
Farrow-to-feeder pig	Involves production phases 1, 2, and 3: breeding and gestation, farrowing, and nursery.
Finisher	Involves only production phase 4 and sometimes phase 3.
Weanling-to-feeder pig (nursery)	Involves only production phase 3. These are also called nursery farms.
Farrow-to-weanling	Involves production phases 1 and 2.

Source: USDA, Economic Research Service.

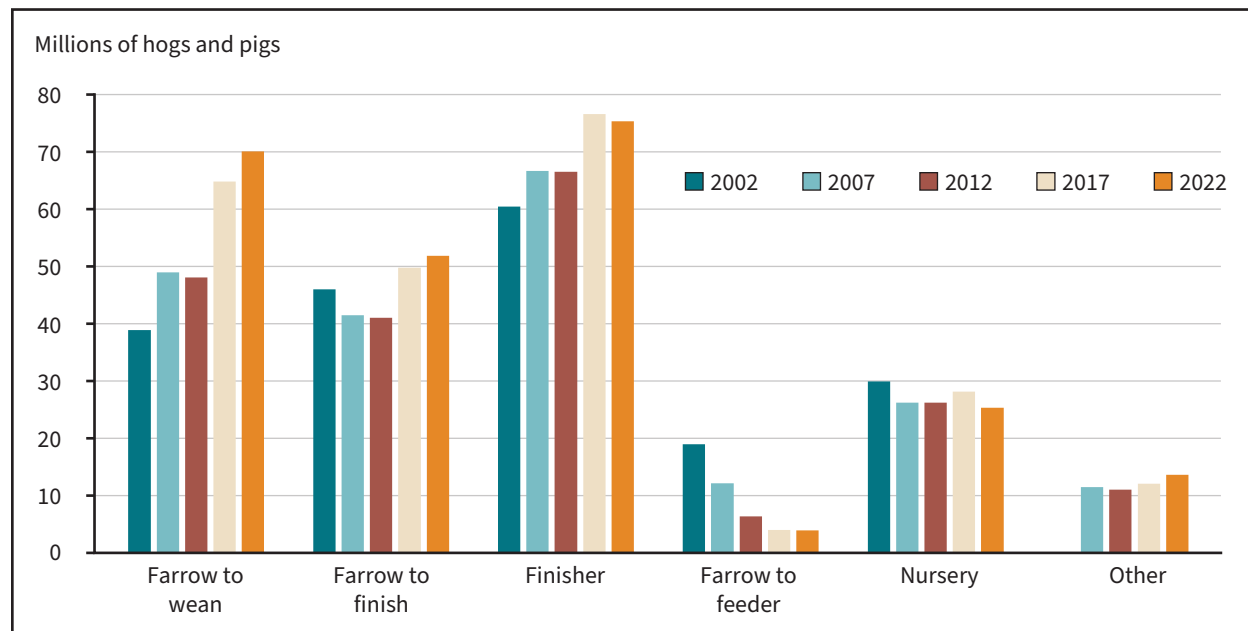
In 2002, the USDA, NASS Census of Agriculture began reporting numbers of hog farms by production type category. The largest number of hogs and pigs sold in 2002 were from finisher operations, followed by farrow-to-finish, and then farrow-to-wean operations (figure 5). The greatest growth in numbers of hogs and pigs sold between 2002 and 2022 was for farrow-to-wean operations, which rose from 39 million hogs and pigs sold to 70 million hogs and pigs sold, an increase of 80.3 percent. On the

<sup>6</sup> USDA, ERS Livestock and Meat International Trade Data (2024) show that 6,745,358 hogs and pigs were imported into the United States in 2023, with all except 38 head coming from Canada. Of these, 4,055,288 were pigs weighing less than 15.4 pounds, which presumably entered the nursery production phase. Imports of hogs and pigs from Canada have varied during 2013–23, from a low of 4,947,751 in 2013 to the 2023 level, and imports of pigs weighing less than 15.4 pounds have varied from 2,780,836 in 2013 to the 2023 level. Only 67,806 hogs and pigs were exported from the United States in 2023. According to USDA, NASS Livestock Slaughter (2023, 2024) estimates, 128,047,300 hogs were slaughtered in the United States in 2023.

other hand, farrow-to-feeder operations sold fewer hogs and pigs, falling from 19 million to 4 million hogs and pigs sold, a decrease of 79 percent.

Figure 5

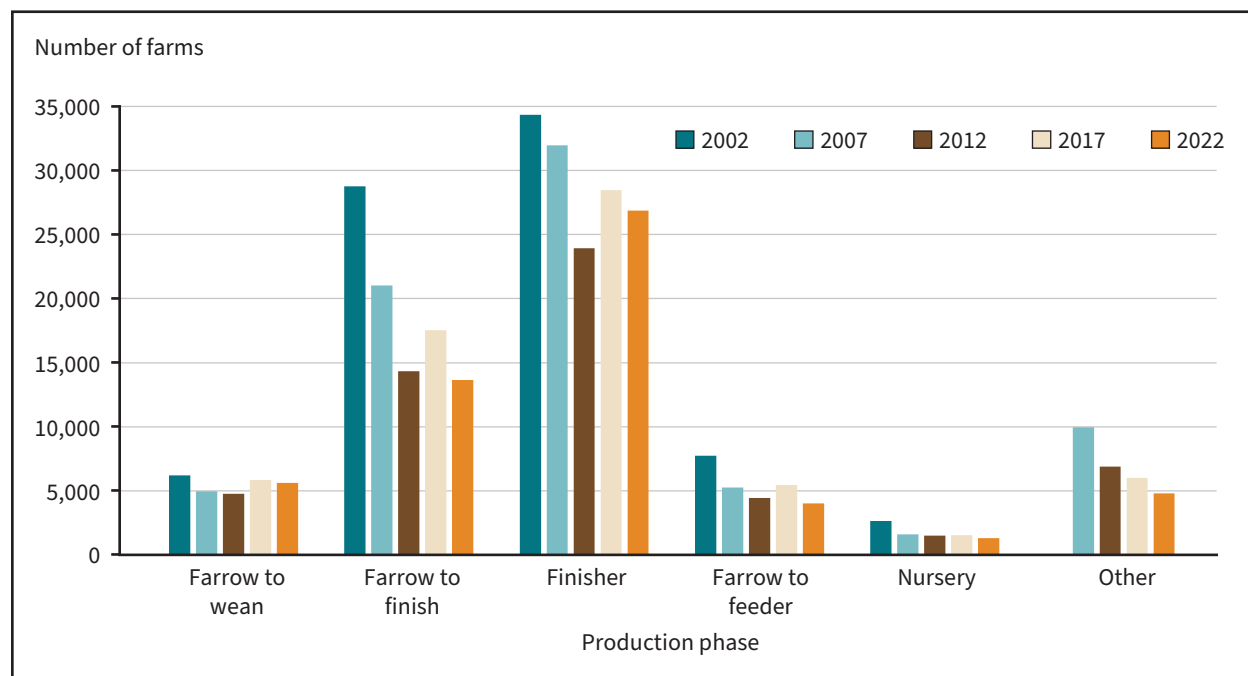
**Number of hogs and pigs sold by production type in the United States, 2002–2022**



Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture 2002, 2007, 2012, 2017, and 2022.

The most common hog farm by production type between 2002 and 2022 was finisher, accounting for 26,860 of the 56,265 total hog farms with sales in 2022 (figure 6). The second-most common farm by production type between 2002 and 2022 was farrow-to-finish, with 13,634 of the hog farms with sales in 2022. From 2002–2022, farrow-to-finish, farrow-to-feeder, and nursery farm numbers decreased the most on a percentage basis, by 53 percent, 48 percent, and 51 percent, respectively. These orderings of farm numbers by type using Census of Agriculture data are generally in-line with percentages of hog farms by production type, as reported in successive ARMS hog versions (table 2). In particular, the ARMS share of hog farms that were farrow-to-finish operations decreased from 49 percent in 1998 to 11 percent in 2020 while the share of hog farms that were feeder pig-to-finish increased from 1998 to 2015 before decreasing in 2020. It is noted, however, that ARMS weights are calibrated to be representative of hog and pig inventory by State, but not production type.

Figure 6

**Number of farms with hog sales in the United States by production type, 2002–2022**

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture 2002, 2007, 2012, 2017, and 2022.

Table 2

**Percentages of U.S. hog farms by production type, 1998–2020**

Percent of farms	1998	2004	2009	2015	2020
Farrow-to-finish	49	31	24	19	11
Farrow-to-feeder pig	6	10	5	7	7
Feeder pig-to-finish (finisher)	31	40	47	60	49
Farrow-to-weanling	3	2	4	1	3
Weanling-to-feeder pig (nursery)	1	5	7	6	6
Mixed hog producer	9	13	14	6	23

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey (ARMS) hog versions, 1998, 2004, 2009, 2015, and 2020.

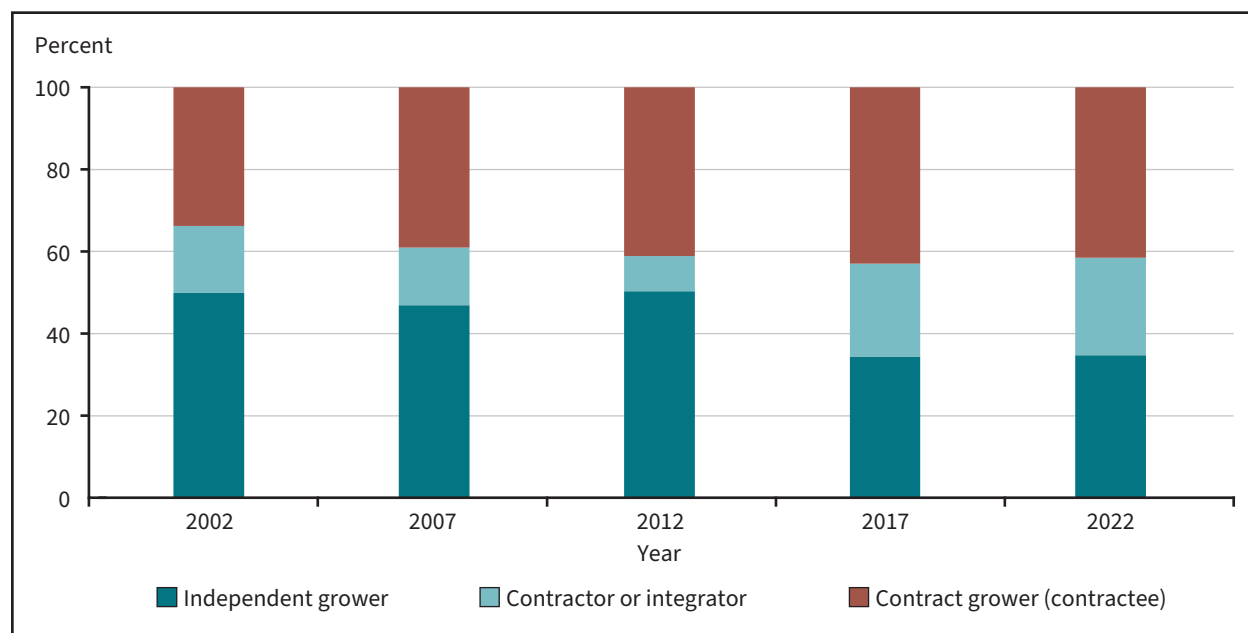
## Hog Production Contracts and Independent Production

The use of production contracts in U.S. hog production has become increasingly common over the last four decades. The typical hog production contract is a business arrangement between a hog or pig owner, or contractor, and a hog or pig grower, or contractee, who takes custody of the hogs or pigs and raises them in contractee-owned facilities. The grower is usually paid an agreed-upon fee by the contractor for raising the hogs or pigs. Typically, contractors not only own the hogs and pigs, but also provide hog production inputs such as feed and technical assistance, and they assemble hogs at the end of the production cycle for marketing or processing. Contractors may be “integrators”—large companies that contract with many growers to produce hogs, usually input suppliers or packers that contract with growers to vertically integrate with their other business functions; or they may be

farmers who want to expand their operations or specialize in one or more hog production phases. The USDA, NASS Census of Agriculture began reporting production contract use in 2002.<sup>7</sup>

Most U.S. farms with hog and pig inventories have been operated by independent growers. Eighty-eight percent of U.S. farms with an inventory of at least 1 hog or pig were independent in the 2002, 2007, 2012, and 2017 USDA, NASS Census of Agriculture, dropping to 87 percent in 2022. These percentages, however, are not indicative of the prevalence of production contracts in U.S. commercial hog production because some of the independent farms with only one or a few hogs would not be considered commercial hog farms. An alternative indicator of the prevalence of contracting in U.S. hog production is the percentage of the U.S. inventory of hogs and pigs produced under production contract. Census of Agriculture data showed that the December 31 hogs and pigs inventory accounted for by contractors and contract growers increased from 31.3 million in 2002 to 48.2 million in 2022, a 54 percent increase. In contrast the December 31 hogs and pigs inventory accounted for by independent growers decreased from 31.2 million in 2002 to 25.6 million in 2022, an 18 percent decline.<sup>8</sup> Over the period, the share of hog and pig inventory accounted for by contractors and contract growers combined increased from 50 percent to 65 percent (figure 7). Examining changes in hog sales by producer type, U.S. Census of Agriculture data show that the number of hogs and pigs sold by contractors and contract growers increased from 112.8 million in 2002 to 156.0 million, a 38 percent increase. In contrast, the number of hogs and pigs sold by independent growers increased from 78.9 million to 84.1 million, a 7-percent increase. Over the period, the share of hogs sold by contractors and contract growers combined increased from 58 percent to 65 percent (figure 8).

Figure 7  
**Percentage of the U.S. hog and pig inventory accounted for by independent growers, contractors or integrators, and contract growers, 2002–2022**



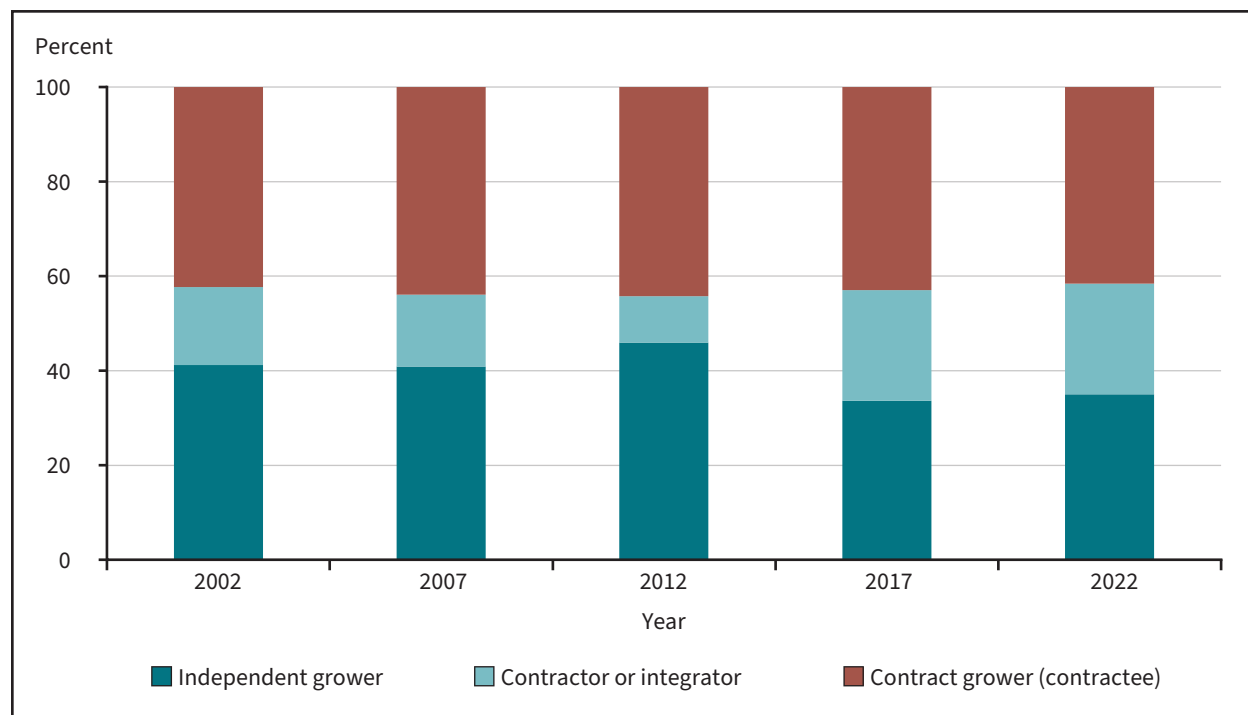
Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture 2002, 2007, 2012, 2017, and 2022.

<sup>7</sup> Marketing contracts can be distinguished from production contracts primarily because the producer (grower) retains ownership of the commodity throughout the production process and furnishes all inputs, usually agreeing on a price and quantity of the commodity to be sold to the buyer at a future date.

<sup>8</sup> The USDA, NASS Census of Agriculture requests respondents provide the number of hogs and pigs on hand on the operation on December 31. In the case of contractors or integrators, this includes only the animals on the land the contractor or integrator operates. Respondents are asked to indicate which of three items best describes the type of producer: independent grower, contract grower (contractee), or contractor or integrator.

Figure 8

**Percentage of U.S. hogs and pigs sold by independent growers, contractor or integrators, and contract growers, 2002–2022**



Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture, 2002, 2007, 2012, 2017, and 2022.

The ARMS hog version data provided additional information about the prevalence of contracting in the hog industry. The ARMS data showed continued increases in the use of production contracts in U.S. hog production (table 3). The percentages of hog and pig inventory under contract during 1998 and 2004 were 42 percent and 56 percent, respectively, which was consistent with USDA, NASS Census of Agriculture data for 2002, which showed 50 percent of the hog and pig inventory accounted for by contractors or integrators and contract growers. The ARMS percentage of inventory under contract for 2015 (66 percent) is also consistent with USDA, NASS Census of Agriculture data for 2017, which showed 67 percent of the hog and pig inventory accounted for by contractors or integrators and contract growers. The ARMS data for 2020, however, showed a higher percentage of inventory under contract for 2020 (78 percent) than was shown by USDA, NASS Census of Agriculture data for 2022, which showed 65 percent of the hog and pig inventory accounted for by contractors or integrators and contract growers. The ARMS 2020 hog data also showed higher hog sales and removals under contract after an almost unchanged percentage between 2009 and 2015. Percentages of finisher operations (which comprise a substantial portion of U.S. hog farms) that were under contract showed similar patterns of growth as shown for all hog farms, with higher prevalence of contracting in the finisher segment than for all hog farms for all measures of contracting prevalence. Overall, higher percentages of inventory under production contract with ARMS were found than with Census of Agriculture. ARMS is a sample-based survey with sample weights that are not calibrated on the basis of contract/independent production.

Table 3

**Four measures of percentages of U.S. hog production and farms under production contract using ARMS hog version data**

Measure	1998	2004	2009	2015	2020
<b>All hog farms</b>					
Percent of hog production (weight gain)	40	58	64	69	77
Percent of hog farms	16	28	48	53	50
Percent of hog sales and removals (head sold or removed)	57	69	73	72	83
Percent of December 31 hog and pig inventory	42	56	65	66	78
<b>Finisher hog farms</b>					
Percent of hog production (weight gain)	64	72	79	79	87
Percent of hog farms	36	50	73	71	77
Percent of hog sales and removals (head sold or removed)	64	73	80	80	88
Percent of December 31 hog and pig inventory	61	71	77	75	88

Note: Percent of hog production is measured in terms of amount of weight gained by hogs.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey (ARMS) hog version data, 1998, 2004, 2009, 2015, and 2020.

## Trends in Operator Demographics and Farm Structure

The ARMS hog version data provide additional information on changes in hog industry structure (table 4). Eligibility for ARMS is limited to the States surveyed and requires the farm to have at least 25 hogs or pigs in inventory at some point during the year. Though ARMS hog version data do not show obvious trends in acres operated from 1998–2020—the average farm size ranged between 443 acres and 666 acres—the average hog and pig inventory per farm increased from 948 in 1998 to 2,938 in 2020. For comparison purposes, using USDA, NASS Census of Agriculture numbers for the “closest” Census years, 1997 and 2022, we divided total hogs and pigs inventory by the number of farms with hogs and pigs inventory, adjusting to include only the farms with at least 25 hogs and pigs in inventory on December 31 since 25 hogs and pigs was the cutoff for inclusion in the ARMS hog surveys. The average USDA, NASS Census of Agriculture hog and pig inventory per farm increased from 884 to 4,248 from 1997–2022 on farms with at least 25 head.

Numbers of feeder pigs and market hogs sold or removed under contract per farm increased over the 5 ARMS hog version survey years. The average number of feeder pigs sold or removed on farms that produced them<sup>9</sup> increased from 1,049 per farm in 1998 to 3,701 in 2020 (table 4). Likewise, the average number of market hogs sold or removed on farms that produced them increased from 1,540 in 1998 to 5,433 in 2020. This is consistent with earlier results showing increases in farm size in the hog industry. The average weight of feeder pigs sold or removed ranged from 36 pounds in 1998 to 51 pounds in 2009. The average weight of market hogs sold or removed increased from 251 pounds in 1998 to 281 pounds in 2020. The increase in market hog weight followed the trend shown by USDA, NASS *Livestock Slaughter* reports (1999, 2021), which showed weights of commercial slaughter hogs on a live basis increased from 256 pounds in 1998 to 289 pounds in 2020.

The principal operator is designated as the individual who makes the majority of the farm decisions. According to ARMS hog versions, the average age of principal operators of U.S. hog farms increased from 50 years in 1998 to 56 years in 2020 (table 4). This follows the trend of increased average prin-

<sup>9</sup> This average does not include farms that did not produce feeder pigs, such as finisher operations.

principal operator age for all U.S. farms as shown by successive USDA, NASS Censuses of Agriculture, from 54 years in 1997 to 59 years in 2017. The percentage of principal operators who held 4-year college degrees trended upward from 1998 to 2020, similar to trends shown recently for other agricultural production segments such as corn (Saavoss et al., 2021), cow-calf (Gillespie et al., 2023) and soybeans (Vaiknoras & Hubbs, 2023).

According to ARMS hog versions, hog farms became more specialized in hog production between 1998 and 2020, with the average percentage of total farm value of production from hogs increasing from 56 percent to 80 percent between the 2 years. Likewise, successively lower percentages of hog farms produced corn, soybeans, and small grains over the period. The increased specialization in hog production is also noted by the increased percentage of purchased relative to homegrown feed for hogs as shown by the USDA, ERS Commodity Costs and Returns data (2024a). These data show that the percentage of the total purchased hog feed cost increased from 72 percent in 1998 to 97 percent in 2023.

Table 4  
**Characteristics of U.S. hog farms, 1998–2020**

Measure	1998	2004	2009	2015	2020
<b>Farm size</b>					
Operated acres, average	443	666	662	527	449
Hog and pig inventory, average	948	1,383	2,561	2,866	2,938
<b>Feeder pigs and market hogs sold or removed and sow inventory</b>					
Number of feeder pigs sold or removed, average	1,049	1,433	2,132	2,878	3,701
Average weight of feeder pigs sold or removed, pounds	36	47	51	49	47
Number of market hogs sold or removed, average	1,540	2,420	4,626	5,531	5,433
Average weight of market hogs sold or removed, pounds	251	261	266	268	281
Average sow inventory, number	132	191	379	372	301
<b>Principal operator demographics</b>					
Average operator age, years	50	49	52	55	56
Percent of operators with 4-year college degree	15	25	21	25	37
<b>Farm financial and diversification</b>					
Farm debt-to-asset ratio, average	0.24	0.17	0.19	0.20	0.21
Percent of household income from farm, average	NA	66	62	68	58
Percent of farm value of production from hogs, average	56	70	70	79	80
Percent of farms producing corn	77	66	65	59	46
Percent of farms producing soybeans	66	51	55	53	40
Percent of farms producing small grains	40	33	26	12	12

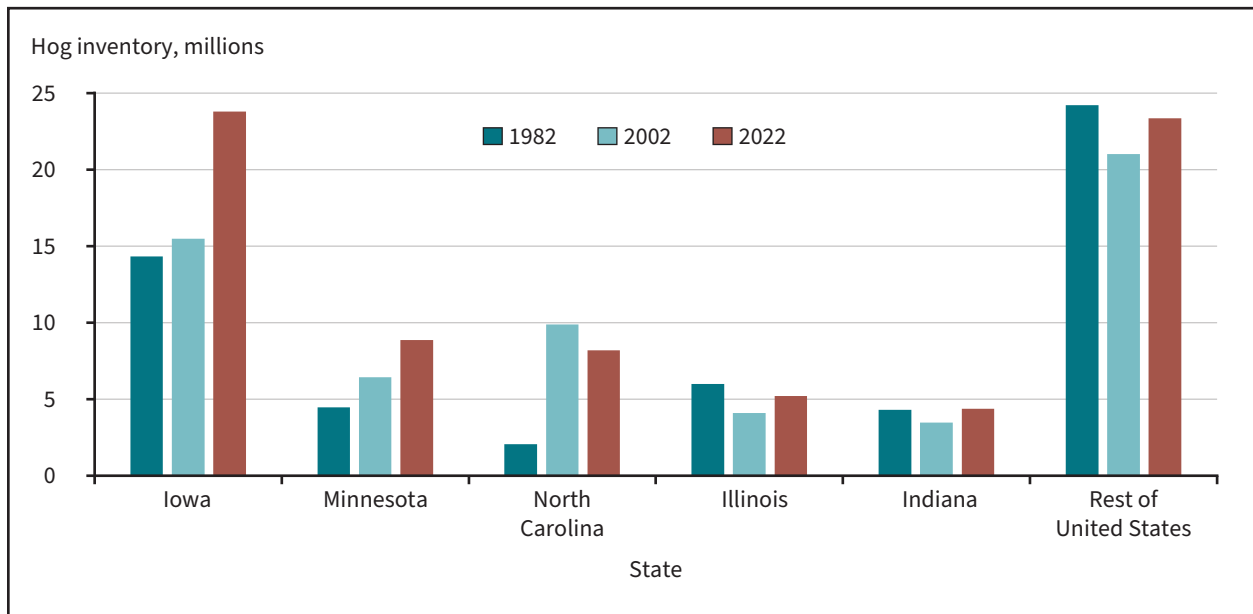
Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey (ARMS) hog versions, 1998, 2004, 2009, 2015, and 2005.

## Hog Production in the Top Five Producing U.S. States

According to USDA, NASS Census of Agriculture data, the top five U.S. States by hog and pig inventory in 2022 held 68 percent of the total December 31 hogs and pigs inventory. These States were (from first through fifth) Iowa, Minnesota, North Carolina, Illinois, and Indiana. Since 1982, hog and pig inventories have increased in Iowa and Minnesota, fluctuated in Illinois and Indiana, and increased

during the late 1980s and 1990s in North Carolina before declining by 2022 (figure 9).<sup>10</sup> Reasons for North Carolina’s growth in the 1990s have been discussed extensively by economists such as McBride and Key (2003), Gillespie et al. (2000), and Zering (2019), with much of the increase occurring through the use of production contracts. Zering (2019) further discusses a 1997 North Carolina moratorium on new or expanded hog operations using conventional manure management systems in response to environmental concerns, which could have contributed to the decline in North Carolina operations from 2002 to 2022.

Figure 9  
**December 31 inventory of hogs and pigs, top five U.S. States in 2022**



Note: Rest of United States includes all other U.S. States with hog and pig inventories in the 3 years surveyed. The top five U.S. States are represented in this figure, with their inventory shown for 1982, 2002, and 2022.

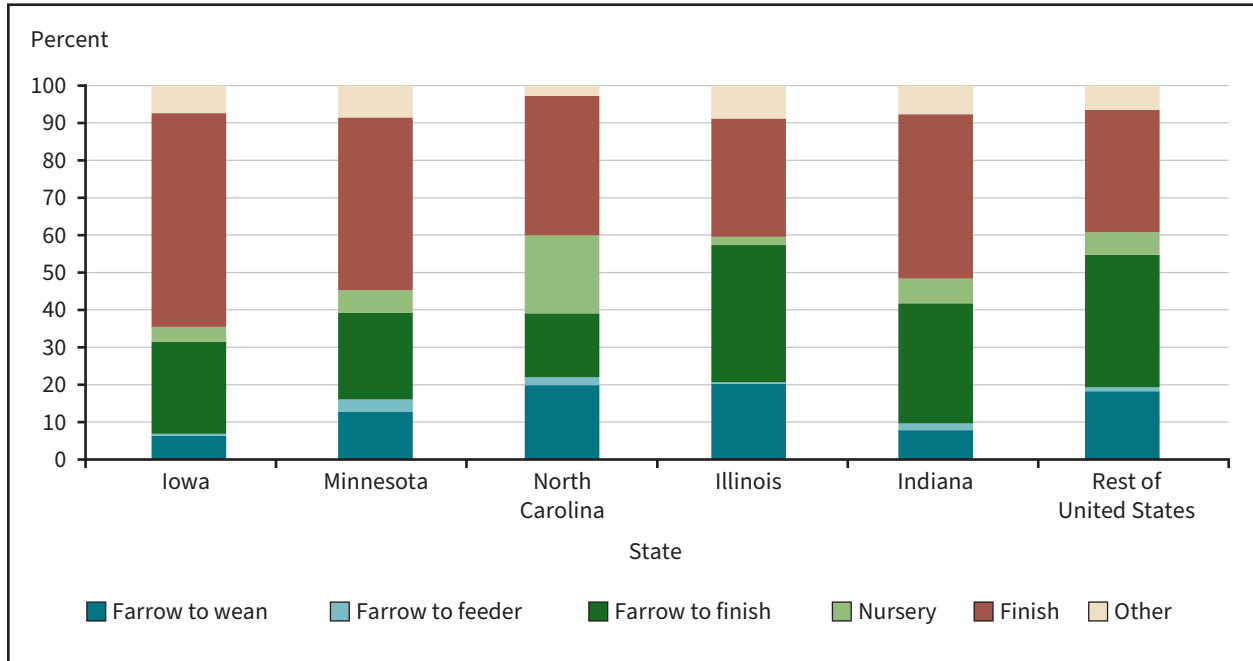
Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture, 2002 and 2022, and U.S. Department of Commerce, Bureau of the Census, Census of Agriculture, 1982.

Percentages of hog and pig inventory by production type differed by U.S. State in 2022 (figure 10). Relative to other States, Iowa had a larger share of its hog and pig inventory on finisher farms, while North Carolina had a larger share of its hog and pig inventory on nursery farms. Illinois, Indiana, and the combined Rest of United States category had relatively higher shares of their hog and pig inventories on farrow-to-finish farms than did the top three States by hog and pig inventory (Iowa, Minnesota, and North Carolina).

<sup>10</sup> North Carolina’s inventory of hogs and pigs peaked with the USDA, NASS 2007 Census of Agriculture at 10,134,004 hogs and pigs before declining in successive Censuses of Agriculture to 8,191,751 hogs and pigs in 2022. In 1982, the top five States by inventory, ranked, were Iowa, Illinois, Minnesota, Indiana, and Nebraska, with North Carolina eighth using U.S. Department of Commerce, Bureau of the Census, Census of Agriculture data.

Figure 10

**Percentages of hog and pig inventory by production type in the top five U.S. States on December 31, 2022**



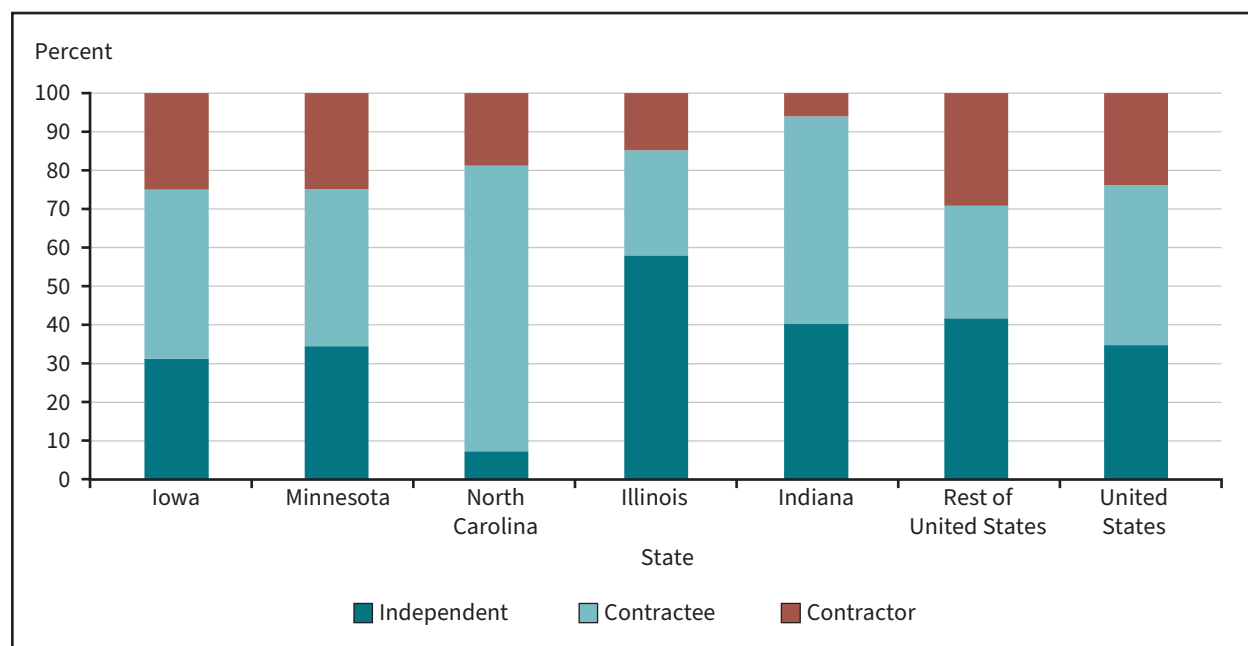
Note: Rest of United States includes all other U.S. States with hog and pig inventory.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture, 2022.

Percentages of U.S. December 31 hog and pig inventory under independent or contract production differed by U.S. State according to Census of Agriculture data (figure 11). Of the top 5 U.S. States by hog and pig inventory, Illinois had the highest share of its inventory under independent production (58 percent), while North Carolina had the lowest share (7 percent). North Carolina’s expansion in hog production during the late 1980s and 1990s occurred primarily via the introduction of hog production contracts. Of the top five States in inventory of hogs and pigs, Iowa and Minnesota’s contracting and independent production percentages are the most closely aligned with total U.S. averages.

Figure 11

**Percentages of hog and pig inventory accounted for by independent growers, contract growers, and contractors in the top five U.S. States, December 31, 2022**



Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Agriculture, 2022.

## Costs and Returns Associated With U.S. Hog Production

Annual estimates of costs associated with producing hogs in the United States have been estimated by USDA, ERS since 1982 as part of its Commodity Costs and Returns Data. Since 1998, USDA, ERS has used consistent methods to estimate the costs and returns associated with hog production. These methods were recommended by the American Agricultural Economics Association Task Force on Commodity Costs and Returns (1998), and the data used to estimate the commodity costs and returns have come primarily from periodic hog versions of the ARMS, conducted in 1998, 2004, 2009, 2015, and 2020. We examine costs and returns associated with U.S. hog production, focusing primarily on the most recent ARMS hog version data (2020) but also examining non-survey year USDA, ERS Commodity Costs and Returns Data from 1998–2023. All costs and returns associated with hog production are expressed on a per-100 pounds of gain basis.

Returns associated with hog production include the sum of the values of production associated with market hogs, feeder pigs, nursery pigs, cull stock, breeding stock, and the fertilizer value of manure production, which is valued according to its estimated contents of nitrogen, phosphorus, and potassium. The gross value of production is adjusted by the value of inventory change during the year. Operating costs associated with hog production include the costs of purchased feed; homegrown harvested feed;<sup>11</sup> feeder pigs; nursery pigs; veterinary and medicine; bedding and litter; marketing;

<sup>11</sup> Purchased feed cost is determined by asking ARMS hog version respondents to report the cost of purchased feed fed to hogs and pigs. Homegrown harvested feed cost is determined by asking ARMS respondents to report the quantities of various feeds that were grown on the farm and fed to hogs and pigs and, in turn, valuing these feeds at their market prices. The percentage of hog feed cost that is homegrown has decreased over the past 27 years, as shown by the USDA, ERS Commodity Costs and Returns data.

custom services; fuel, lubrication (oil and other lubricants), and electricity; repairs on buildings and equipment; hired labor; and interest on operating capital, which is the opportunity cost associated with capital invested in short-term operating inputs. Ownership costs include capital recovery costs—which is the cost of replacing the capital investment in buildings, equipment, and hog breeding stock that is consumed in the production process—as well as the interest on the remaining capital investment that could have been earned in an alternative use (an opportunity cost); and expenses associated with taxes and insurance. Opportunity and overhead expenses include the opportunity cost of unpaid labor, which is mostly family labor that is valued at the wage that could be expected if unpaid labor were working off the farm; the opportunity cost of land, which is valued at the rate at which it could be rented to another farmer; and general farm overhead. Four measures of profitability are presented: return over feed costs, return over operating costs, return over operating and ownership costs, and return over total costs.

Costs and returns include the major economic costs associated with producing hogs; thus, they include not only cash costs but also opportunity and ownership costs. Costs and returns are those associated with the value of production and costs incurred by all parties in hog production: the grower, the contractor, and the landlord. We present costs and returns in this report in a different manner than those presented in the USDA, ERS Commodity Costs and Returns Data so that a wider array of profitability measures can be assessed. Specifically, in this report, hired labor is included as an operating cost rather than an allocated overhead expense and interest on operating capital is recalculated accordingly. Thus, total costs differ slightly from those presented by the USDA, ERS Commodity Costs and Returns Data. We present costs and returns for all hogs combined, followed by those separately by production type, including farrow-to-finish and finisher.

Average costs and returns associated with producing hogs by all U.S. hog farms and by separate farm size categories (maximum inventories during the year of less than 2,000 hogs and pigs; 2,000–4,999 hogs and pigs; 5,000–9,999 hogs and pigs; and 10,000 or more hogs and pigs) are presented in table 5. In 2020, the majority of the value of production (67 percent) was from market hogs, followed by feeder pigs. No statistically significant differences in returns per 100 pounds of weight gain were found by farm size. For all farms, feed costs of \$30.39 per 100 pounds of gain accounted for the highest component of costs and accounted for approximately 40 percent of the total cost of production. Smaller operations incurred higher homegrown harvested feed costs, with larger-scale operations tending to substitute purchased feed for homegrown feed. Though some numeric differences were found in total operating costs, the differences were not statistically significant.

Total ownership costs and unpaid labor expenses per 100 pounds of gain were lowest for farms with 10,000 or more hogs and pigs. Even though total costs per 100 pounds of gain for the 10,000 or more hogs and pigs category were numerically lower than for the less than 2,000 hogs and pigs category, and net return over total costs per 100 pounds of gain were numerically higher for the 10,000 or more hogs and pigs category than for the 2,000 hogs or pigs category, these differences were not statistically significant. This is attributed to wide variation in the cost and returns data, which is primarily due to the wide heterogeneity of farms in each of the production type categories, including farrow-to-finish, finisher, and other types of farms that are combined together in this analysis. Despite this lack of statistical significance, numerically lower costs per 100 pounds of gain with larger-scale operations have been consistently found using the ARMS hog data for 1998, 2004, 2009, 2015, and 2020 as shown in figure 12.<sup>12</sup>

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<sup>12</sup> In figure 12, the higher costs associated with later years can be attributed to inflation—increasing input prices over time.

Table 5

**Costs and returns associated with U.S. hog and pig production, dollars per hundredweight gain unless otherwise indicated, 2020**

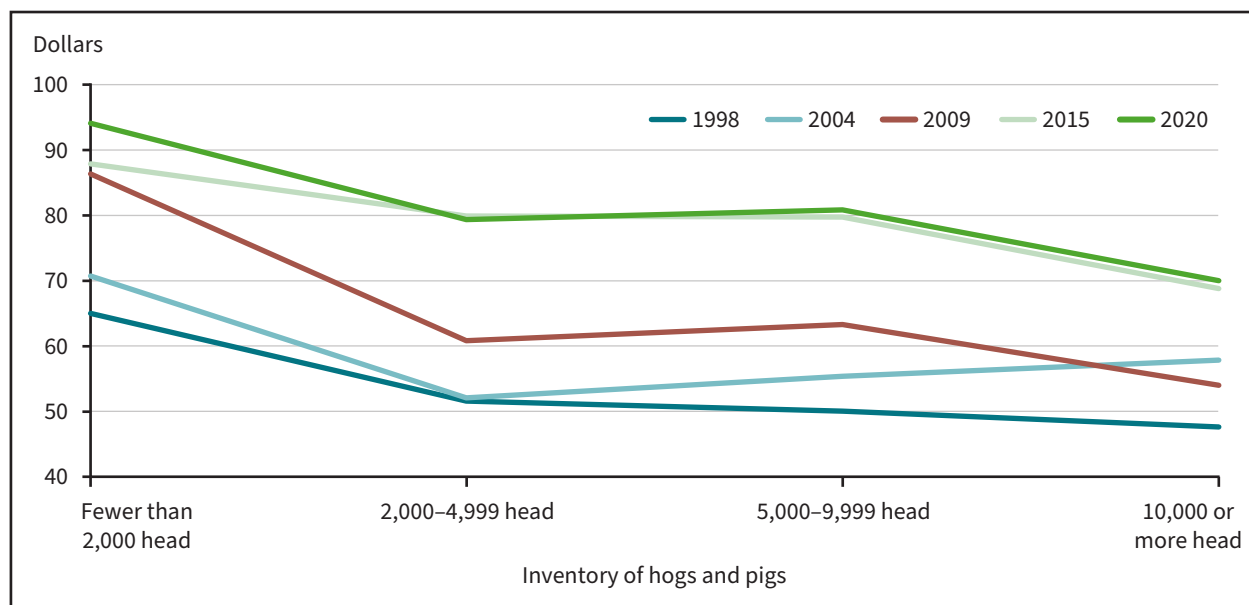
	Less than 2,000 hogs and pigs (a)	2,000–4,999 hogs and pigs (b)	5,000–9,999 hogs and pigs (c)	10,000 or more hogs and pigs (d)	All farms
<b>Gross value of production</b>					
Market hog value	48.08	49.89	49.11	43.93	47.05
Feeder pig value	5.21	8.97	10.78	20.42	14.20
Nursery pig value	6.42	2.89	5.14	1.84	3.15
All other hogs and pigs value	6.86	5.78	5.17	5.17	5.41
Total gross value of production	66.57	67.53	70.19	71.36	69.81
<b>Operating costs</b>					
Purchased feed cost	27.20	28.93	27.65	30.81	29.35
Homegrown feed cost	2.59 <sup>bc</sup>	0.84 <sup>a</sup>	1.22 <sup>a</sup>	0.92	1.04
Total feed cost	29.78	29.77	28.86	31.73	30.39
Feeder pig cost	15.11	17.06	16.04	10.29	13.80
Nursery pig cost	3.10 <sup>c</sup>	8.07	11.38 <sup>a</sup>	10.51	9.74
Hired labor cost	1.48	1.87	1.95	2.11	1.98
Other operating costs	8.15	7.34	7.71	7.06	7.35
Total operating costs	57.62	64.12	65.94	61.70	63.25
<b>Ownership costs</b>					
Total ownership cost	26.13	10.19 <sup>d</sup>	10.82	6.73 <sup>b</sup>	9.53
<b>Opportunity and overhead costs</b>					
Unpaid labor cost	8.38 <sup>d</sup>	3.19 <sup>d</sup>	1.75 <sup>d</sup>	0.54 <sup>abc</sup>	1.91
Other opportunity and overhead cost	1.97	1.86 <sup>d</sup>	2.31	1.04 <sup>b</sup>	1.62
Total opportunity and overhead cost	10.35	5.05 <sup>d</sup>	4.06 <sup>d</sup>	1.58 <sup>bc</sup>	3.54
<b>Total costs</b>					
Total cost	94.09	79.35	80.82	70.00	76.32
<b>Net return over costs</b>					
Return over feed cost	36.79	37.75	41.33	39.63	39.42
Return over operating cost	8.96	3.41	4.25	9.66	6.56
Return over operating and ownership cost	-17.17	-6.78	-6.56	2.93	-2.98
Return over total cost	-27.52	-11.83	-10.63	1.36	-6.51
<b>Farm descriptors</b>					
Percent finisher (percent)	24	80 <sup>d</sup>	67	63 <sup>b</sup>	49
Total hogs and pigs (number)	342	3,236	6,790	23,080	3,491

Note: Superscripts refer to results of statistical tests of differences between item means in each column. Tests are expressed at a 90-percent level of confidence. Lettered superscripts denote that the mean reported in a column is significantly statistically different from the mean in the superscript column. Tests were conducted using a delete-a-group jackknife variance estimator, with 30 replicates provided with the Agricultural Resource Management Survey (ARMS) data.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey (ARMS) hogs data.

Figure 12

**Total nominal costs per 100 pounds of gain associated with U.S. hog production, by operation hog and pig inventory and year**

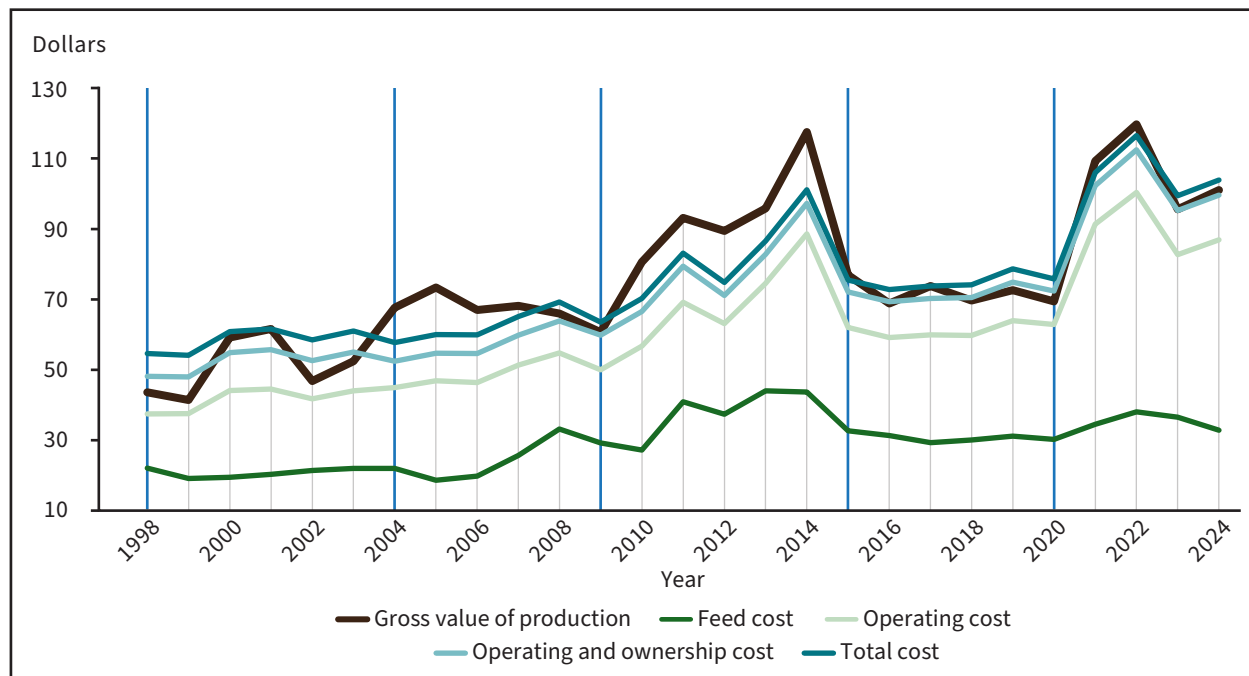


Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, hog version.

The estimates presented in table 5 show that value of production did not cover operating and ownership costs or total costs in 2020. However, USDA, ERS estimates costs and returns in all years including the ARMS survey years (1998, 2004, 2009, 2015, and 2020 for hogs) using the ARMS data. The estimates also include the non-survey years by adjusting the most recent survey year estimates, using updated hog and input prices, while holding the most recent survey year production parameters constant. For example, 2021 hog costs and returns estimates used the 2020 estimate as a base, adjusting all hog and input prices upward or downward according to the average prices in 2021 relative to 2020. Estimates in figure 13 show that in the 27 years between 1998 and 2024, the average hog farm covered feed expenses and total operating costs in all years, operating and ownership costs in 19 years, and total costs in almost half (13) of the years. Fluctuations in prices and production conditions account for the variation in costs, returns, and net returns. For example, the USDA all-hogs price ranged from a low of \$15 per pound in December 1998 to a high of \$93.30 in July 2014. Recent market developments included slaughter disruptions during 2020 resulting from COVID-19 (Padilla, 2021) and a downturn in profitability of hog production in 2023, as discussed by Shrader (2023).

Figure 13

**Costs and returns associated with all U.S. hog production, 1998–2024**



Note: Vertical blue lines indicate new Agricultural Resource Management Survey (ARMS) years, from which all subsequent costs and returns estimates are based using updated price data, until the next ARMS survey year.

Source: USDA, Economic Research Service (ERS) and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, hog version, and USDA, ERS Commodity Costs and Returns data.

Combining all hog farms together for analyzing costs and returns provides an overview of costs, returns, and profitability in the overall hog sector. However, the high variation in costs and returns associated with aggregating all hog farms together and the usefulness of providing cost and return estimates that better reflect an actual farm’s production system led us to present additional estimates by production type. Thus, we examine the costs and returns associated with two production types for which we have sufficient 2020 data to provide comparisons by farm size: feeder-to-finish (finisher) and farrow-to-finish farms. Finishing systems generally raise hogs from 30–80 pounds up to a slaughter weight of 225–300 pounds. We examine finishing farm sizes with maximum annual inventories of less than 2,000 hogs and pigs, 2,000–4,999 hogs and pigs, 5,000–9,999 hogs and pigs, and 10,000 or more hogs and pigs.

The majority of the value of production on feeder-to-finish (finisher) farms is derived from market hogs, as shown in table 6. Differences in several operating costs are noted, with the largest farms incurring lower homegrown feed costs per 100 pounds of gain, and the smallest farms incurring lower paid labor costs per 100 pounds of gain. Total operating costs, however, did not differ significantly by size. Ownership costs decreased with increased farm size from \$11.42 per 100 pounds of gain for farms with less than 2,000 hogs and pigs to \$5.49 per 100 pounds of gain for farms with 10,000 or more hogs and pigs. This is because the costs of buildings and equipment are allocated over greater numbers of animals as the size of the hog enterprise increases. Likewise, unpaid labor costs per 100 pounds of gain decreased with increased farm size, showing increased labor efficiency as the hog enterprise increases in size. Total cost decreased from \$85.85 per 100 pounds of gain for farms with less than 2,000 hogs and pigs to \$61.21 per 100 pounds of gain for farms with 10,000 or more hogs and pigs. Return over operating cost, return over operating and ownership cost, and return over total cost increased likewise with increased farm size.

The finding of decreased total hog finishing costs per 100 pounds of gain with increased hog farm size is consistent with cost structure results found using previous ARMS hog data (figure 14). All years show decreases in costs per 100 pounds of gain with larger farm sizes. Furthermore, because nominal costs are shown rather than real costs, later years show higher costs, consistent with the impact of inflation on production costs. Though 2020 ARMS hog estimates show that the average finishing operation did not cover total costs or operating and ownership costs in any of the size categories, some farms in all size categories did cover these costs. More than 20 percent of finishing hog operations with 5,000 or more hogs and pigs covered total costs in 2020 (figure 15). Eighty percent or more of the finishing hog operations with 2,000 or more hogs and pigs covered total costs in 2004. Generally, higher percentages of larger-scale hog finishing operations than smaller-scale hog finishing operations had value of production that exceeded total costs.

Table 6

**Costs and returns associated with U.S. finishing hog production, dollars per hundredweight gain unless otherwise indicated, 2020**

	Less than 2,000 hogs and pigs (a)	2,000–4,999 hogs and pigs (b)	5,000–9,999 hogs and pigs (c)	10,000 or more hogs and pigs (d)	All farms
<b>Gross value of production</b>					
Market hog value	58.45	54.73	54.57	54.30	54.66
All other hogs and pigs value	0.81	3.65	4.31	4.10	3.89
Total gross value of production	59.26	58.39	58.87	58.40	58.56
<b>Operating costs</b>					
Purchased feed cost	28.17	27.51	25.50	27.23	26.88
Homegrown feed cost	0.55	0.80	0.89 <sup>d</sup>	0.12 <sup>c</sup>	0.58
Total feed cost	28.71	28.31	26.39	27.35	27.46
Feeder pig cost	26.81	19.02	19.34	15.84	18.26
Nursery pig cost	2.57	3.30	4.66	3.67	3.78
Hired labor cost	1.54 <sup>bc</sup>	1.85 <sup>a</sup>	1.74 <sup>a</sup>	1.72	1.77
Other operating costs	7.83	6.57	6.07	5.69	6.17
Total operating costs	67.46	59.06	58.21	54.28	57.44
<b>Ownership costs</b>					
Total ownership cost	11.42 <sup>cd</sup>	8.41 <sup>d</sup>	7.73 <sup>ad</sup>	5.49 <sup>abc</sup>	7.31
<b>Opportunity and overhead costs</b>					
Unpaid labor cost	4.94 <sup>bcd</sup>	2.92 <sup>acd</sup>	1.45 <sup>abd</sup>	0.56 <sup>abc</sup>	1.76
Other opportunity and overhead cost	2.02 <sup>cd</sup>	1.57 <sup>d</sup>	1.25 <sup>ad</sup>	0.89 <sup>abc</sup>	1.26
Total opportunity and overhead cost	6.96 <sup>bcd</sup>	4.50 <sup>acd</sup>	2.70 <sup>abd</sup>	1.44 <sup>abc</sup>	3.02
<b>Total costs</b>					
Total cost	85.85 <sup>bcd</sup>	71.96 <sup>acd</sup>	68.65 <sup>ab</sup>	61.21 <sup>ab</sup>	67.76
<b>Net return over costs</b>					
Return over feed cost	30.55	30.08	32.48	31.05	31.09
Return over operating cost	-8.20 <sup>d</sup>	-0.67	0.67	4.12 <sup>a</sup>	1.11
Return over operating and ownership cost	-19.62 <sup>bcd</sup>	-9.08 <sup>ad</sup>	-7.07 <sup>a</sup>	-1.37 <sup>ab</sup>	-6.19
Return over total cost	-26.59 <sup>bcd</sup>	-13.57 <sup>acd</sup>	-9.77 <sup>ab</sup>	-2.80 <sup>ab</sup>	-9.21

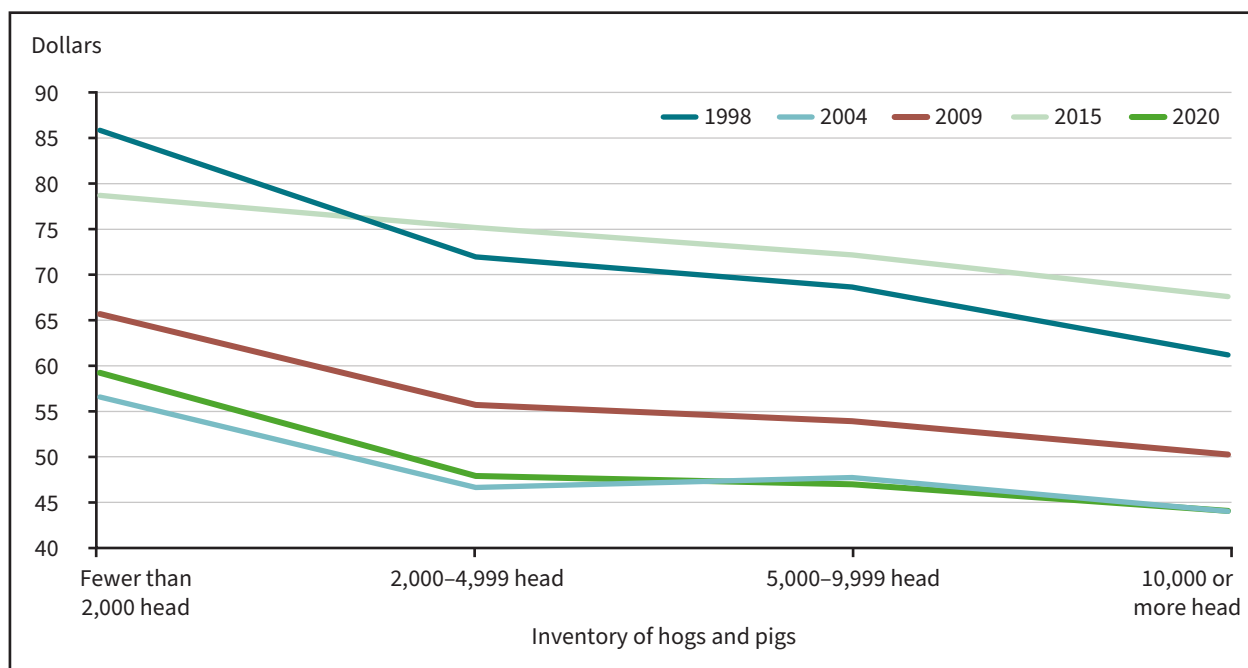
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	Less than 2,000 hogs and pigs (a)	2,000–4,999 hogs and pigs (b)	5,000–9,999 hogs and pigs (c)	10,000 or more hogs and pigs (d)	All farms
Farm descriptors					
Percent under contract (percent)	43 <sup>bd</sup>	91 <sup>a</sup>	83	90 <sup>a</sup>	78
Total hogs and pigs (number)	599 <sup>bcd</sup>	3,220 <sup>acd</sup>	6,898 <sup>abd</sup>	18,520 <sup>abc</sup>	4,470

Note: Superscripts refer to results of statistical tests of differences between item means in each column. Tests are expressed at a 90-percent level of confidence. Lettered superscripts denote that the mean reported in a column is significantly statistically different from the mean in the superscript column. Tests were conducted using a delete-a-group jackknife variance estimator, with 30 replicates provided with the Agricultural Resource Management Survey (ARMS) data.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey (ARMS) hogs data.

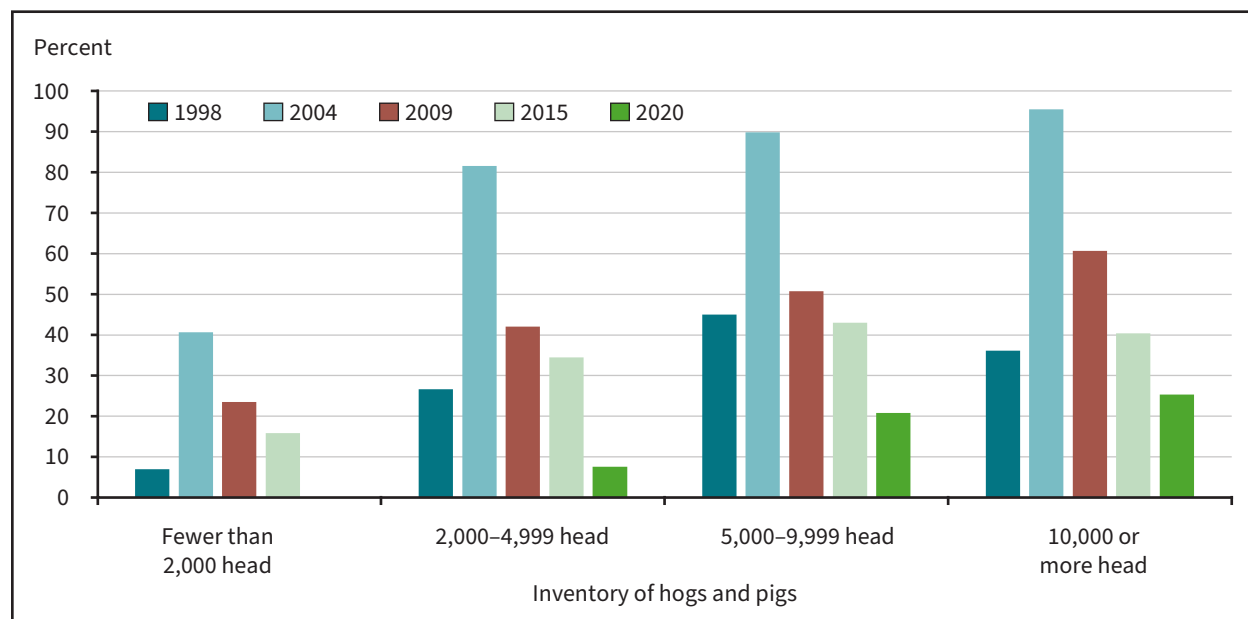
Figure 14  
**Total nominal costs per 100 pounds of gain associated with finishing hog production in the United States, by operation hog and pig inventory and year**



Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, hog version.

Figure 15

**Percentage of finishing hog operations covering total costs by hog and pig inventory and year**



Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, hog version.

Decreasing numbers of farrow-to-finish operations, combined with a lower response rate for the 2020 hog survey during the COVID-19 pandemic, resulted in a smaller number of farrow-to-finish operations surveyed in 2020 relative to earlier ARMS hog survey years. There were sufficient farrow-to-finish farm observations to analyze two size categories of farrow-to-finish farms for 2020, less than 2,000 hogs and pigs and 2,000 or more hogs and pigs (table 7). Operating costs per 100 pounds of gain were numerically, but not statistically, higher for the larger operations. This is attributed to the smaller operations being primarily “low-input” operations—for example, 32 percent of the operations with fewer than 2,000 hogs and pigs used pasture as a part of their feeding programs, which partially accounts for the lower feed costs associated with these farms.

Ownership and unpaid labor costs per 100 pounds of gain were higher for the smaller farms since the larger farms were able to allocate building and equipment expenses and unpaid (mostly operator and family) labor costs over more hogs. Mean total costs per 100 pounds of gain were \$88.59 for farms with fewer than 2,000 hogs and pigs, 46 percent higher than the \$60.59 cost for farms with 2,000 or more hogs and pigs. Economies of size, or lower costs per unit with increased size, are shown for farrow-to-finish hog production for all ARMS survey years, 1998, 2004, 2009, 2015, and 2020 (figure 16).

Table 7

**Costs and returns associated with U.S. farrow-to-finish hog production, dollars per hundredweight gain unless otherwise indicated, 2020**

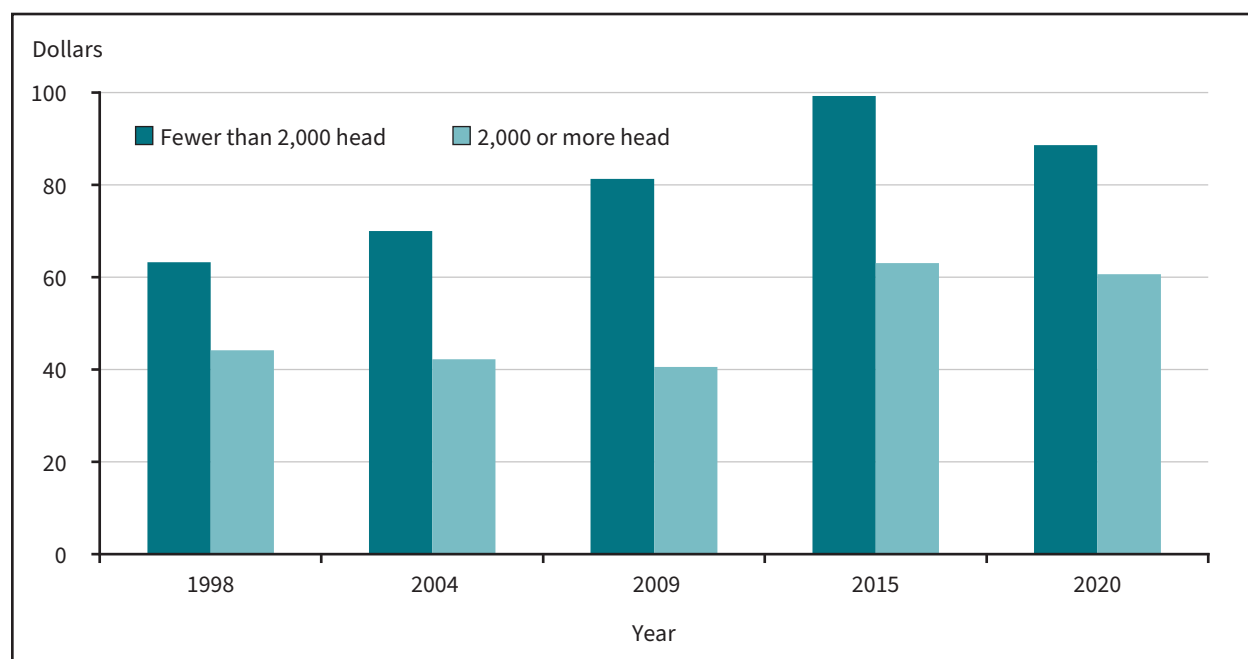
	Less than 2,000 hogs and pigs (a)	2,000 or more hogs and pigs (b)	All farms
Market hog value	47.56	46.42	46.55
All other hogs and pigs value	5.09	4.91	4.93
Total gross value of production	52.65	51.34	51.49
<b>Operating costs</b>			
Purchased feed cost	24.00	31.73	30.86
Homegrown feed cost	6.90	5.67	5.81
Total feed cost	30.89	37.40	36.67
Hired labor cost	1.47	3.16	2.97
Other operating costs	6.77	7.62	7.53
Total operating costs	39.12	48.18	47.16
<b>Ownership cost</b>			
Total ownership cost	36.52 <sup>b</sup>	9.86 <sup>a</sup>	12.87
<b>Opportunity and overhead costs</b>			
Unpaid labor cost	11.50 <sup>b</sup>	1.02 <sup>a</sup>	2.20
Other opportunity and overhead cost	1.45	1.52	1.51
Total opportunity and overhead cost	12.95 <sup>b</sup>	2.54 <sup>a</sup>	3.71
Total cost	88.59 <sup>b</sup>	60.59 <sup>a</sup>	63.75
<b>Net return over costs</b>			
Return over feed cost	21.76	13.94	14.82
Return over operating cost	13.53	3.15	4.32
Return over operating and ownership cost	-23.00	-6.71	-8.55
Return over total cost	-35.94 <sup>b</sup>	-9.25 <sup>a</sup>	-12.26
<b>Farm descriptors</b>			
Percent using pasture for hogs and pigs (percent)	32	0	27
Total hogs and pigs (number)	399 <sup>b</sup>	14,552 <sup>a</sup>	2,629

Note: Superscripts refer to results of statistical tests of differences between item means in each column. Tests are expressed at a 90-percent level of confidence. Lettered superscripts denote that the mean reported in a column is significantly statistically different from the mean in the superscript column. Tests were conducted using a delete-a-group jackknife variance estimator, with 30 replicates provided with the Agricultural Resource Management Survey (ARMS) data.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey (ARMS) hogs data.

Figure 16

**Total nominal costs per 100 pounds of gain associated with U.S. farrow-to-finish hog production, by operation hog and pig inventory and year**

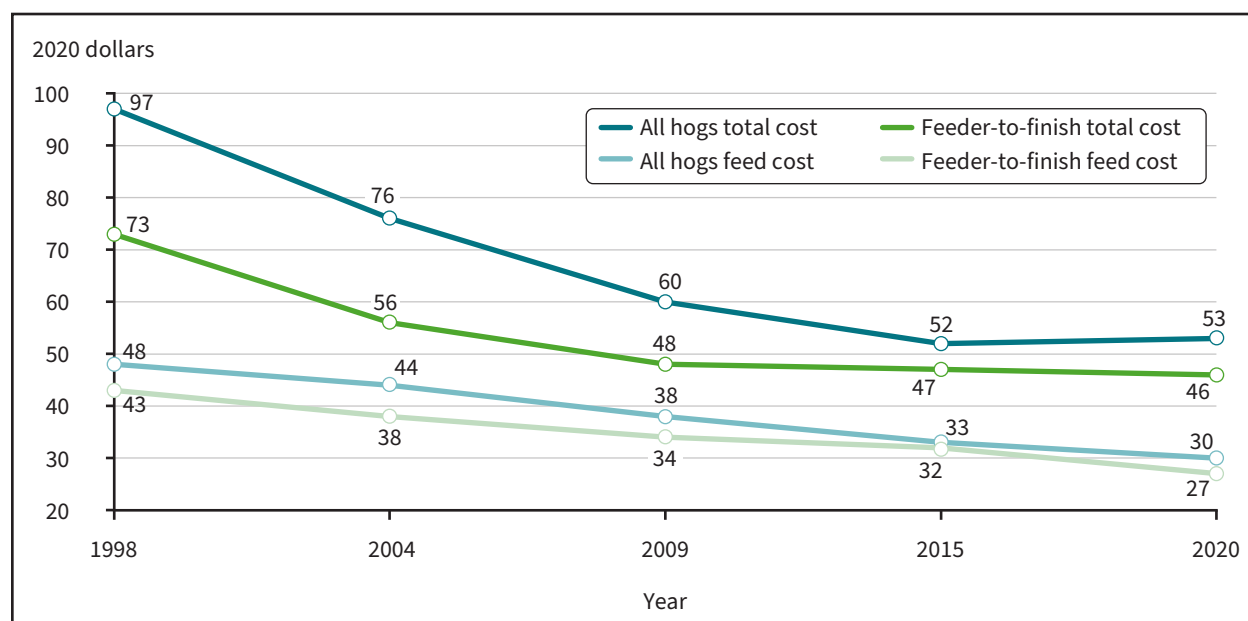


Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey, hog version.

One method for measuring productivity change over time is to examine how production costs have changed. Continuing the analysis provided by Davis et al. (2022), we examine how productivity changed during the period of successive ARMS hog version surveys from 1998 to 2020 (figure 17). To isolate the impacts of input quantities on hog weight gain, we deflate feed costs using the USDA, NASS feed price index and the remaining costs using the USDA, NASS production items index, both found in the *Agricultural Prices* reports. This method of measuring productivity change by deflating values by an appropriate price index is consistent with standard methods as shown by Wang et al. (2015) and Wang et al. (2024) and has been used in previous research examining productivity change in the production of a commodity (e.g., McBride & Key, 2013; McBride et al., 2018; Saavoss et al., 2022; Vaiknoras & Hubbs, 2023). All costs included in the USDA, ERS Commodity Costs and Returns Data are included in the calculation, except for feeder pig and nursery pig costs because pigs are inputs that do not contribute to weight gain. Results show that for all hog farms, from 1998 to 2020, deflated production costs decreased by 45 percent and feed costs decreased by 38 percent. For feeder-to-finish farms, from 1998 to 2020, both deflated production costs and feed costs decreased by 37 percent. These increases in production efficiency are partially explained by improvements in swine genetics that have led to increases in feed efficiency; housing and equipment technology that better control the climate in which animals are raised; and economies of size, where labor, housing, machinery, equipment, and other input costs can be spread over greater output.

Figure 17

**Deflated production costs per hundred pounds of gain, all hog producers and feeder pig-to-finish producers, 1998–2020 (2020 dollars)**



Note: Feed costs are converted to 2020 dollars using the agricultural feed price index and other production costs are deflated to 2020 dollars using the production items index, USDA, National Agricultural Statistics Service, *Agricultural Prices*. Feed costs are the sum of purchased and homegrown feeds. Total costs are operating and allocated overhead costs less nursery pig and feeder pig costs.

Source: USDA, Economic Research Service (ERS) using data from the USDA, ERS and USDA, NASS Agricultural Resource Management Survey.

## Housing of Hogs and Pigs and the Impact of Animal Welfare Legislation

### Housing Types

Hog housing types are an important component of hog industry structure. In each of the four stages of hog production listed in table 8, it is apparent that the industry divides into two identifiable groupings. The first grouping, enclosed confinement with no outside access, accounts for the greatest share of U.S. hog building capacity at each production stage. This large grouping tends to employ technologies that allow production on a large scale, likely permitting producers to realize scale economies. The second grouping, which includes all other housing types, accounts for a significantly smaller share of national building capacity. It is comprised of a varied set of other production technologies, typically used by smaller operations producing hogs on a small scale.

In the first production stage, gestating gilts and sows, about 75 percent of U.S. hog building capacity was accounted for by “enclosed confinement with no outside access” in 2020. The balance of the building types used by producers to house gestating gilts and sows—about 25 percent of building capacity—consisted of a variety of housing options. In comparison, the USDA, Animal Plant Health Inspection Service (APHIS) National Animal Health Monitoring System (NAHMS) survey (2021a) data show that in 2021, 88 percent of U.S. gestation facilities on farms with at least 1,000 hogs and pigs used total confinement with mechanical ventilation, with the higher NAHMS estimate likely explained

at least partially by the larger farms represented in their sample. The NAHMS (2021a) data also show that in 2021, 58 percent of U.S. gestation sites on farms with at least 1,000 hogs and pigs used individual stalls or crates for the majority of their gestating sows and gilts, while 42 percent used group housing such as in pens.

At the farrowing stage of production, the greatest share of building capacity—89 percent—again employed enclosed confinement with no outside access in 2020. In comparison, NAHMS (2021a) data show that in 2021, 95 percent of U.S. farrowing facilities on farms with at least 1,000 hogs and pigs used total confinement with mechanical ventilation. The NAHMS (2021a) data also show that in 2021, 83 percent of U.S. farrowing sites with at least 1,000 hogs and pigs used individual stalls or crates for the majority of their sows and gilts in the farrowing phase, while the remainder used group housing such as in pens.

At the nursery stage of production, the same break out into two distinct groupings is evident for 2020: 95 percent of building capacity in the nursery stage was identified as “enclosed confinement with no outside access,” the production model most often used in large-scale hog operations. The balance of hog buildings—5 percent of U.S. hog building capacity for the nursery stage—are typically associated with smaller hog production operations. In comparison, NAHMS (2021a) survey data show that in 2021, 99 percent of sites on farms with at least 1,000 hogs and pigs that raised most of their nursery-aged pigs in a traditional wean-to-finish facility used total confinement with mechanical ventilation.

The final stage of hog production shown in table 8, the growing-finishing stage, shows the same general pattern as the previous three stages. Buildings associated with large-scale hog production—enclosed confinement with no outside access—accounted for 87 percent of capacity of buildings for the growing-finishing stage of U.S. hog production in 2020. The remainder of growing-finishing capacity—13 percent—are technologies most often associated with smaller operations. In comparison, NAHMS (2021a) data show that in 2021, 89 percent of sites on farms with at least 1,000 hogs and pigs that raised most of their grower/finisher-aged pigs in a traditional or wean-to-finish facility used total confinement with mechanical ventilation.

Table 8

**Percentages of U.S. hog building capacity and U.S. hog farms using selected housing types, 2020 ARMS hog survey**

Housing type	Percent of U.S. hog building capacity by production phase	Percent of all U.S. hog farms using housing type
Gestating gilts and sows		
Average total operation building capacity = 393 head		
Enclosed confinement with no outside access	75	13
Open-sided confinement with no outside access	8	7
Open confinement with outside access	16	13
Quonset or hoop or lean-to	<1	3
Sun-shade	<1	2
Portable	1	3
Total	100	NA

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Housing type	Percent of U.S. hog building capacity by production phase	Percent of all U.S. hog farms using housing type
<b>Farrowing</b>		
Average total operation building capacity = 205 head		
Enclosed confinement with no outside access	89	26
Open-sided confinement with or without outside access	10	3
Quonset or hoop, lean-to, sun-shade, or portable	1	3
Total	100	NA
<b>Nursery</b>		
Average total operation building capacity = 1,510 head		
Enclosed confinement with no outside access	95	43
Open-sided confinement with no outside access	2	3
Open confinement with outside access	2	4
Quonset or hoop, lean-to, or portable (no sun-shades in sample)	<1	3
Total	100	NA
<b>Growing-finishing</b>		
Average total operation building capacity = 2,528 head		
Enclosed confinement with no outside access	87	66
Open-sided confinement with no outside access	12	16
Open-sided confinement with outside access	1	5
Quonset or hoop	<1	3
Lean-to, sun-shade, or portable	<1	4
Total	100	NA

Note: NA = not applicable. Percentages of all hog farms using housing types within production phase as shown in the third column do not sum to 100 because most farms do not include all production phases. These entries are not limited only to the hog farms that included the referenced production phase.

Source: USDA, Economic Research Service using the USDA, National Agricultural Statistics Service 2020 Agricultural Resource Management Survey (ARMS), hogs version.

Data shown in table 9 largely validate the U.S. hog building capacity observations discussed regarding table 8. The data in table 9 show that building technology that is older and better suited to smaller operations comprised a larger percentage of building capacity on operations with less than 2,000 head of hogs and pigs, while buildings able to accommodate enclosed confinement without outside access—technology usually associated with large-scale industrial hog production—explain U.S. hog building capacity on farms with 2,000 or more head of hogs and pigs.

At the gestating gilt and sow stage of hog production, ARMS data show that “enclosed confinement without outside access” comprised 41 percent of hog building capacity for operations with less than 2,000 head of hogs and pigs in 2020. For larger operations with 2,000 or more hogs and pigs, enclosed confinement without outside access accounted for 81 percent of building capacity in the gestation gilt and sow stage. For the farrowing stage, the difference between small and large operations was smaller: For operations with less than 2,000 head, 93 percent of operations used enclosed confinement without outside access or open-sided confinement without outside access. For larger operations, 100 percent of farrowing buildings employed this variety of building.

In the nursery section, ARMS responses for small operations show that 82 percent of buildings were of the enclosed, confined variety in 2020, while for the larger operations survey responses indicate that 96 percent of nursery buildings were enclosed and confined. For the grow-finishing stage, the smaller operations allocated 78 percent of building capacity to enclosed confined buildings, while for larger operations 88 percent of growing-finishing buildings were of the enclosed confined variety.

Table 9

**Percentage of U.S. hog building capacity and U.S. hog farms using selected housing, by hog and pig inventory**

Housing type	Less than 2,000 hogs and pigs		2,000 or more hogs and pigs	
	Percent of U.S. hog building capacity by production phase	Percent of all U.S. hog farms using housing type	Percent of U.S. hog building capacity by production phase	Percent of all U.S. hog farms using housing type
<b>Gestating gilts and sows</b>				
Enclosed confinement without outside access	41	16	81	10
Open-sided confinement without outside access	14	12	7	2
Open confinement with outside access	36	25	13	1
Quonset or hoop, lean-to, sun-shade, or portable	9	14	0	0
Total	100	NA	100	NA
<b>Farrowing</b>				
Enclosed confinement without outside access or open-sided confinement without outside access	93	42	100	10
Open confinement with outside access, Quonset or hoop, lean-to, sun-shade, or portable	8	12	0	0
Total	100	NA	100	NA
<b>Nursery</b>				
Enclosed confinement without outside access	82	52	96	35
Open-sided confinement without outside access, open confinement with outside access, or Quonset or hoop	16	13	4	3
Lean-to, sun-shade, or portable	2	4	0	0
Total	100	NA	100	NA
<b>Growing-finishing</b>				
Enclosed confinement without outside access	78	56	88	75
Open-sided confinement without outside access	17	19	12	13
Open confinement with outside access, quonset or hoop, lean-to, sun-shade, or portable	6	22	1	1
Total	100	NA	100	NA

Note: Percentages of all hog farms) do not sum to 100 (by inventory within production phase, as shown in the third and fifth columns) because most farms do not include all production phases.

Source: USDA, Economic Research Service using the USDA, National Agricultural Statistics Service 2020 Agricultural Resource Management Survey, hogs version.

## Animal Welfare Policies Exert Structural Pressures on the Hog Industry

The U.S. hog industry faces increasing pressure towards structural change from a growing number of State-level animal welfare policies addressing gestation crate use during the breeding phase of production. By 2024, 11 States had passed or instituted at least 1 policy restricting the use of confinement practices in hog production, effectively or explicitly banning gestation crates or stalls.<sup>13</sup> In addition, some State policies include minimum usable floorspace requirements for sows. For example, California's Proposition 12 (passed in 2018) requires a minimum of 24 square feet of floorspace per sow, a 71-percent increase over the average 14 square feet of space in a typical gestation crate (Marchant-Forde, 2010). As a result, compliance with a State's policy can require a combination of facility type and stocking density. The majority of policies directly addressing production practices have been enacted in States with small shares of the national hog industry, in aggregate accounting for less than 8 percent of the national breeding herd (Ufer, 2022).

Some States have laws that prohibit the sale of products coming from operations that employed certain production practices, even if the products originate out of State. California's Proposition 12 exemplifies such policies, forbidding the sale of covered pork products originating from hogs kept in any breeding operation not in compliance with State production requirements, as well as from the direct offspring of sows kept in non-compliant housing. It is notable that most pork consumed in California comes from out of State. Retail policies like Proposition 12 have a greater potential to impact the structure of the national industry at large than the production policies in States with small industries. As a result, the National Pork Producers Council (NPPC) and the American Farm Bureau Federation (AFBF) brought a Supreme Court challenge against Proposition 12, though the court's ruling in May of 2023 upheld the California policy. Though data on the distribution of breeding hog facilities are scarce, the NPPC's 2021 challenge claimed that 28 percent of the national industry employed some form of group housing for breeding sows (National Pork Producers Council v. Ross, 2021). It is unclear whether this share represents an increasing or decreasing trend in group housing or a consistent share over recent decades. Additionally, the NPPC further pointed out that many producers that employ group housing likely do so with practices which do not meet the comprehensive requirements of Proposition 12 and similar policies. Gestation crate policies now address not only production practices in-State but also the sale of relevant products. Alongside other market influences like shifting consumer demand and private industry commitments to crate-free pork, the U.S. hog industry faces growing pressure to shift away from using gestation crates in hog breeding.

## Manure Management on U.S. Hog Operations

The handling, storage, and usage of manure are key components of U.S. hog production. Continued industry consolidation (McBride & Key, 2013; Davis et al., 2022) has resulted in more concentrated manure production in some areas, which has implications for both air and water quality (Aillery et al., 2005; Sneeringer, 2010; Key et al., 2011; Raff & Meyer, 2022). Large amounts of manure are stored in pits, slurry tanks, or lagoons on hog farms—often for extended periods of time—and then spread onto nearby cropland or shipped off-site. Both manure storage and spreading produce greenhouse gases, including methane from the anaerobic breakdown of organic material in the manure, and nitrous oxide

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<sup>13</sup> The States that had enacted a policy addressing gestation crate use or space requirements for breeding sows prior to 2024 include Arizona, California, Colorado, Florida, Maine, Massachusetts, Michigan, New Jersey, Ohio, Oregon, and Rhode Island.

and ammonia from the nitrogen contents (Phillipe & Nicks, 2015; Dennehy et al., 2017; Baral et al., 2018). Excess manure nutrients can run off the land after application during precipitation events, thus impairing water quality (Kellogg et al., 2014; Raff & Meyer, 2022).

As a result of these environmental impacts, certain livestock operations face regulatory constraints. First, livestock operations that meet a specific size threshold (1,000 animal units)<sup>14</sup> or exhibit other characteristics (e.g., direct effluent discharge) must obtain National Pollutant Discharge Elimination System permits under the Clean Water Act (Aillery et al., 2005; Key et al., 2011; Chen et al., 2024; Raff & Earnhart, 2024). These operations are regulated like point-source wastewater dischargers, with more stringent nutrient management requirements than traditional agricultural sources (e.g., subject to a comprehensive nutrient management plan). Second, livestock operations that emit air pollutants can be regulated under the Clean Air Act (Sneeringer & Key, 2011). Typically, these operations are regulated as part of State Implementation Plans when they operate in an area in nonattainment with a particular National Ambient Air Quality Standard. Livestock operations in “nonattainment areas” must decrease emissions as part of the area’s efforts to improve ambient air quality to a level below that of the standard.

Manure nutrients serve as a source of fertilizer for farms. Historically, hog farms have used nearby fields to produce corn and soybeans that serve as homegrown feeds (Key et al., 2011; McBride & Key, 2013). Operations use the manure produced on-site as a supplemental fertilizer, thus lowering commercial fertilizer costs (Davis et al., 2022; Lim et al., 2023). However, changes in hog industry structure over the past several decades have altered this standard practice, including expansion to southern States with different production practices (McBride & Key, 2013).

There are several components of the manure management process on U.S. hog operations. First is the production of manure. Many hog farms now have thousands of animal units (AU) on site, producing large quantities of manure in concentrated areas. Because of environmental regulations and land application needs, operators must carefully consider how much manure is produced, its nutrient content, and the investment necessary to manage the manure. Second, the handling of manure (i.e., the movement of the manure from the animals/barns to storage areas/structures) requires certain systems and equipment. Third, manure must be stored on-site, most commonly in pits (dry or slurry manure), slurry tanks, or in lagoons/ponds as liquid. Finally, the manure is removed from the storage structures (at various frequencies depending on the structure) and applied to cropland or shipped off-site. In 2015, nearly 70 percent of U.S. hogs and pigs were produced on farms with some crop production (Lim et al., 2023).

## Manure Handling

In 2020, the most common manure handling system on U.S. hog farms was a deep-pit system, which nearly half of all U.S. hog farms used (figure 18). Large, confined operations primarily use deep-pit systems, which require minimal manure handling. When weighting by hog production animal unit, rather than number of farms, 72 percent of U.S. hog production used deep-pit manure handling systems. With these systems, hogs are located in buildings (typically in crates or pens) with slatted floors. Floor gaps allow manure to fall directly into a deep pit under the building, which can range from 8–30 feet deep. These systems do not involve water pumping and store manure as a slurry under

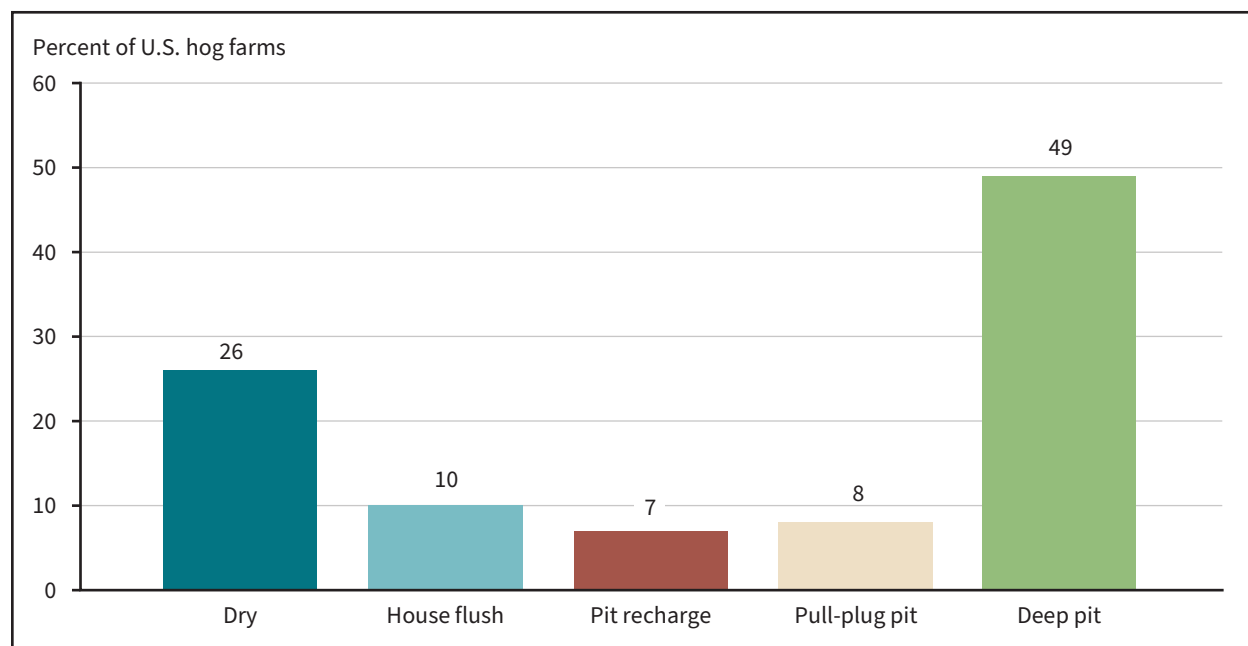
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<sup>14</sup> Animal units is the scale used to compare the size of livestock operations for different animals. An animal unit is the equivalent of 1,000 pounds live weight of animals. The U.S. Environmental Protection Agency (EPA) and most State agencies consider hogs more than 55 pounds as 0.4 animal unit and hogs under 55 pounds as 0.1 animal unit.

the barn—usually for an extended period—until removal. Other pit systems—pit recharge, used on 7 percent of operations, and pull-plug pit, used on 8 percent of operations—are like deep-pit systems (slatted floors to collect manure in a pit under the building, used by larger, confined operations) but with important differences. Pit recharge systems have shallower pits (typically 2–3 feet) and are flushed with water to create liquid manure, which is pumped relatively frequently to a lagoon. Pull-plug pit systems do not add water to the manure and use a plug and gravity to pump manure out of the pit and into an outdoor slurry tank.

Outside of pit systems, 26 percent of U.S. hog operations used a dry manure handling system in 2020. For dry systems, hogs are managed in open lots, rather than in confinement, so manure is collected from the lot using various tools and equipment. The dry (i.e., solid) manure is gathered and placed in piles/pits or stored under tarps. Although a sizable fraction of U.S. hog farms use dry manure handling systems, they are a relatively small fraction of total hog production (1 percent when weighting by animal units in 2020), since dry systems are used almost exclusively by small operations. House flush systems are like pit recharge systems but use concrete alleys—rather than pits—to collect the manure below the slatted floor. Then, water is flushed through the alleys several times each day to move the manure, in liquid form, through a pipe and to a lagoon or pond. Ten percent of U.S. hog operations used house flush systems in 2020.

Figure 18  
**Primary manure handling systems on U.S. hog farms**



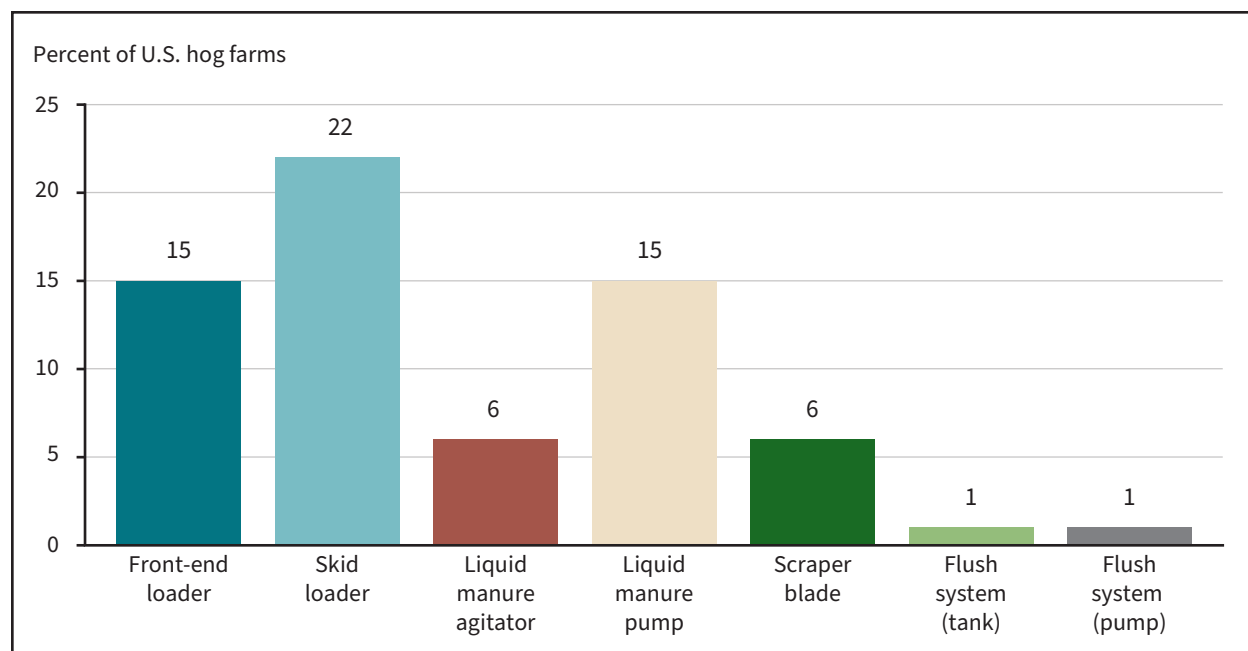
Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey hogs version.

Manure handling systems require different tools and equipment to properly operate and move manure to storage structures. In 2020, 15 percent of U.S. hog operations used a front-end loader and 22 percent used a skid loader to handle manure (figure 19). Front-end and skid loaders are frequently used on farms, and moving manure—particularly solid manure—is a primary use (16 percent of dry systems used either type of loader in 2020). Additionally, 23 percent of operations with deep-pit systems used front-end and skid loaders to handle manure. Loaders are useful in barns to collect the

manure that has combined with bedding material or dried and does not fall through the floor slats to the pit. Similarly, 6 percent of U.S. hog operations used scraper blades in 2020, which also help to gather solid manure and move it to storage structures.

Fifteen percent of U.S. hog farms used liquid manure pumps in 2020. Manure pumps are used by large operations with under-the-barn pits or alleys to transport the slurry or liquid manure for application or to storage systems. Liquid manure agitators (used by 6 percent of U.S. hog operations in 2020) mix liquid or slurry manure to ensure that solids and liquids in the manure remain mixed. Pit recharge and house flush systems use pump or tank flush systems to liquify manure and move it from the shallow pits or alleys and into lagoons.

Figure 19  
**Manure handling equipment usage on U.S. hog farms**



Note: Includes only manure handling equipment used on at least 1 percent of U.S. hog farms.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey hogs version.

The frequency of manure removal from holding and handling facilities also varies by system. Seventy-three percent of hog operations that used deep-pit systems, which can store large quantities of untreated manure, removed their manure annually in 2020 (table 10). The manure is typically transported via pipe or pump directly from the deep pit for land application during the spring planting season. This combination of manure handling system and removal frequency was the most common of all systems and frequencies in 2020, as it was practiced on 35 percent of all U.S. hog farms. Also frequent with deep-pit systems is “other” removal. This likely represents removal twice per year, which coincides with spring and fall spreading for large operations. Most common removal frequencies for other manure handling systems are exclusively weekly and monthly. For the pit recharge and house flush systems, the more frequent removal of slurry or liquid manure involves moving it to a tank or lagoon, where the manure sits until application. Dry system removal involves using loaders and scraper blades to move solid manure from the open lot to piles or outdoor pits.

Table 10

**Most common removal frequencies of manure handling systems on U.S. hog farms**

Manure handling system	Removal frequency	Percent of U.S. hog farms using the designated manure handling system that used the designated removal frequency	Percent of all U.S. hog farms using the designated manure handling system and removal frequency
Deep pit	Annually	73	35
Pit recharge	Weekly	51	4
Pull-plug pit	Monthly	27	2
Dry	Weekly	44	12
House flush	Monthly	55	6

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey hogs version.

## Manure Storage

There are two primary types of hog manure storage systems, and their use varies across production practices and region. First, manure pits/tanks consist of several similar structures. Under-the-building pits, like those described earlier, hold large amounts of untreated manure in slurry form directly below the barns. Outside the building, slurry is stored in watertight tanks. Manure slurry maintains nutrients better than anaerobically digested liquid manure (Chantigny et al., 2008), which means it is valuable as a fertilizer but poses more of a surface water quality concern when spilled or spread. Dry or solid manure can also be stored in outdoor pits, typically on smaller operations, and is sometimes covered with tarps.

Second, lagoons are holding ponds outside of the barn that hold diluted (liquid) manure that has been flushed or mixed with water. Anaerobic lagoons are widely used in North Carolina and other southern States. These storage systems, which were designed based on USDA, Natural Resource Conservation Service (NRCS) and American Society of Agricultural and Biological Engineers standards from the 1980s and promoted as a conservation technology, allow for the anaerobic digestion of the manure, thus decreasing its nutrient contents. Unlike manure storage in slurry tanks, anaerobic lagoons are a treatment system, modifying manure through anaerobic processes and producing a highly diluted effluent. The effluent, which is roughly 99 percent water, requires significantly less land for application than untreated manure slurry. Lagoon effluent is also recycled for manure flushing. The widespread adoption of these systems enabled farmers with little acreage for spreading to establish larger-scale hog operations while complying with land application regulations, shaping regional manure practices. Anaerobic digestion of the manure nutrients, however, releases methane as a greenhouse gas (Leytem et al., 2017; Sobhi et al., 2021). Lagoons can be lined to prevent leaching or covered to lower greenhouse gas emissions and odor. Anaerobic digesters may be used to reduce greenhouse gas emissions from swine production, but the swine industry has not yet experienced large-scale construction of anaerobic digesters (DuMortier et al., 2024).

Throughout the United States, pits or tanks are the primary form of hog manure storage, with 85 percent of operations using this type of system in 2020 (table 11). Lagoons are used less frequently, on 18 percent of U.S. hog operations in 2020. The primary difference in manure storage system usage is by region, which we designate according to the USDA, ERS Farm Resource Regions as shown in USDA, ERS (2000) and figure 20. Ninety-four percent of hog operations in the Heartland region (which contains Iowa, Illinois, Indiana, and much of Minnesota—all among the top-5 U.S. hog producing

States) used a pit/tank system in 2020, compared to only 17 percent in the Southern Seaboard (which contains most of North Carolina, which is also among the top-5 U.S. hog producing States) (table 11). Alternatively, only 9 percent of hog operations in the Heartland used lagoon/pond systems, while 86 percent of operations in the Southern Seaboard used lagoons. In comparison, USDA, APHIS’s most recent NAHMS survey for hogs, administered in 2021, contains information on manure handling (all operation sizes by number of hogs) and storage (operations with more than 1,000 hogs) systems on U.S. hog farms (USDA, APHIS, 2021). NAHMS data suggest that, dependent on hog production phase, between 36 and 40 percent of U.S. hog farms used a deep pit handling system, and between 55 and 60 percent used some sort of pit system. More than 88 percent of large wean-to-finish operations stored manure in a pit or tank, according to NAHMS. Of note, ARMS allows respondents to select the usage of more than one storage system, while NAHMS does not, likely contributing to the small discrepancies between surveys.

The regional differences in manure storage systems are attributable to two reasons. First, lagoons are better suited for warmer climates where anerobic digestion can occur more efficiently and during the entire year (Key et al., 2011; Varma et al., 2021). Second, there is more cropland and more fertile soils in the Heartland, allowing operations to better use slurry as fertilizer than in the Southern Seaboard (McBride & Key, 2013; Varma et al., 2021; Shea et al., 2022). We examine the latter difference empirically in the following subsection.

Table 11  
**Manure storage systems usage, percentage of U.S. hog farms**

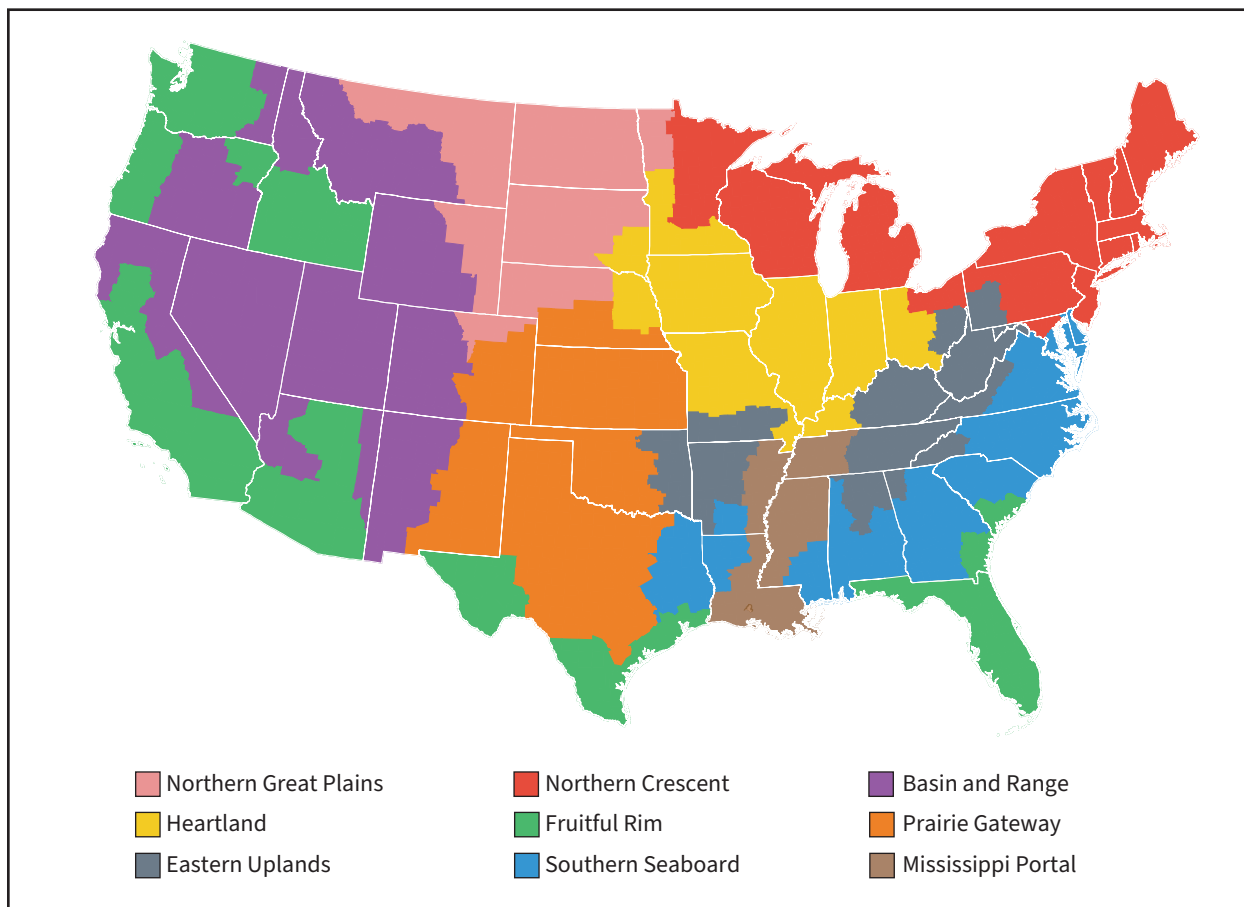
Manure storage system	Region		
	National	Heartland (a)	Southern Seaboard (b)
Pit/tank	85	94 <sup>b</sup>	17 <sup>a</sup>
Lagoon/pond	18	9 <sup>b</sup>	86 <sup>a</sup>

Note: Percentages do not necessarily equal 100 because some hog farms use more than one manure storage system type. Superscripts refer to results of statistical tests of differences between item means in each column or row. Tests are expressed at a 90-percent level of confidence. Lettered superscripts denote that the mean reported in a row is significantly statistically different from the mean of the corresponding measure in the appropriate column or superscript group. Tests were conducted using a delete-a-group jackknife variance estimator, with 30 replicates provided with the ARMS data.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey (ARMS) hogs version.

Figure 20

**USDA, Economic Research Service Farm Resource Regions**



Note: USDA, Economic Research Service (ERS) Farm Resource Regions do not include Alaska and Hawaii because they are not included in ERS and USDA, National Agricultural Statistics Service’s Agricultural Management Resource Survey (ARMS).

Source: USDA, Economic Research Service, Farm Resource Regions, 2000.

### Manure Application

The final stage of manure management on hog farms is application or removal, with this study focused on the application of manure to cropland. In 2020, 68 percent of U.S. hog farms applied manure to cropland, continuing the decline in operations that have applied manure to cropland over the past 20 years. According to Key et al. (2011), 83 percent, 82 percent, and 76 percent of hog farms applied manure to farms in 1998, 2004, and 2009, respectively. In 2020, 43 percent of these operations applied manure and fertilizer to the same acres (table 12, panel A). Nationally, the average hog farm operated 623 acres of cropland, of which nearly three-quarters were in corn and soybeans and 27 percent were applied with manure in 2020.

In the Heartland, hog farms have more cropland than hog farms in the Southern Seaboard (760 acres versus 184 acres, on average) (table 12, panel A). Differences in crop production on U.S. hog farms are also evident between the Heartland and Southern Seaboard. Whereas 80 percent of cropland acres in

the Heartland were in corn and soybeans in 2020, just over one-third of cropland acres in the Southern Seaboard were in these crops.<sup>15</sup> Manure application statistics are also provided by farm size categories at the national level (table 12, panel B).

Table 12

**Manure application on cropland, U.S. hog farms**

Manure application variable	Region		
	Heartland (a)	Southern Seaboard (b)	National
<i>Panel A. All hog farms</i>			
Percent of operations applying manure on the farm	69	62	68
Percent applying fertilizer and manure on same acres	46	D	43
Total acres of cropland	760 <sup>b</sup>	184 <sup>a</sup>	623
Acres with manure application	214 <sup>b</sup>	56 <sup>a</sup>	166
Manure applied cropland, percent	28	31	27
Corn acres	343 <sup>b</sup>	26 <sup>a</sup>	258
Soybean acres	268 <sup>b</sup>	36 <sup>a</sup>	203
Corn and soybean acres, percent	80 <sup>b</sup>	34 <sup>a</sup>	74
<i>Panel B. By farm size (animal units)</i>			
1. < 300 animal units (x)			
Percent of operations applying manure on the farm			63
Percent applying fertilizer and manure on same acres			47
Total acres of cropland			308
Acres with manure application			50 <sup>z</sup>
Manure applied cropland, percent			16 <sup>z</sup>
Corn acres			79
Soybean acres			66
Corn and soybean acres, percent			47
2. 300–999 animal units (y)			
Percent of operations applying manure on the farm			72
Percent applying fertilizer and manure on same acres			35
Total acres of cropland			707 <sup>z</sup>
Acres with manure application			171 <sup>z</sup>
Manure applied cropland, percent			24 <sup>z</sup>
Corn acres			304 <sup>z</sup>
Soybean acres			261 <sup>z</sup>
Corn and soybean acres, percent			80 <sup>z</sup>

continued on next page ►

<sup>15</sup> Hog operations in the Southern Seaboard use their cropland for a greater percentage of hay production than hog operations in the Heartland. In 2020 according to the 2020 ARMS hog version, 61 percent of Heartland hog farms produced corn, compared with 21 percent of Southern Seaboard hog farms; 54 percent of Heartland hog farms produced soybeans, compared with 22 percent of Southern Seaboard hog farms; and 17 percent of Heartland hog farms produced hay, compared with 31 percent of Southern Seaboard hog farms. The percentages of hog farms growing other crops differed by less than 2 percentage points between these two regions.

Manure application variable	Region		
	Heartland (a)	Southern Seaboard (b)	National
3. ≥ 1,000 animal units (z)			
Percent of operations applying manure on the farm			71
Percent applying fertilizer and manure on same acres			46
Total acres of cropland			1,158 <sup>y</sup>
Acres with manure application			449 <sup>xy</sup>
Manure applied cropland, percent			39 <sup>xy</sup>
Corn acres			562 <sup>y</sup>
Soybean acres			395 <sup>y</sup>
Corn and soybean acres, percent			83 <sup>y</sup>

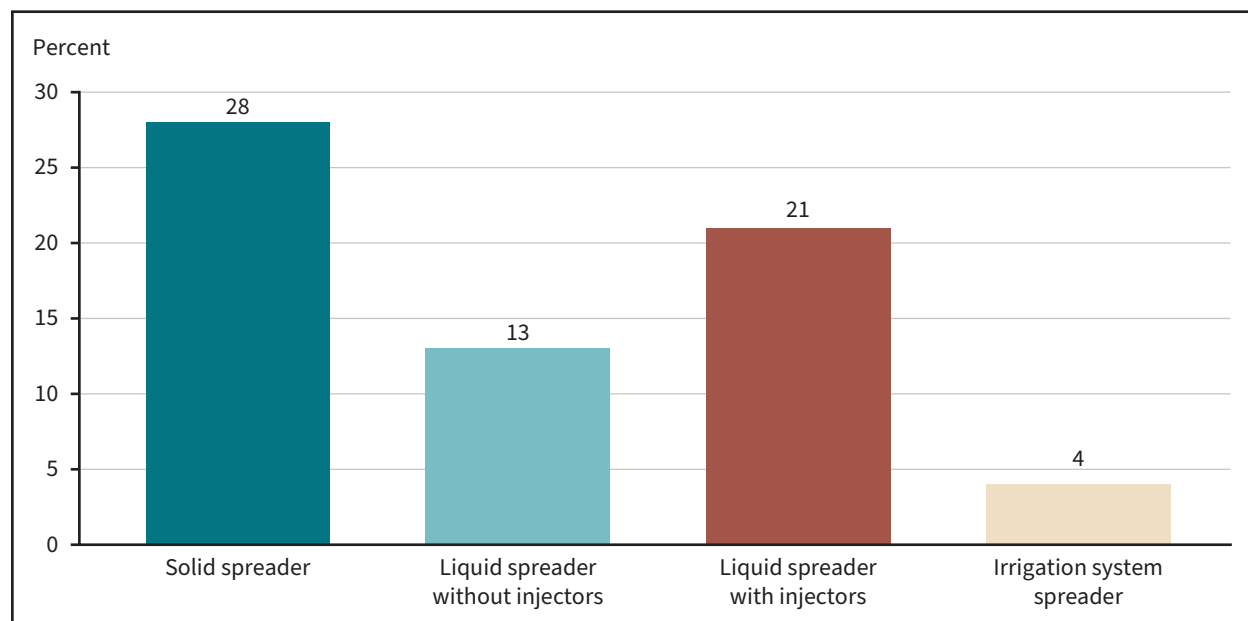
Note: Means are for hog operations with more than 0 acres of manure application. D indicates insufficient data for disclosure.

Superscripts refer to results of statistical tests of differences between item means in each column or row. Tests are expressed at a 90-percent level of confidence. Lettered superscripts denote that the mean reported in a row is significantly statistically different from the mean of the corresponding measure in the appropriate column or superscript group. Superscripts of “a” or “b” refer to columns “a” and “b”. Superscripts “x”, “y”, and “z” refer to the less than 300, 300–999, and ≥ 1,000 animal unit size categories, which indicate that the number differs from the corresponding number in the other size category. Tests were conducted using a delete-a-group jackknife variance estimator, with 30 replicates provided with the ARMS data.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey (ARMS) hogs version.

The equipment and methods used on hog operations to spread manure onto cropland depend partially on the manure storage structure. There are also water and air quality implications associated with different spreading methods. In 2020, the most commonly used manure spreading equipment was a solid spreader (figure 21). Solid spreaders are more commonly used on smaller operations, where solid or dry manure is typically held in outdoor pits. Indeed, when weighting by animal units (rather than number of farms), only 11 percent of U.S. hog production used solid spreaders. Larger operations with slurry pits/tanks apply the slurry manure using liquid spreaders. In 2020, 13 percent of U.S. hog operations used liquid spreaders without injection, while 21 percent of operations used liquid spreaders with injectors. Compared to land application of liquid manure, injection (i.e., incorporating manure slurry directly into the soil) allows the soil to better retain manure nutrients and can improve yields (Federolf et al., 2016; Bierer et al., 2021), reduces the risk of runoff during precipitation events (Saha et al., 2023), and reduces greenhouse gas emissions (Webb et al., 2010; Aguirre-Villegas et al., 2024). Finally, 4 percent of U.S. operations used an irrigation system manure spreader in 2020. These systems were used primarily on Southern Seaboard farms that store manure in lagoons and require less cropland for application (84 percent of operations in the Southern Seaboard used an irrigation spreader in 2020).

Figure 21  
**Manure spreading equipment usage on U.S. hog farms**



Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey hogs version.

## Adoption of Feeding and Biosecurity Management Practices in 2020

A variety of management practices are available to increase hog production efficiency and productivity. Phase feeding is the practice of changing hog feed rations as hogs increase in age and weight, with the objective of matching the changing nutrient requirements as the hog grows. Benefits include the potential to reduce feed costs and improve hog growth rate by reducing metabolic surpluses. Phase feeding may reduce the passage of unnecessary nutrients into the waste stream (Albrecht, 2002). Recent studies that have examined the impacts of phase feeding on hog production include Pomar et al. (2014), Hong et al. (2016), Andretta et al. (2016), and Camp Montoro et al. (2022). Another feeding technology, split-sex feeding, is the practice of feeding barrows and gilts<sup>16</sup> differently by feeding barrows with lower protein rations compared to gilts, with the benefit of reducing the nitrogen content of the urine (Albrecht, 2002).

All-in/all-out (AIAO) housing management involves moving all hogs of the same age as a group from one place to another. AIAO may be conducted by room, building, or site, with non-AIAO production referred to as continual flow management (USDA, APHIS, 2024a). AIAO helps to prevent the potential for disease introduction among hogs of different weights (Hogeland, 1995).

ARMS 2020 hogs version data indicate that in 2020, about half of U.S. hog operations raising finishing hogs utilized phase feeding, and about 18 percent of U.S. hog operations raising finishing hogs utilized split-sex feeding for finishing hogs (figure 22). AIAO housing management use varied by production phase. Sixty-one percent of operations that were involved in the farrowing phase used AIAO management for farrowing facilities, 52 percent of operations with a nursery phase used AIAO management

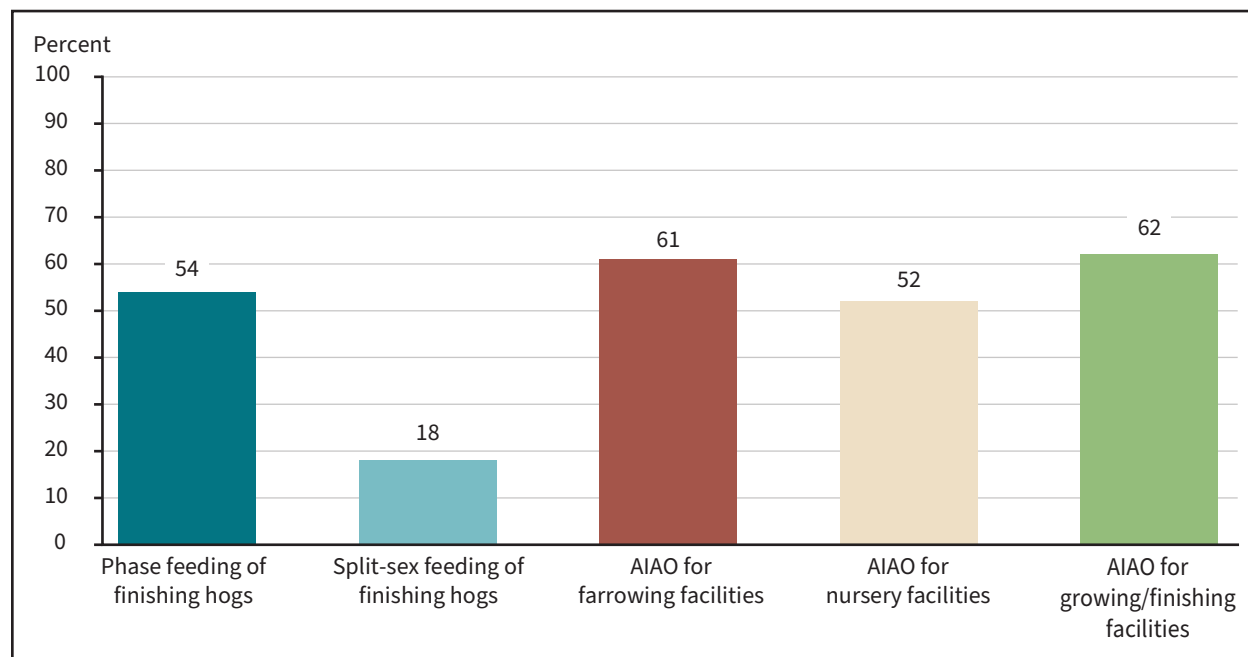
<sup>16</sup> Barrows are young, castrated male pigs and gilts are young female pigs.

for nursery facilities, and 62 percent of operations that finished hogs used AIAO management for growing-finishing facilities. The usage rates for AIAO management, according to the 2020 ARMS survey data, were lower than those reported in the 2021 NAHMS survey which collected information on biosecurity practice adoption in 2021, including AIAO housing management. USDA, APHIS (2024a, 2024b) conducted separate surveys for small operations with fewer than 1,000 pigs and large operations with 1,000 or more pigs. USDA, APHIS (2024a) reported that of large operations (those with 1,000 or more hogs and pigs), 74 percent used AIAO management for farrowing, 86–96 percent used AIAO management for nursery, and 88–89 percent used AIAO management for finishing facilities. Alternatively, USDA, APHIS (2024b) reported that of small operations (those with fewer than 1,000 hogs and pigs), 52 percent used AIAO management for farrowing, 52 percent used AIAO management for nursery, and 64 percent used AIAO management for hog finishing facilities. The discrepancy in AIAO management adoption rates between the ARMS and NAHMS surveys may be due in part to different survey years and survey populations. To be eligible for ARMS, the farm must have had at least 25 pigs in inventory at some point during the year, while NAHMS required 1 or more pigs. However, previous studies reporting earlier ARMS hog version and NAHMS AIAO adoption rates have also shown higher adoption rates using NAHMS compared with ARMS (Davis et al., 2022; USDA, APHIS, 2015).

Feeding management practice usage was similar across hog production types. Phase feeding was used on 55 percent of farrow-to-finish and 59 percent of feeder-to-finish operations, while split-sex feeding was used on 17 percent of both farrow-to-finish and feeder pig-to-finish operations. AIAO management usage, however, differed by production type. Notably, for AIAO farrowing facilities, 44 percent of farrow-to-finish operations used the practice compared with 61 percent of all operations that farrowed sows. For AIAO nursery facilities, 73 percent of wean-to-feeder operations used the practice while 52 percent of all hog operations with a nursery used it. For AIAO grow-finishing facilities, 79 percent of feeder pig-to-finish operations used the practice while 62 percent of all hog operations that finished hogs used it.

Figure 22

**Percentage U.S. hog farms involved in the referenced production phase using selected management practices, 2020**



AIAO = all-in/all-out.

Note: Percentages are based on the percent of the total producers who responded and were involved in the referenced production phase, excluding the nonresponse, as some producers did not answer all questions.

Source: USDA, Economic Research Service using the USDA, National Agricultural Statistics Service 2020 Agricultural Resource Management Survey.

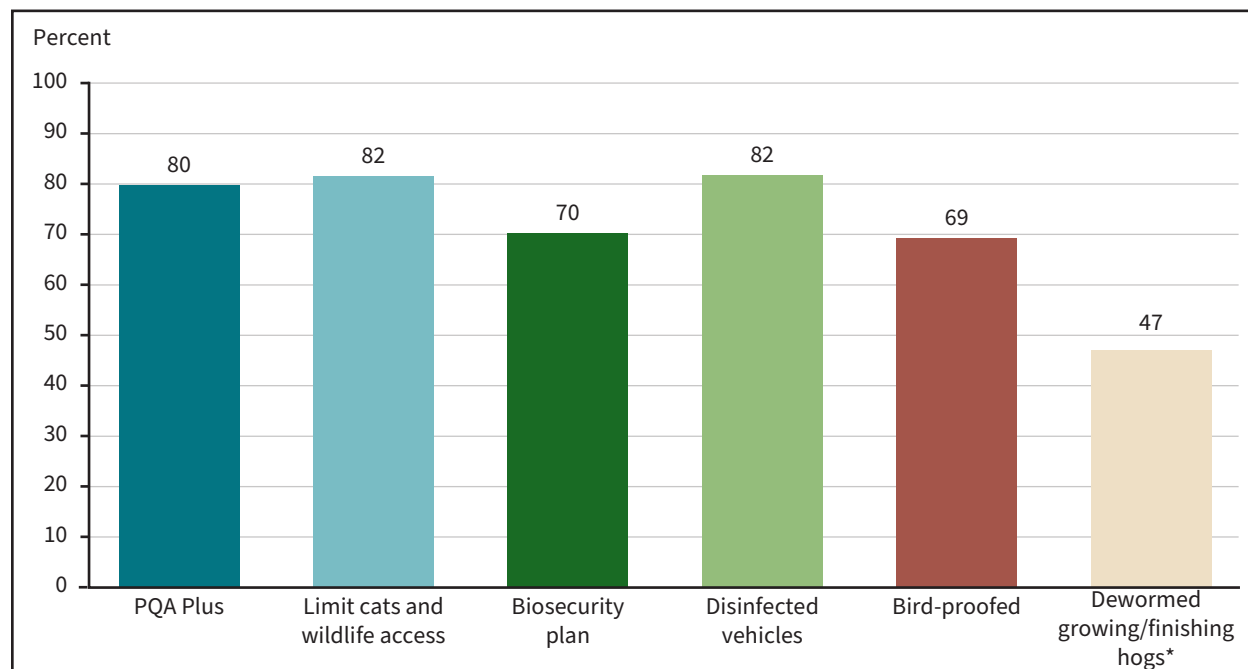
Adopting appropriate biosecurity methods helps reduce production risk by preventing disease spread (Alarcón et al., 2021). A higher biosecurity level has been associated not only with decreased probability of swine disease occurrence but also an increased number of piglets weaned per sow per year (Postma et al., 2015). The 2020 ARMS hog version requested information for six different biosecurity practices used on U.S. hog farms, including limiting cats and wildlife access to production facilities or feed preparation areas, having production facilities “bird-proofed” with screening, having a written bio-security plan, cleaning and disinfecting vehicles used to transport hogs before loading the hogs, deworming finishing hogs, and having Pork Quality Assurance (PQA) Plus certification. PQA Plus certification was initiated by the National Pork Board under the “We Care” program in 2007 to improve production practices used for food safety, animal welfare, public health, and a safe working environment by providing an education program and farm site assessment by trained assessors (DeWitte, 2019; van de Weerd & Ison, 2019).

The 2020 ARMS hog version data show that the majority of hog producers used five of the six surveyed biosecurity practices in 2020; 80 percent of hog producers were PQA Plus certified, 82 percent limited cats and wildlife access to production facilities or feed preparation areas and/or cleaned and disinfected vehicles used to transport hogs before loading hogs, 70 percent had a written bio-security plan, and 69 percent had “bird-proofed” screening on their production facilities. Less than half of hog producers dewormed finishing hogs. These adoption rates are compared with USDA, APHIS, NAHMS (2024a, 2024b) results, which showed that more than 90 percent of both small (those with fewer than 1,000 hogs and pigs) and large (those with 1,000 or more hogs and pigs) hog operations limited cats

and wildlife access. Of the large operations reported by NAHMS (2024a), 97 percent had PQA Plus certification, 91 percent had bird screens, 58 percent disinfected the outside of trailers before coming onsite, and 79 percent of large operations disinfected the inside of trailers before coming onsite.<sup>17</sup>

Figure 23

**Percentage of U.S. hog farms using other biosecurity practices, 2020**



PQA Plus = Pork Quality Assurance Plus certification.

Note: Percentages are based on the percent of the total producers who responded, excluding the nonresponse, as some producers did not answer all questions.

\* This percentage refers only to the hog farms that were finishing hogs in 2020.

Source: USDA, Economic Research Service using the USDA, National Agricultural Statistics Service 2020 Agricultural Resource Management Survey.

Conducting biosecurity methods varied by production type, particularly for having a biosecurity plan, bird-proofing, disinfecting vehicles, and deworming finishing hogs. Feeder pig-to-finish operations had the highest usage rates for having a written biosecurity plan (87 percent), “bird-proofing” (89 percent), and disinfecting vehicles to transport hogs (88 percent). In contrast, deworming finishing hogs was conducted primarily in farrow-to-finish operations, with an 83 percent usage rate.

## COVID-19 and Hog Production in 2020: The Experience of ARMS Hog Survey Respondents

The spread of COVID-19 accelerated in the United States in early 2020. Starting around March, many workplaces were affected, either through temporary shutdowns or slowdowns. Hogs themselves are not infected by COVID, so there were no mass depopulations of diseased animals. However, hog farms were first affected by the shutdown or slowdown at hog slaughter and processing facilities due to

<sup>17</sup> USDA, APHIS, NAHMS (2024a) collected the percentage of farms practicing five different methods for disinfecting vehicles: cleaning the inside and outside of the trailer, disinfecting the inside and outside of the trailer, and drying the trailer.

worker illness at these facilities. In some cases, hogs were euthanized because there was no opening for them at nearby slaughter plants and continued feeding would be costly. An alternative to euthanasia was shipping the hogs to more distant slaughter plants, while another was to feed the hogs a less costly “maintenance” diet, intended to keep them close to the usual market weight at a lower cost. Johnson et al. (2021) discussed swine management strategies during this period and Padilla et al. (2021) discussed the effect of COVID-19 on hog slaughter, which differed by region depending to some degree on the size of slaughter plants in the region.

The 2020 ARMS hog version survey included several questions related to COVID-19 and its impact on hog farms. The first was, “During 2020, were any hogs and pigs euthanized for COVID-19-related reasons?” with those responding “Yes” being asked to provide the number of head euthanized in each of the following size categories: less than 50 pounds, 50–119 pounds, 120–179 pounds, and 180 pounds and more. Respondents were also asked about loss of off-farm employment and their participation in several economic relief programs intended to lessen the economic impact of the pandemic.

Just under 6 percent of surveyed farms indicated that they had to euthanize any animals for COVID-19-related reasons, with the average number of animals euthanized in these cases amounting to 405 head per farm (table 13). Less than 2 percent of farms reported receiving any direct compensation for these animals. The number of respondents reporting the amount of direct compensation received was too small to develop a statistically meaningful estimate of compensation amounts. Respondents reporting euthanizing hogs and pigs indicated that animals of a range of weights were euthanized. About 49 percent and 29 percent of the euthanized animals were reported in the Southern Seaboard and Heartland regions, respectively.

Table 13

**Impacts of the Coronavirus (COVID-19) pandemic on U.S. hog farms in 2020**

Measure	Response
Percent of respondents reporting any euthanized hogs	5.8
Percent of respondents that received compensation for euthanized animals	1.7
Average number of hogs euthanized when euthanization occurred (head)	405
Percent of respondents reporting euthanized hogs by weight class	
Pigs under 50 pounds	2.8
Pigs 50–179 pounds	1.3
Hogs 180 pounds and more	2.8
Regional shares of total reported euthanized hogs	
Heartland	29
Southern Seaboard	49
Other regions	22
Percent of farms where off-farm employment was lost or interrupted for:	
The principal producer	2.6
The principal producer’s spouse or other members of the household	0.4
Percent of farms where principal producer received payments under:	
Paycheck Protection Program	33.8
Economic Injury Disaster Loan	0.5
COVID Food Assistance Program	35.8
Other Federal, State, or local programs	6.0

Note: Other regions include all regions other than the Heartland and Southern Seaboard as shown in figure 20.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2020 Agricultural Resource Management Survey hogs data.

Another effect of COVID-19 on hog farms was its impact on off-farm employment for the farm operator, spouse, or other household members. ARMS respondents indicated whether anyone in their household was temporarily or permanently laid off from an off-farm job (table 13). For surveyed farms, this affected a relatively small number: 2.6 percent of respondents indicated that the hog farm operator lost or had their off-farm job temporarily interrupted, while 0.4 percent of farms had an operator's spouse or other household member have their off-farm job affected.

A variety of Federal, State, and local programs were provided to businesses to lessen the economic impact of COVID-19's disruptions from shutdowns, slowdowns, and related loss of jobs and commerce. The ARMS survey examined how some of these programs were utilized by hog farmers, and participation in these programs is reported in table 13. The first of these programs was the Paycheck Protection Program (PPP), which provided small businesses with funds to pay up to 8 weeks of payroll costs. PPP funds could also be used to pay interest on mortgages, rent, and utilities. PPP was operated through the U.S. Department of the Treasury, Small Business Administration, and about one-third of hog farms in the survey reported that they received PPP payments.

The Small Business Administration also administered another relief program called the Economic Injury Disaster Loans program (EIDL). This program provided funding to help small businesses recover from the economic impact of the COVID-19 pandemic by providing funds for working capital and other normal operating expenses. Less than 1 percent of surveyed hog farms received any funds under EIDL. A third relief program considered was the USDA's Coronavirus Food Assistance Program (CFAP). This program focused on offsetting farmer losses due to lower commodity prices or additional marketing costs related to the COVID-19 pandemic. Among the programs examined, CFAP showed the highest participation rate, at 35.8 percent of the surveyed farms. A variety of other Federal, State, and local programs were available across the United States, but only 6 percent of respondents reported participation. Respondents were not asked to provide program details for any of these other activities.

## Conclusion

The U.S. hog industry has experienced significant structural change over the past four decades, with fewer farms producing more hogs, increased specialization in hog production, increased use of production contracts, and shifts in production locations. This report uses ARMS hog version data and USDA, NASS Census of Agriculture data to examine these trends and report statistics from the most recent ARMS hog version, 2020.

Economies of size are evident in U.S. hog production. When examining all hog farms regardless of the phase(s) of production in which they are involved, economies of size are noted in ownership, opportunity, and overhead costs. This grouping of all hog farms together consists of a wide range of farm types, from farrow-to-wean to finisher, so it is not surprising that statistically significant differences in total costs by size (measured as the inventory of hogs and pigs on the farm) were not found. However, when examining the subsets of finishing and farrow-to-finish operations, clear reductions in total costs and increases in net returns over total cost were found with increased operation size. Though economies of size were found, it is noted that profitable farms were found in all size categories. Overall, from 1998 to 2024, USDA, ERS's Commodity Costs and Returns Data show that on average, the value of U.S. hog production covered operating costs in all years, operating and ownership costs in most years, and total costs in about half of the years. Hog farm productivity has increased over time.

When measured in terms of real (inflation-adjusted) production costs per 100 pounds of gain from 1998 to 2020, finisher farms have continued to lower their costs of production, suggesting an increase in productivity.

The majority of U.S. hog farms used enclosed confinement housing with no outside access for all phases of hog production. Housing and the environment in which hogs are raised has been of increased interest from a policy perspective, particularly at the State level. Some U.S. States have passed laws that place restrictions on the production systems that can be used, for example, whether gestation crates are allowed.

Manure management on hog operations is of interest because of the impact of hog manure on air and water quality. With hog farm sizes increasing, more manure is produced at individual sites. This concentration of manure nutrients creates air and water quality concerns through greenhouse gas emissions, nutrient runoff, and storage risks. Anaerobic decomposition in pits, tanks, and lagoons releases methane, while nitrogen present in manure emits nitrous oxide and ammonia. Nutrient runoff and nitrate leaching can contaminate both surface and groundwater, particularly in high application regions like the Heartland. Storage spills further impact water quality. Given the regional heterogeneity in manure management at hog operations, one-size-fits-all policy options are unlikely to decrease the external costs from these operations. In 2020, the most common manure handling system was the deep pit system. Overall, manure was stored primarily in pits or tanks in the United States, but this differed by region, with farms in the Heartland region more likely to use this storage system and farms in the Southern Seaboard region more likely to use lagoons. About 68 percent of U.S. hog operations applied manure to the operation in 2020. Biosecurity measures such as Pork Quality Assurance Plus certification, limiting cats and wildlife access to facilities, having a written biosecurity plan, disinfecting vehicles used to transport hogs before loading hogs, and having bird-proofed screening on production facilities were used on a majority of U.S. hog farms in 2020.

Finally, in 2020, the COVID-19 pandemic impacted hog production in a number of ways, particularly because of shutdowns or slowdowns of hog slaughter and processing facilities due to worker illness. ARMS data suggest that about 6 percent of hog producers euthanized hogs in response to COVID-19 slaughter plant closures, with the Southern Seaboard having a relatively higher share (49 percent) of euthanized hogs. Some hog producers received payments from several programs during this period, with about a third of producers receiving assistance from the Paycheck Protection Program and about a third receiving assistance from the Coronavirus Food Assistance Program.

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