United States Department of Agriculture

Economic Research Service

Economic Information Bulletin Number 189

March 2018

Three Decades of Consolidation in U.S. Agriculture

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United States Department of Agriculture

Economic Research Service
www.ers.usda.gov

Recommended citation format for this publication:

James M. MacDonald, Robert A. Hoppe, and Doris Newton. *Three Decades of Consolidation in U.S. Agriculture,* EIB-189, U.S. Department of Agriculture, Economic Research Service, March 2018.

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Abstract

Agricultural production has shifted to much larger farming operations over the last three decades, even as the number of very small farms grows. Consolidation of acreage and production has been persistent, widespread, and pronounced in crop production. Structural change has been quite dramatic in some livestock commodities—such as dairy, egg laying, and hogs—but consolidation has been modest or nonexistent in pasture/grazing land and in the associated cow-calf sector. This report, based on detailed farm-level data, measures trends in consolidation and tracks developments in farm-level specialization as well as the organization of farming businesses.

Keywords: Farm consolidation, large farms, family farms, industrial agriculture, agribusiness, concentration in agriculture, Agricultural Resource Management Survey, ARMS, Census of Agriculture

Acknowledgments

The authors thank Bob Dubman and Marcelo Castillo, U.S. Department of Agriculture (USDA), Economic Research Service *(*ERS); and Cathy Ott, USDA, National Agricultural Statistics Service (NASS) for assistance with data and advice. They also thank the following individuals for technical peer reviews: Dan Sumner, University of California at Davis; Michael Boland, University of Minnesota; Virginia Harris, USDA/NASS, and one reviewer who requested anonymity. Thanks also to Dale Simms and Lori Fields (USDA-ERS) for editing and design assistance.

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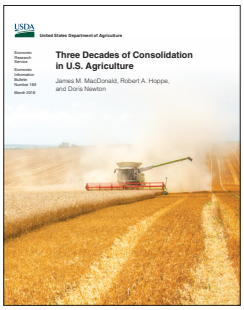


Three Decades of Consolidation in U.S. Agriculture

James M. MacDonald, Robert A. Hoppe, and Doris Newton

What Is the Issue?

Farm production has been shifting to larger farms for many years—one element of broad-based changes in farm structure. However, the U.S. farm size distribution in agricultural production is highly skewed—there are many very small farms in the Nation, but most agricultural production is concentrated among a small number of much larger farms. As a result, simple measures of average farm size—such as the mean and median farm size (both in acreage and sales)—are not representative of the mass of very small farms or of the large farms that account for most acreage, livestock, and production. Moreover, means and medians do not capture the shift of acreage and production to larger farms. In this report, we use detailed farm-level data from two major USDA data sources to develop more informative measures of consolidation in U.S. agriculture since the 1980s.

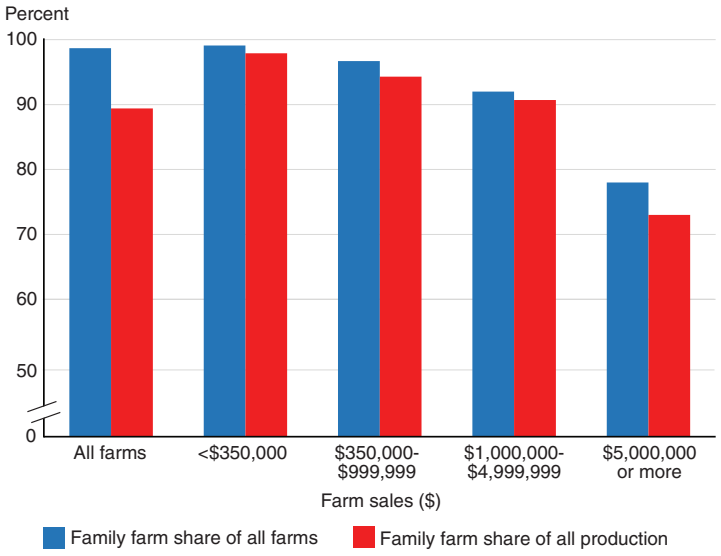
What Did the Study Find?

- Farm production has continued to shift to larger farms. By 2015, 51 percent of the value of U.S. farm production came from farms with at least $1 million in sales, compared to 31 percent in 1991 (adjusted for price changes).
- Consistent with the shift in the value of production, cropland acreage has also concentrated into fewer, but larger, farms. By 2012, 36 percent of all cropland was on farms with at least 2,000 acres of cropland, up from 15 percent in 1987. The midpoint for cropland acreage, at which half of all cropland is on larger farms and half is on smaller farms, nearly doubled from 650 acres in 1987 to 1,201 acres in 2012.
- Consolidation in crop production has been persistent, increasing in each 5-year Census of Agriculture between 1982 and 2012. It has also been widespread across crops, with midpoint values for harvested acreage increasing in 53 of the 55 field, vegetable, melon, fruit, tree nut, and berry crops reviewed.
- In contrast to crops, consolidation in livestock appears to be episodic, with little change over some periods, interspersed with dramatic changes in farm/industry organization and farm size. Such dramatic shifts have occurred in the last 25 years in U.S. dairy, egg, hog, and turkey production; consolidation has continued to occur in broiler and fed cattle production, within an industry organization that was set in earlier decades.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

- Bucking the general trend of consolidation in agriculture, cattle cow-calf operations exhibit little consolidation. On a related note, 44 percent of pasture and grazing land (primarily used for cattle) was on ranches with at least 10,000 acres in 2012, down from 51 percent in 1987. These sectors are important because permanent pasture and grazing land accounts for over 400 million acres (45 percent) of U.S. farmland, and because over 700,000 U.S. farms have beef cows.
- The long-term shifts toward agricultural consolidation have occurred in tandem with a shift toward greater farm specialization. While few farms specialize in a single crop, field crop operations increasingly grow just 2 or 3 crops, versus 4-6 crops previously. Livestock production continues to shift toward farms that produce no crops, and instead rely on purchased feed.
- The pace of farm consolidation appears to have slowed after 2007. In livestock, only dairy shows continued rapid consolidation. In field crops and in vegetable/melon crops, land continued to consolidate onto larger farms after 2007, but at a slower pace than in previous years. However, financial considerations still favor larger operations, as their profits (rates of return on assets) considerably exceed those for smaller operations.
- Despite increased consolidation, most production continues to be carried out on family farms, which are owned and operated by people related to one another by blood or marriage. Family farms accounted for 90 percent of farms with at least $1 million in sales in 2015, and produced 83 percent of production from million-dollar farms.
- Large corporate firms play a coordination role in U.S. farming through the use of contracts, particularly in hog and poultry production. Some firms—for example, in specialty crops, cattle feedlots, poultry, and hogs—operate multiple farms. USDA data track contract production, but do not currently link the farm operations of multi-farm businesses.

Family farms continue to dominate U.S. agriculture



Note: Farm sales are measured as gross cash farm income. On a family farm, the majority of the farm business is owned by the principal operator and people related to the principal operator.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

How Was the Study Conducted?

The study drew upon data from two primary sources. The Census of Agriculture, conducted by the USDA's National Agricultural Statistics Service (NASS), provides comprehensive, historical, and publicly available data on consolidation and specialization trends. The study also relied on confidential farm-level census records—accessed in a secure environment to ensure confidentiality—to generate measures of consolidation and farm size for the United States, the 50 States, and major commodities for 1982-2012.

The second primary source of data is the annual Agricultural Resource Management Survey (ARMS), jointly administered by NASS and ERS. The ARMS covers U.S. farming operations and their operators in the 48 contiguous States. The survey was used to supplement historic census data on consolidation with more recent annual developments, and to provide data on farm financial performance, business organization, and specialization.

Three Decades of Consolidation in U.S. Agriculture

Introduction

Farming in the United States continues to be dominated by family-owned and operated businesses, as it has been throughout the Nation's history. While many of today's farms are small operations run by people whose primary source of income is off the farm, the commercial farms that provide a livelihood for the families running them have gotten much larger, and account for a large and growing share of agricultural production.

Production has been shifting to larger farms for many years, with striking longrun consequences. Looking back at developments between 1950 and 2000, the geographer John Fraser Hart said "The scale of farming has changed so dramatically that farmers have had to add a zero or two to the way they once thought, be it dollars or acres, crops or animals, bushels or head" (Hart, 2003, p. 1). Increased farm size is one element in an array of linked changes in the organization of the U.S. farm sector, including greater farm specialization, a movement of certain tasks off the farm, and increased contracting and vertical integration, furthering ties between farmers and farm product buyers (Gardner, 2002).

Changes in the sector's organization have accompanied and facilitated major improvements in agricultural productivity, allowing the United States to substantially increase agricultural production while reducing the amount of land, labor, and capital devoted to agriculture. At the same time, large-scale farming operations are said to force small farms out of business, damage the viability of rural communities, reduce the diversity of agricultural production, and create environmental risks through their production practices.

While farm structure and size attract widespread commentary, precise measurement of how extensively farm structure has changed—and whether production continues to shift to larger farm operations—is scarce. Indeed, some measures of average farm size show little change in recent decades, while other measures show substantial growth.

This report focuses on long-term changes in farm size and organization, with a focus on large-scale farming operations.[1] We explore U.S. Department of Agriculture (USDA) statistics to show why they can sometimes give conflicting signals, and track the consolidation of agricultural production into larger operations since the 1980s, in aggregate and for specific crop and livestock commodities. The early 1980s is a logical start because farm consolidation and its related statistics have become more complex since then.

[1]This report updates and expands on two earlier reports: *Million-Dollar Farms in the New Century* (Hoppe et al., 2008) and *Farm Size and the Organization of U.S. Crop Farming (*MacDonald et al., 2013).

Consolidation in crop production is pronounced, nearly ubiquitous across commodities and States, and persistent over time. Livestock is different. In one major sector—cattle-raising and its associated grazing land—consolidation has yet to occur. Elsewhere, livestock consolidation is episodic rather than persistent, but often quite dramatic when it occurs, with far-reaching changes in industry organization. There is some evidence that the pace of consolidation, in crops and in livestock, has slowed in the last decade, and we consider that closely.

Large farms are not just larger. While most are family-owned and operated, large farms encompass a wide range of legal structures and ownership patterns. They use leases and rental agreements to access land and capital, and they often hire custom service providers and labor contractors for some farm tasks, freeing the operators to specialize. Some large farms are part of firms that own multiple farms and operate them as integrated businesses. In short, large farms embody a range of distinctive organizational strategies and business practices.

Data Sources

We rely primarily on farm-level records from two USDA sources, the Census of Agriculture and the Agricultural Resource Management Survey (ARMS). Both use the USDA definition of a farm—any place that sold or normally would have sold at least $1,000 of agricultural products in a year (see box, "Defining Farms"). These sources do not cover multiple-farm firms, and they are therefore primarily helpful in examining the size and organization of individual farm operations.[2]

The census, administered by USDA's National Agricultural Statistics Service (NASS), elicits information from all U.S. farms. It provides deep and comprehensive coverage of acreage and production for all States and a wide range of commodities. The census was conducted at irregular 4-, 5-, and 10-year intervals until 1982, and at 5-year intervals since then. We develop a set of new statistics, drawn from confidential farm-level census records for 1982-2012, accessed under an agreement with NASS that is designed to protect data security and confidentiality.

The ARMS, jointly administered by NASS and the Economic Research Service (ERS), is based on a representative sample of farms in the 48 contiguous States. It has been conducted annually since 1996; the most recent data available for this report covered farm performance in 2015. For historical comparisons, we also use 1991-95 data from the Farm Costs and Returns Survey (FCRS), the predecessor to ARMS.

With a total national sample of 30,000-40,000 farms, ARMS cannot provide the comprehensive State-, county-, or commodity-level coverage that the census provides, nor can it match the long temporal span of the census. However, it provides more recent (through 2015) and detailed data on farm finances, operators, resources, and practices.

[2]We explore links among farms under common ownership later in this report, drawing on company websites, trade publications, and the proprietary National Establishment Time Series (NETS) dataset.

Defining Farms

The U.S. Department of Agriculture (USDA) defines a farm as any place from which $1,000 or more of agricultural products were sold or would normally have been sold during a given year (USDA, NASS, 2017, p. 18). This definition was first used in the 1974 census. The census farm definition is consistent with the definition used by the National Agricultural Statistics Service (NASS) for current USDA surveys.

Counting farms, however, is more involved than this definition might imply. Places with less than $1,000 in sales may be counted as farms. In addition, some farming operations may own multiple farms, while others may encompass multiple counties or States. NASS aims to define a farming operation as a "distinct decision-making entity." With that in mind, a large business, which owns separate farms, may be divided into separate, distinct farms for statistical purposes. Each farm will be reported separately in the census and ARMS, and neither program collects and reports data on the entire multi-farm business. In addition, if a large farming operation is located in more than one county or State, it may be divided into separate, distinct farms for statistical reporting, so that the data are assigned to the county or State in which production occurred.

Sales Less than $1,000

Farms with sales less than $1,000 are counted as farms if they might normally have sales high enough to meet the sales requirement. If a place does not have $1,000 in sales, a "point system" assigns points—each valued at $1—for acres of various crops and head of livestock to estimate normal or potential sales. "Point farms" are farms with less than $1,000 in sales but with sales and points worth at least $1,000 (O'Donoghue et al., 2009, pp. 3-4). Point farms accounted for 20 percent of U.S. farms in the 2012 Census of Agriculture.

Multiple Farming Operations

NASS counts multiple operations of a farming business as separate entities if the operations are run separately. According to the *Report Form Guide* for the 2012 Census of Agriculture (USDA, NASS, 2012, p. 6):

> A census report form should be completed for each separate and distinct agricultural operation…. A separate report form is required for each distinct agricultural operation (farm, ranch, feedlot, greenhouse, etc.) for which separate records of operating expenses and sales, livestock, and crop acreage and production are normally maintained.

Multiple County or State Production

Large farming operations with significant production in more than one county may have their data allocated to the counties involved, creating distinct county-specific operations (USDA, NASS, 2014, p. A-9). Similarly, large farms with operations in more than one State may have their data allocated to distinct State-specific operations. These adjustments assign the data to the areas where production actually occurs.

Measuring Farm Size

Farm size can be measured in several ways: a farm's land area, the number of animals (for livestock operations); or the dollar sales of the farm business. Each has strengths. Each also has weaknesses, and no measure suits all questions (Sumner, 2014). We use each basis as appropriate.

Land Area

Since land accounts for about 80 percent of U.S. farm sector assets, and nearly half of the country's land area is devoted to agricultural uses (Bigelow and Borchers, 2017), the consolidation of land ownership and operation is of direct interest. Land measures—recorded in Federal, State, and local records for many years—also allow for easy long-term comparisons.

However, land-based measures of farm size need to be treated with care. Land is only one input to agricultural production. In livestock feeding operations or in crop farms with intensively farmed small acreages (such as horticultural specialties), land is a weak indicator of the amount of economic activity occurring on a farm. Land quality also varies: some land produces very high crop yields from each acre, while other land is used only for occasional grazing of cattle or sheep. Thus, a given land area may generate widely varying amounts of agricultural production.

Livestock Counts

For livestock operations, simple counts of animals—as inventory or shipments—can be useful in comparing differences across farms or over time. However, head counts ignore crop production. Some livestock farms purchase all or most of their animal feed, while others produce most of it; for a given amount of livestock production, feed producers have more economic activity than feed purchasers. Livestock counts are nonetheless widely available and of interest in themselves, particularly in view of the major shifts to substantially larger herds and flocks over time.

Dollar Sales

Sales, encompassing all economic activity on a farm, are a more comprehensive measure than land area or animal counts. However, farm sales must be adjusted for commodity price changes in order to effectively measure changes in farm production over time. We adjust for price changes with the Producer Price Index (PPI) for Farm Products, a sectorwide measure. But because price changes can vary widely across commodities, farms with different commodity mixes face different rates of actual commodity price inflation, and adjustment will be subject to errors.

Farm sales can be defined in several ways. We prefer gross cash farm income (GCFI), which captures all revenues flowing to a farm business—from commodity sales, government payments, and other farm-related income like custom work and production contract fees.

GCFI has been available from ARMS since 1996, but the census of agriculture reports a different sales measure—the market value of agricultural products sold (MVAPS), which is the market value of all commodities sold or removed from a farm by the farm operator, contractors, and share landlords. MVAPS measures commodity sales from a farm, regardless of who realizes the revenue, while GCFI measures revenue to the farm operator's business.

MVAPS can substantially exceed GCFI for contract poultry and hog growers. Because contract growers bear only some of the costs of contract production, the fees received by growers are usually a small share of commodity value, with the rest going to contractors and landlords. While MVAPS includes the full value of commodities produced under contract, it excludes government payments and the farm-related income that is included in GCFI.[3]

GCFI versus MVAPS: What's included?

Item	GCFI	MVAPS
Revenue to the farm from:		
Crop and livestock sales	Yes	Yes
Government payments	Yes	No
Other farm-related income[1]	Yes	No
Value of production accruing to:		
Share landlords	No	Yes
Contractors	No	Yes

GCFI = Gross cash farm income.
MVAPS = Market value of agricultural products sold.
[1]Receipts from custom work, machine hire, livestock grazing fees, timber sales, outdoor recreation, production contract fees, etc.
Source: Hoppe and MacDonald, 2013.

Skewness in Farm Size Measures

Farm production is highly skewed: of the 2.1 million U.S. farms, relatively few account for most production, while the many small and very small farms collectively account for little. Standard measures of average size can be misleading in highly skewed distributions, so we must use alternative measures to effectively describe farm structure and its changes over time.

Consider sales (GCFI) for 2015 (figure 1). About 65,300 farms—those with GCFI of at least $1 million—accounted for 51 percent of the value of U.S. agricultural production.[4] At the other extreme, nearly 1 million farms—or 48 percent of the total—had GCFI of less than $10,000, and collectively accounted for less than 1 percent of production.

Farms are defined quite broadly in U.S. statistics, requiring sales of only $1,000 in a given year. The definition, established in 1974, is not adjusted for price changes. With agricultural commodity prices higher today than in the 1970s, many places that would not have been counted as farms then would be counted today.

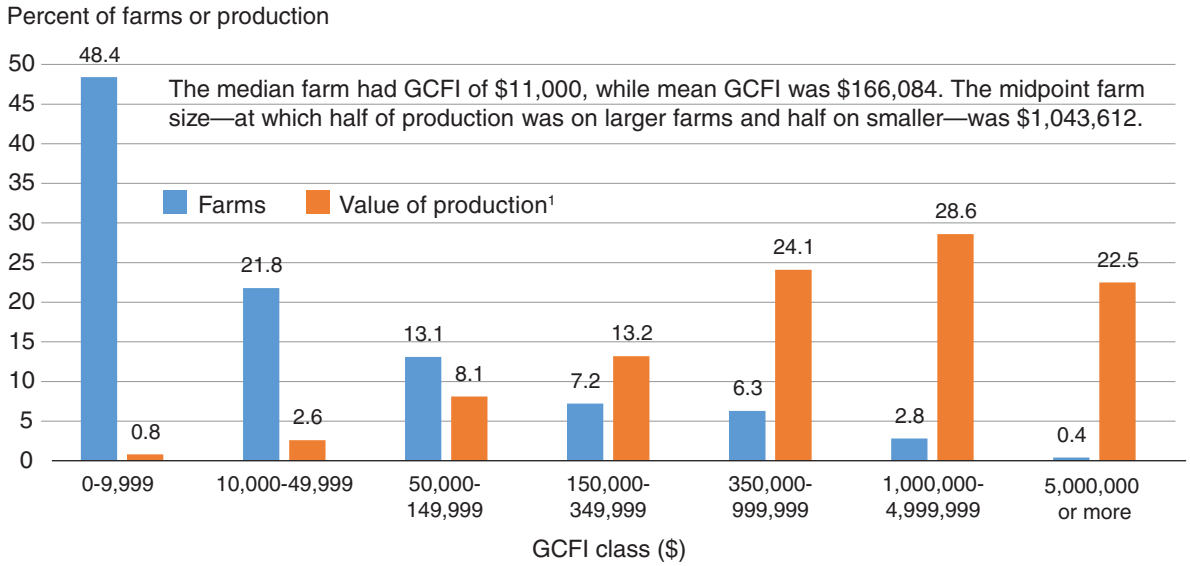
[3]Hoppe and MacDonald (2013) provide more detail on the choice between MVAPS and GCFI, and on measuring sales for contract operations. One could also measure farm size with value added, or sales net of purchases of intermediate goods and services (given sales, farms with higher value-added are likely hosting more economic activity). Value-added measures still require adjustment for inflation; while we can calculate value added with ARMS, we cannot do it with census records and so refrain from adding a fourth size measure.

[4]The value of production, calculated from ARMS, multiplies the quantity of each commodity produced in a year by the relevant State-level average commodity price. It differs from MVAPS in that it is based on commodities produced while MVAPS is based on commodities sold in a year, including sales of commodities produced in previous years and held in storage.

Figure 1

U.S. farms and production by GCFI class, 2015

The distribution of farms and the value of production is skewed



GCFI = Gross cash farm income.

[1]The value of production measures the value of commodities produced in a given year, without the effects of inventory change. It is calculated by multiplying the quantity of each commodity produced by the price of the commodity.

Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

The U.S. farm definition helps to account for the highly skewed nature of the farm size distribution, but that's not the only reason. Even with a higher threshold ($10,000, for example, or $50,000), most farms would still be small, and most production would occur on much larger farms. Farm production—in the aggregate and for specific commodities—is highly skewed toward a relatively small number of farms, a pattern that holds in many U.S. industries. Skewness is a fact of life, and what matters is how we deal with it in our reporting.

Reporting on Skewed Size Distributions

The problem with skewness is that standard measures of average size may not be very informative. For example, median farm sales (GCFI) in 2015 amounted to $11,000—half of farms have sales greater than the median, and half have less (figure 1). The mean was $166,084, far larger than the median, but the vast bulk of farm production occurs on much larger farms, and most of the places defined as farms have sales well below the mean. These estimates are not inaccurate, but neither are they very informative. When USDA reports that the "average" farm has sales of $11,000 (median) or $166,084 (mean), commercial farmers often find these estimates to be unbelievable and may doubt the relevance of USDA statistics.

This report handles skewness in two ways. We report comprehensive sector and commodity data so that readers can see the full distribution of farm sizes (as in figure 1) and its evolution over time. But full distributions take up report space and readers' time, so we also rely on another summary measure—the midpoint farm size. In figure 1, the midpoint is the farm size (measured by GCFI) at which half of all production occurs on larger farms and half on smaller. The midpoint farm size was $1,043,612 in 2015.[5] Most farms have sales that are far below the midpoint, but the midpoint is useful for locating the center of production—the average size of farm from which most production comes. It is especially useful for identifying the size of commercial farms and for tracking changes in the size of farms that generate most production.

The midpoint has equivalent interpretations for other measurement bases: for land area, the midpoint is the farm size at which half of all acres (of cropland, harvested cropland, or farmland) is on larger farms, and half is on smaller. Thus, it is useful for locating the center of acreage—the size of farm that centers the distribution of acreage. For livestock, it is the herd or flock size at which half of all animals come from larger farms and half from smaller.

[5]The midpoint is a median, in this case the median of the distribution of production by farm sales, as distinct from the simple median reported earlier, which is the median of the distribution of farms by farm sales (half of all farms are larger than the simple median, while half are smaller). Midpoint measures have been applied to agriculture by Lund and Price (1998), Key and Roberts (2006), and MacDonald et al. (2013). Their derivation and relation to other measures of average farm size are more fully explained in OECD (2016), which compares recent consolidation trends across countries.

Large Farms Today

What we mean by a large farm depends, of course, on the measurement basis that we use. ERS and NASS reports classify large farms as those with at least $1 million in sales and very large farms as those with at least $5 million. The census also sorts farms according to acreage; in some public census tables, the largest size category is 2,000 acres or more of farmland, while others use 5,000 acres or more.[6] These are arbitrary measures, but they are clear and transparent, and NASS and ERS clearly find these classifications to be useful for reporting to a broad public.

The measurement basis matters (table 1). Of the 2.1 million U.S. farms in the 2012 Census, 82,207 operated at least 2,000 acres of farmland, while 30,158 harvested at least 2,000 acres of cropland; 67,816 farms realized at least $1 million in sales (GCFI basis). Large farms thereby accounted for 1.4 to 3.9 percent of all U.S. farms, depending on the basis.

The degree of consolidation also varies around different measurement bases. For example, the number of farms that harvested at least 2,000 acres of ***cropland*** increased fourfold between 1987 and 2012, from 7,193 farms to 30,158, while the number of farms with at least 2,000 acres of ***farmland*** grew by only 23 percent. This disparity provides an initial hint to consolidation—it has occurred in crop production, but cropland accounts for less than half of all farmland; it is much less apparent in livestock grazing and in the extensive land associated with it.

Having lots of farmland doesn't guarantee high sales: less than half of farms with at least 2,000 acres of farmland also generated sales of at least $1 million, and many actually had less than $10,000 (table 2). Correspondingly, less than half of farms with at least $1 million in sales also had at least 2,000 acres of farmland. Some farmland is in arid areas, with little vegetation and poor soils. Farmland that is not suitable for cropping will often be used for livestock grazing that generates low sales per acre of land. In contrast, harvested cropland is more closely tied to sales: nearly 80 percent of farms that harvested 2,000 acres of cropland also realized at least $1 million in GCFI.[7]

Table 1
Large farms under five measurement bases, 1987 and 2012

Definition basis	Farms		Change, 1987-2012	Share of farms, 2012
	1987	2012		
	Number		Percent	
Farmland ≥ 2,000 acres	66,786	82,207	23.1	3.9
Cropland ≥ 2,000 acres	20,638	38,205	85.1	1.8
Harvested cropland ≥ 2,000 acres	7,193	30,158	319.3	1.4
MVAPS ≥ $1 million	33,543	79,225	136.2	3.9
GCFI ≥ $1 million	na	67,816	na	3.2

Notes: GCFI is gross cash farm income, while MVAPS is market value of agricultural products sold. "na" is not available; the measure could not be calculated in 1987. GCFI and MVAPS are expressed in 2012 dollars, using the Producer Price Index for Farm Products to adjust for price changes.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

[6]For example, see tables 1-9 in the 2012 Census of Agriculture, U.S. National Level Report. See Hoppe and MacDonald (2016) for ERS reporting.

[7]The two sales bases (GCFI and MVAPS) show considerable but incomplete overlap: 79 percent of farms receiving at least $1 million in MVAPS also received at least $1 million in GCFI, while 92 percent of farms with at least $1 million in GCFI also realized $1 million in MVAPS.

Table 2
Overlap among bases for measuring farm size, 2012

Definition and size class	Gross cash farm income		All farms
	Less than $1 million	$1 million or more	
	Number of farms		
Farmland			
Less than 2,000 acres	1,990,138	36,958	2,027,096
2,000 acres or more	51,349	30,858	82,207
All farms	2,041,487	67,816	2,109,303
Harvested cropland			
Less than 2,000 acres	2,035,216	43,929	2,079,145
2,000 acres or more	6,271	23,887	30,158
All farms	2,041,487	67,816	2,109,303
MVAPS			
Less than $1 million	2,024,626	5,452	2,030,078
$1 million or more	16,681	62,364	79,225
All farms	2,041,487	67,816	2,109,303

Notes: MVAPS is market value of agricultural products sold.
Source: USDA, Economic Research Service, complied from the 2012 Census of Agriculture.

What Do Large Farms Produce?

Large U.S. farms, however defined, produce a different mix of commodities—with a different mix of own, hired, and contract labor—than smaller farms. Larger farms also assemble land and capital assets differently than small farms. We first examine differences in specialization among farms (see box, “Commodity Specializations”).

Farms with lots of farmland tend to specialize in grain and oilseed crops or in beef cattle farming and ranching (figure 2). About half of all farms with 2,000-4,999 acres of farmland specialize in grains and oilseeds, while cattle operations dominate on operations with at least 5,000 acres. Among the 1,968 U.S. farms with at least 25,000 acres of farmland, most (69 percent) specialize in beef cattle farming/ranching and only 5 percent in grains and oilseeds.

Land use reflects a farm’s specialization. For farms with 2,000 to 4,999 acres of farmland, 49 percent of the land is in harvested crops and 37 percent is grazed. As farmland acres increase (and specialization shifts to cattle), the share of land that is grazed increases, to 93 percent for farms with at least 25,000 acres of farmland.

Commodity Specializations

Commodity specializations used in figure 2 and table 3, based upon the North American Industry Classification System (NAICS), are outlined in the table below. Farms are assigned to that commodity code (or commodity group) that accounts for at least 50 percent of the farm's market value of sales. Under each size measure, some specializations must be combined or collapsed into miscellaneous crops or miscellaneous livestock to avoid disclosure. Most of the specializations are self-explanatory, but two—miscellaneous crops and miscellaneous livestock—require some explanation.

Miscellaneous crops:

- Farms specializing in minor crops not mentioned in the table, such as various grass seed, herbs, hops, maple sap gathering, or tea.
- Farms growing a mixture of crops where no crop or group of crops accounts for half of sales.
- Farms that produce no crops or livestock, but receive payments from government agricultural programs (for example, farms that have placed all land in the Conservation Reserve Program).

Miscellaneous livestock:

- Farms specializing in livestock not mentioned in the table, such as alpacas, bison, elk, or laboratory animals.
- Farms growing a mixture of livestock where no species or group of species accounts for half of sales.
- Farms with 100 acres or more of pasture or rangeland only; no grazing livestock.

Other specializations are merged with other crops or other livestock as needed to avoid disclosure, as indicated in the table.

continued—

Specialization	Size measure used to define large farms		
	Farmland	Harvested acres	GCFI or MVAPS
Grains and oilseeds	X	X	X
Specialty crops[1]	X	X	X
Tobacco	MC	X	Tobacco and cotton are combined
Cotton	X	X	
Sugarcane	X	X	X
Hay	X	MC	X
Sugarbeets	X	MC	MC
Peanuts	X	X	MC
Miscellaneous crops	X	X	X
Beef cattle farming and ranching	X	X	X
Cattle feedlots	X	X	X
Dairy cattle and milk	X	X	X
Hogs and pigs	X	X	X
Poultry and eggs	X	X	X
Sheep and goats	X	ML	ML
Horses and other equines	X	ML	ML
Animal aquaculture	ML	ML	X
Miscellaneous livestock	X	X	X

GCFI = Gross cash farm income. MVAPS = Market value of agricultural products sold.
X = Specialization is used. MC = Added to miscellaneous crops. ML = Added to miscellaneous livestock.
[1]Farms specializing in vegetables/melons, fruits/tree nuts, or nursery/greenhouse/floriculture production.
Source: Hoppe and Korb, 2013.

For more information, see the documentation for the 2012 Census of Agriculture (U.S. Dept. of Agriculture, NASS, 2014, pp. B-8 to B-9) or the Census Bureau's website for the North American Industry Classifications System.

When land is measured by harvested cropland instead of farmland, roughly four-fifths of farms with 2,000 or more acres specialize in grains and oilseeds, until farm size reaches 25,000 acres or more (figure 2). The share of farmland harvested or grazed is fairly constant—regardless of acreage class—for large farms defined in terms of harvested acres. As large farms add more cropland, there is no large shift from grains/oilseeds to cattle.

High-sales farms encompass a diverse group of specializations. Using MVAPS, no single specialization accounts for half of the farms in any of the three sales classes, and four or five are required to account for 75 percent (table 3). Five specializations did not appear in the farmland-based measures—poultry/eggs, specialty crops, dairy/milk, hogs and pigs, and cattle feedlots.

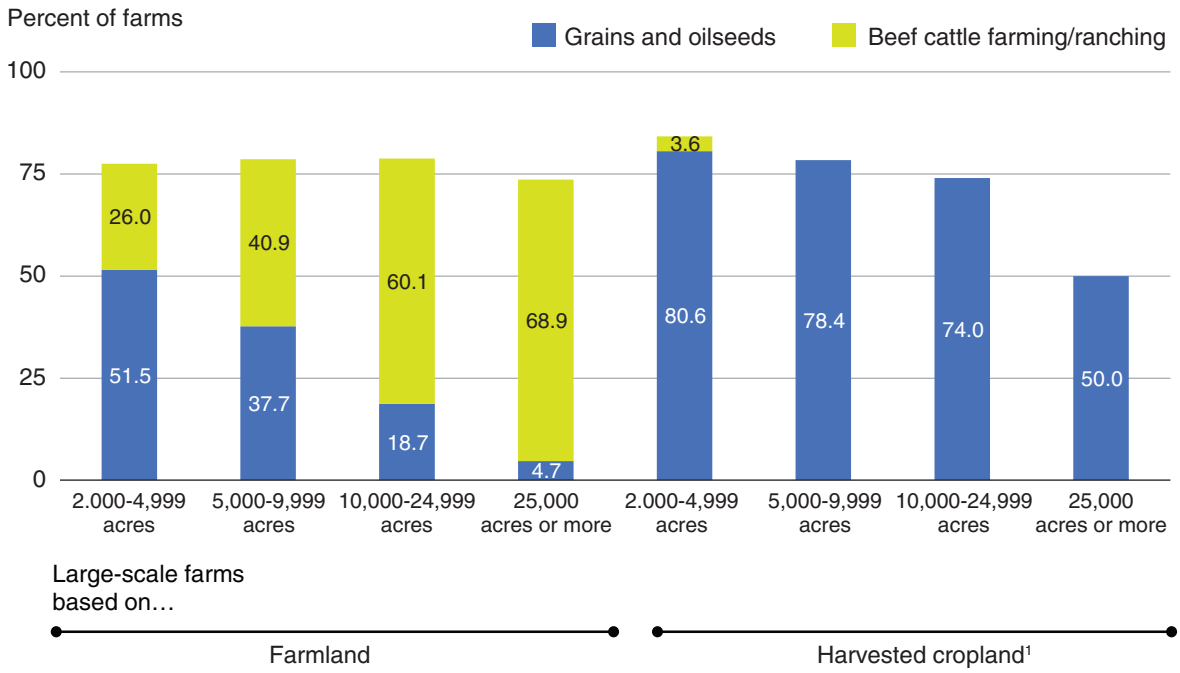
Specialty crops—fruits, vegetables, tree nuts, melons, berries, nurseries, greenhouses, and floriculture—loom large in both sales-based measures. These crops frequently combine lots of

labor and capital inputs to generate high per-acre sales, often on a limited land base. Four livestock specializations appear only in the sales-based measures—poultry/eggs, dairy/milk, hogs and pigs, and fed cattle. Those enterprises are largely based on confined feeding of animals in houses or pens, largely from purchased feed; they therefore generate high sales from a limited land base. (MacDonald et al., 2013).

Figure 2

Beef cattle and grain specializations of large farms by acreage class, 2012

The share of farms specializing in grains and oilseeds is more stable when using acres of harvested cropland to define large farms



[1]Beef cattle farming/ranching is not presented for classes with 5,000 or more acres of harvested cropland due to insufficient observations.

Source: USDA, Economic Research Service, compiled from the 2012 Census of Agriculture.

Table 3

Large and very large farms by top five specializations, 2012

Percent (in parentheses) = *Specializations accounting for 75% of farms in the class*

Definition and size class	Specialization[1] and share of farms in each acreage or sales class				
	1	2	3	4	5
Farmland—2,000 acres or more:					
2,000 to 4,999 acres	Grains and oilseeds (51.5)	Beef cattle farming & ranching (26.0)	Miscellaneous crops (6.4)	Hay (3.7)	Cotton (2.4)
5,000 acres or more	Beef cattle farming & ranching (48.7)	Grains and oilseeds (29.6)	Miscellaneous crops (5.3)	Miscellaneous livestock (4.4)	Hay (3.6)
Acres harvested—2,000 or more:					
2,000 to 4,999 acres	Grains and oilseeds (80.6)	Miscellaneous crops (5.1)	Beef cattle farming & ranching (3.6)	Specialty crops[2] (3.0)	Cotton (2.9)
5,000 acres or more	Grains and oilseeds (77.7)	Specialty crops[2] (6.8)	Miscellaneous crops (5.7)	Beef cattle farming & ranching (2.6)	Cotton (2.6)
MVAPS—$1,000,000 or more:					
$1,000,000 to $4,999,999	Grains and oilseeds (43.4)	Poultry and eggs (16.4)	Specialty crops[2] (9.9)	Dairy cattle and milk (7.1)	Hogs and pigs (7.0)
$5,000,000 to $9,999,999	Specialty crops[2] (23.2)	Dairy cattle and milk (17.7)	Grains and oilseeds (16.9)	Poultry and eggs (12.0)	Hogs and pigs (9.9)
$10,000,000 or more	Specialty crops[2] (29.4)	Dairy cattle and milk (21.7)	Cattle feed lots (16.3)	Poultry and eggs (12.2)	Hogs and pigs (8.0)
GCFI—$1,000,000 or more:					
$1,000,000 to $4,999,999	Grains and oilseeds (54.0)	Specialty crops[2] (12.0)	Dairy cattle and milk (8.7)	Beef cattle farming & ranching (6.9)	Miscella-neous crops (4.3)
$5,000,000 to $9,999,999	Specialty crops[2] (26.6)	Dairy cattle and milk (20.6)	Grains and oilseeds (20.3)	Beef cattle farming & ranching (6.6)	Cattle feed lots (6.6)
$10,000,000 or more	Specialty crops[2] (32.1)	Dairy cattle and milk (24.0)	Cattle feed lots (12.9)	Poultry and eggs (10.9)	Hogs and pigs (7.3)

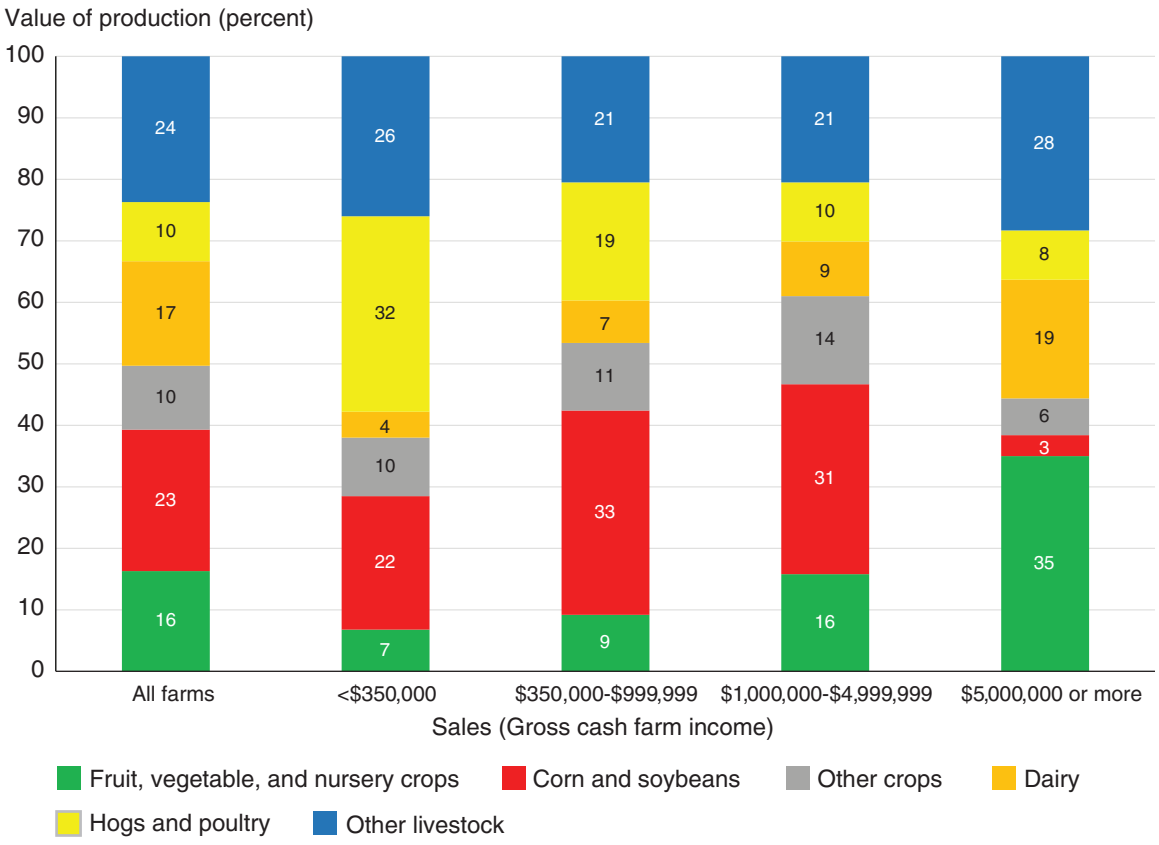
GCFI = Gross cash farm income.
MVAPS = Market value of agricultural products sold.
Note: Eighteen specializations were used in this analysis: Grains/oilseeds, specialty crops, tobacco, cotton, sugarcane, hay, sugarbeets, peanuts, miscellaneous crops, beef cattle farming/ranching, cattle feedlots, dairy cattle and milk, hogs/pigs, poultry/eggs, sheep/goats, horses/other equines, and miscellaneous livestock. For more information, see box, "Commodity Specializations," p. 10.
[1]In order from largest to smallest, by share of farms in the acreage or GCFI class.
[2]Farms specializing in vegetables/melons, fruits/tree nuts, or nursery/greenhouse/floriculture production.
Source: USDA, Economic Research Service, compiled from the 2012 Census of Agriculture.

Farm Sales and Commodity Mix

Farms are assigned specializations in table 3, based on their predominant commodity, but farms may also produce other commodities. In figure 3, we use ARMS data to evaluate the full commodity mixes of large and small farms, instead of focusing only on specializations, using four GCFI classes: less than $350,000 (small), $350,000-$999,999 (midsize), $1-$5 million (large), and very large farms with at least $5 million in sales.

Commodity mixes vary noticeably across sales classes, in line with our findings for specializations. For example, across the entire farm sector, specialty crops (fruit, vegetable, and nursery) accounted for 16 percent of the value of production in 2015, while corn and soybeans accounted for 23 percent. But among very large farms, specialty crops were 35 percent of production while corn and soybeans were just 3 percent. Corn and soybeans were far more important for midsize and large farms, and hog and poultry production were important for small farms.

Figure 3
Commodity mix by farm sales class, 2015
The importance of a given commodity differs by farm size

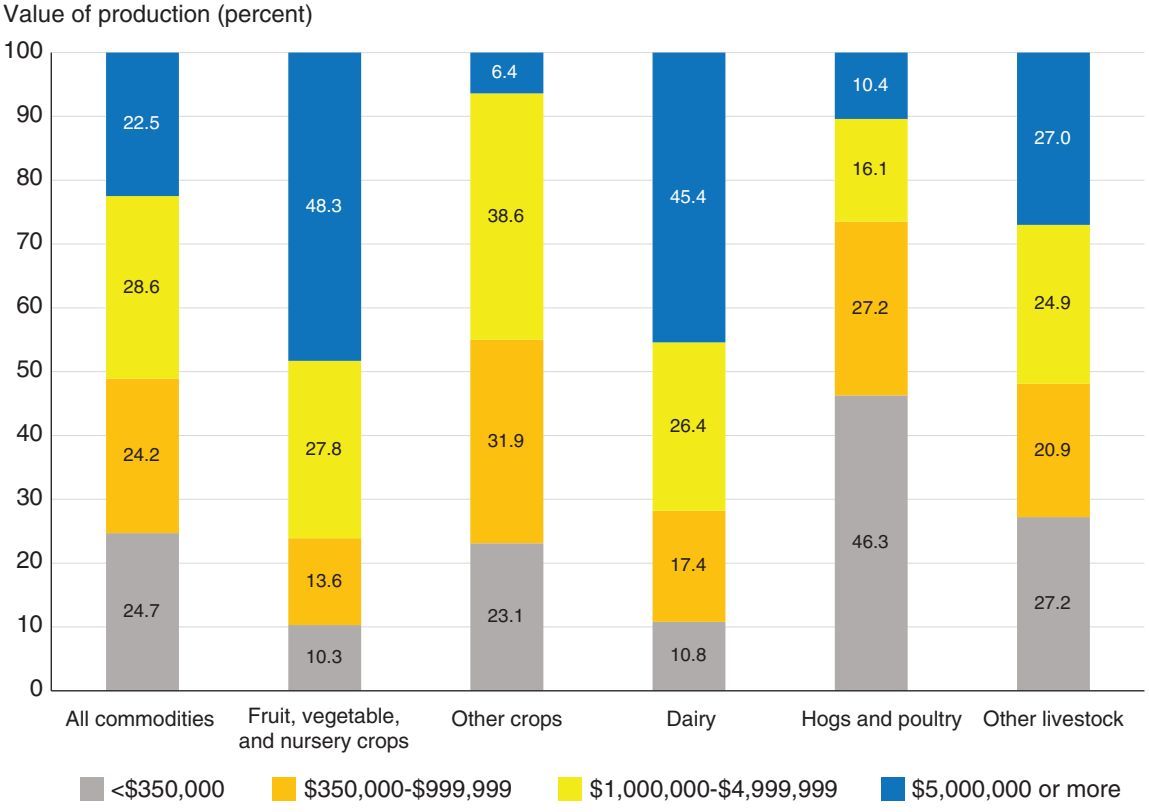


Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

We have focused on the importance of different commodities to farms in each sales class, but we can also measure the importance of each sales class to production of specific commodities (figure 4). Total farm production ("all commodities") is split fairly evenly across the four sales classes of farms, with each holding 23-29 percent of production. However, there are sharp variations across specific commodity groups. Large and very large farms accounted for 76 percent of specialty crop production and 72 percent of dairy production, but only 27 percent of hog and poultry production in 2015. Small farms accounted for 46 percent of hog and poultry production, and 23 percent of "other crops" production, but only 11 percent of dairy and 10 percent of specialty crops.

To summarize, commodity mixes vary across farm size classes. Very large farms (sales basis) are more likely to specialize in specialty crops, dairy, egg production, and cattle feeding, and use relatively little land. Field crop farms tend to occupy a midsize to large range of sales and to use lots of cropland. Many contract poultry and hog producers are relatively small farms.

Figure 4
Commodity production by farm size class, 2015
Different sizes of farms account for the production of specific commodities



Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

How Farms Assemble and Use Production Inputs

Commercial farming requires a significant commitment of capital. With Illinois cropland valued at $7,350 an acre, on average, in 2017, the land in a 1,500-acre grain and soybean operation would be valued at over $11 million. The structures and equipment required for such an operation, even with used equipment, would likely amount to another $1 million. At 2017 prices for milk cows, a Minnesota dairy farm with 500 cows would represent a livestock investment of nearly $800,000, in addition to nearly $4 million for cropland, housing, and milking/cropping equipment.[8] The capital assets needed to operate a modern commercial farm can be daunting for a family. Farms rarely finance their capital assets entirely from the family's equity.

Instead, farms choose a variety of means to assemble production inputs: they can purchase land, livestock, structures, and machinery—using equity or debt finance—but they can also lease inputs. They can hire custom service providers to perform farm tasks like field preparation, planting, spraying, or harvesting (effectively hiring the machinery and labor used for those tasks). Livestock operations can grow feed, and acquire the land and equipment to do so, or purchase their feed. Finally, operations can provide their own labor, can rely on labor hired to work as employees on the farm, or can hire contract labor for specific tasks through contract labor providers. By leasing inputs or hiring custom services, farms can economize on the cost of investing in long-lived capital and react more flexibly to market changes by using such inputs more or less intensively.

Farms in different size classes use different methods of assembling the land base needed for production (figure 5). Only 30 percent of small farms rent any land, and in the aggregate they rent about one-third of the land that they operate. Small farms account for most (81 percent) of the 57 million acres that is rented out by farmers to other farmers.

In contrast, 79 percent of midsize farms and 87 percent of large farms rent land, and half of their operated farmland is rented. Midsize and large farms tend to specialize in field crop production, and together accounted for 62 percent of harvested cropland acres in 2015. Very large farms focus on specialty crops, dairy, and cattle feeding—which don't require much land—and they account for only 6 percent of harvested cropland. However, about three-quarters of very large farms do rent land, and rented land accounts for nearly two-thirds of the land they operate.

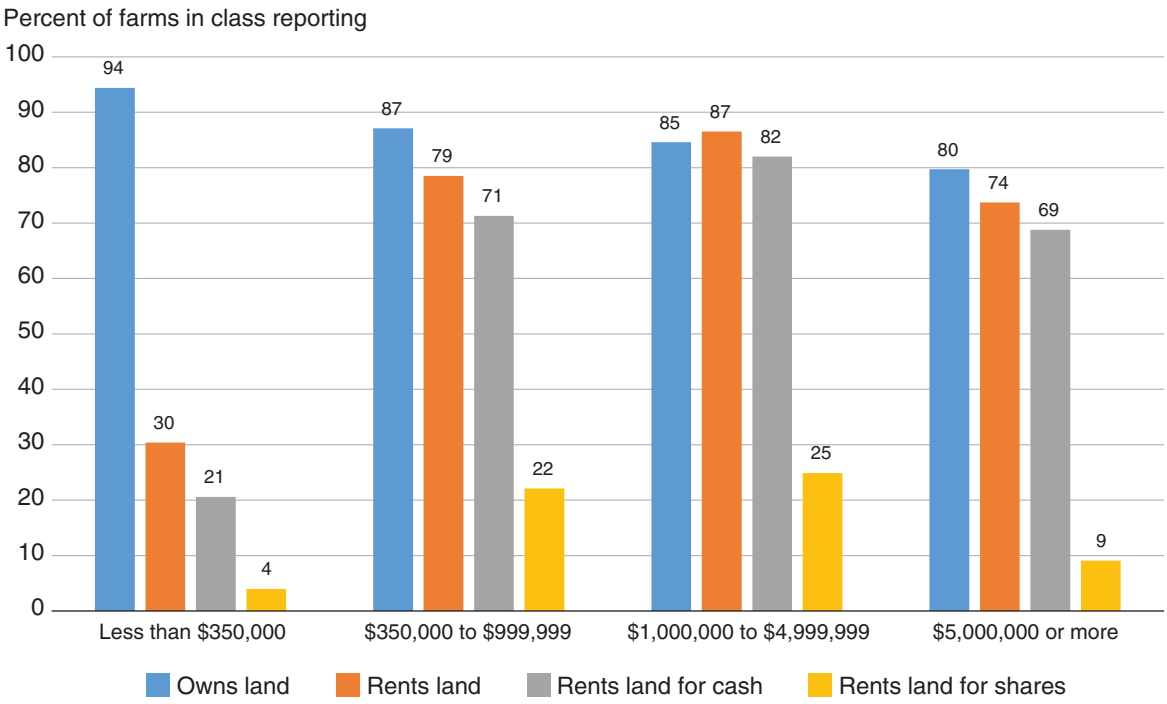
Few farms lease livestock, but very large farms are most likely to do so (6 percent), while small farms are least likely (figure 6). Larger operations often lease some of their machinery, while small farms rarely do. Most midsize, large, and very large farms hire at least some custom services, while just one in five small farms does. Finally, almost all very large farms use hired or contract labor, as do most midsize and large farms, while a smaller proportion of small farms do.

[8]Cropland values and cow prices are derived from NASS, *Agricultural Land Values and Agricultural Prices*. Other estimates are from Williamson (2017).

Figure 5

Methods of accessing land, by gross cash farm income class, 2015

Most farms with GCFI of $350,000 or more rent land

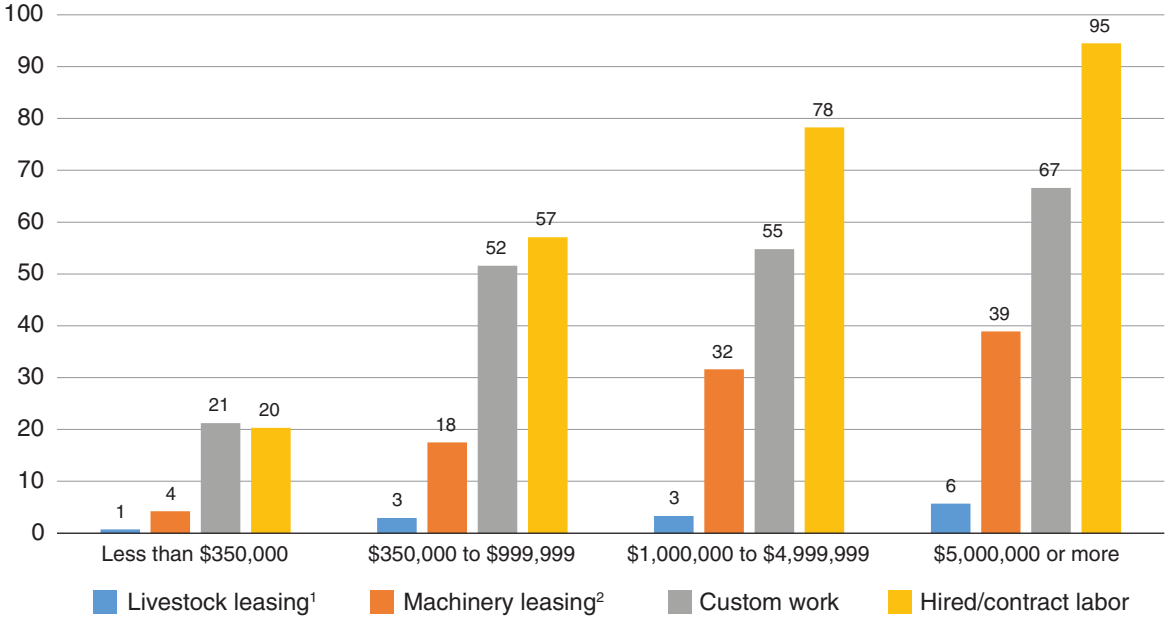


Note: Rent for cash includes fixed cash payments and flexible cash payments. Free rental agreements are not shown separately. GCFI = gross cash farm income.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

Figure 6

Selected methods of input procurement by GCFI, 2015

Machinery leasing, custom work, and hired/contract labor are most common among farms with GCFI of $5 million or more



GCFI = gross cash farm income.
[1]Includes leasing bees for pollination.
[2]Renting or leasing tractors, vehicles, farm machinery and equipment, and storage structures.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

Labor Use on U.S. Farms

Farm families are an important source of labor on farms, but they are not the only source, and farms of different sizes rely on different mixes of labor (table 4). The principal operator, and the principal operator's spouse, provide most (75 percent) of the labor hours used on small farms.[9] That share falls to 47 percent on midsize farms, 20 percent on large farms, and 3 percent on very large farms. Most small farms have a single operator, and those that report two operators most often report the spouse as the second operator. Larger farms often have additional operators, and those operators and other unpaid family members provide roughly 10 percent of the labor on small, midsize, and large farms, but only 5 percent on very large farms.

Table 4
Labor use and sources in farming by GCFI, 2015

Item	Gross cash farm income				All farms
	<$350,000	$350,000-$999,999	$1,000,000-$4,999,999	$5 million or more	
	Number of farms				
Total farms	1,863,442	130,578	57,880	7,373	2,059,272
	Annual hours per farm				
Median hours worked	1,430	5,330	8,463	37,089	1,586
Mean hours worked	2,088	7,346	17,769	110,801	3,251
	Percent of total farm hours				
Share of hours					
Principal operator	59.8	38.6	16.5	2.5	43.1
Spouse	14.3	8.3	3.5	0.5	10.1
Other operators	6.2	9.8	7.2	2.3	6.4
Unpaid workers	3.1	2.3	0.9	2.5	2.6
Hired labor	14.5	35.2	62.2	69.2	31.5
Contract labor	2.0	5.9	9.7	23.0	6.3
	Annual full-time equivalent persons per farm				
Median FTEs	0.72	2.67	4.23	18.55	0.793
Mean FTEs	1.04	3.67	8.89	55.40	1.625
	Annual FTEs per $100,000 of gross cash farm income				
Hours/sales $	2.73	0.62	0.48	0.47	0.979

Notes: The principal operator is the person primarily responsible for decision making on the farm. The spouse of the principal operator may or may not be listed as an operator, but if listed as an operator, he or she is recorded in the spouse row here. Unpaid workers typically include other family members working on the farm (only farms that are incorporated are allowed to pay salaries to operators, who in other cases draw compensation as a withdrawal from owner equity).
FTEs (full-time equivalents) are measured as labor hours divided by 2,000.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

[9]We collect hours worked for operators, their spouses, unpaid workers, and hired labor directly on the ARMS survey. We infer contract labor hours worked by dividing expenditures on contract labor—also from the survey—by an hourly hired labor wage rate for farms in the State.

Larger farms are able to use their labor more intensively. On large and very large farms, it takes only half an FTE to generate $100,000 in GCFI, while midsize farms use 0.62 FTE and small farms use 2.73. Put another way, 1 FTE generates $36,630 in annual sales at small farms, compared to $161,290 at a midsize farm and $212,766 at a very large farm.

Combining Labor and Capital

Differences in sales per worker largely follow from differences in the amount of land and capital equipment employed, and in the commodity mix of a farm. We illustrate this by comparing cash grain and specialty crop farms with at least $1 million in GCFI (table 5), effectively combining large and very large size classes for this analysis. Together, those two specialties accounted for nearly 58 percent of all farms with GCFI $1 million or more in 2015.

Table 5
Labor and capital use on large and very large cash grain and specialty crop farms, 2015

	Cash grain	Specialty crop
	Number with at least $1 million in GCFI	
Total farms	26,987	10,580
Share of:	Percent	
All large and very large farms	41.4	16.2
Labor on large/very large farms	13.0	40.5
	Acres per farm	
Median acres owned	660	172
Median acres operated	2,500	370
	Annual FTEs per $100,000 of GCFI	
Labor hours/sales $	0.25	0.72
	Dollars per FTE	
Assets per FTE	1,552,413	290,531
Current assets	223,206	51,003
Real estate	1,043,596	218,930
Other noncurrent assets	285,610	20,599
Asset productivity	GCFI ($) per dollar of assets	
Real estate	0.38	0.63
Other noncurrent assets	1.40	6.74

Notes: Large farms and very large farms had at least $1 million in gross cash farm income (GCFI) in 2015.
Specialty crop farms specialize in vegetables, melons, fruits, nuts, berries, horticulture, or greenhouse crops.
A FTE (full-time equivalent) is equal to 2,000 hours of annual labor time.
Current assets are primarily made up of inventories, while other noncurrent assets primarily include machinery and equipment.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

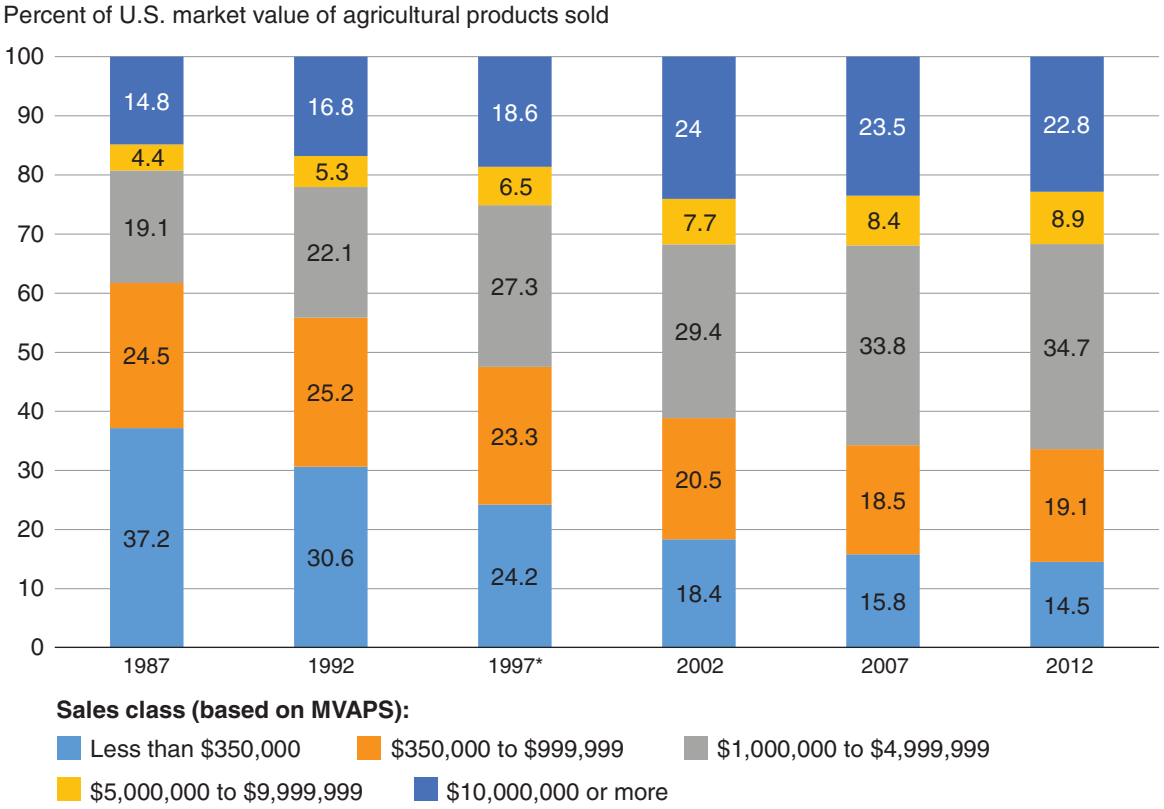
Cash grain farms use considerably more land than specialty crop operations and considerably less labor. They also use far more capital: "other noncurrent assets" represent primarily machinery and equipment owned by the farm, and cash grain farms have nearly 14 times as much, per FTE, as specialty crop farms. Because of their capital intensity, cash grain farms show higher labor productivity: cash grain farms generated $400,000 in sales per FTE, while high-value crop farms generated $138,888 per FTE. But specialty crop operations generate much higher land and capital productivity: 63 cents in annual sales from every dollar of real estate, compared to 38 cents for cash grain operations, and $6.74 in annual sales from every dollar invested in machinery and equipment, compared to $1.40 for cash grain operations.

Production Shifts to High-Sales Farms

Farm production has shifted from small to large farms, when measured by sales. Over 25 years, the shift is substantial. However, sales-based measures also show slowing consolidation over the last decade.

Figure 7 extends an analysis, first reported in Hoppe and Korb (2002), to the most recent (2012) Census of Agriculture. Farms are sorted into five sales categories, using market value of agricultural products sold (MVAPS): small farms with less than $350,000 in annual sales, midsize farms with $350,000 to $999,999, large farms with $1-$5 million, and two classes of very large farms—$5-10 million, and $10 million or more.[10] Because commodity prices change over time, we use the Producer Price Index (PPI) for Farm Products to express MVAPS in 2012 dollars, and focus on changes in production.

Figure 7
Market value of agricultural products sold (MVAPS) by constant-dollar sales class, 1987-2012
Sales shifted to farms with sales of at least $1 million, largely from farms with sales less than $350,000



MVAPS = Market value of agricultural products sold.*Coverage adjustment introduced in 1997 (see Appendix A).
Note: MVAPS is expressed in constant 2012 dollars, using the Producer Price Index for farm products to adjust for price changes.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

[10]The large sample size and comprehensive coverage of the census allow us to break very large farms, with $5 million or more in sales, into two categories, and to cover shifts since 1987.

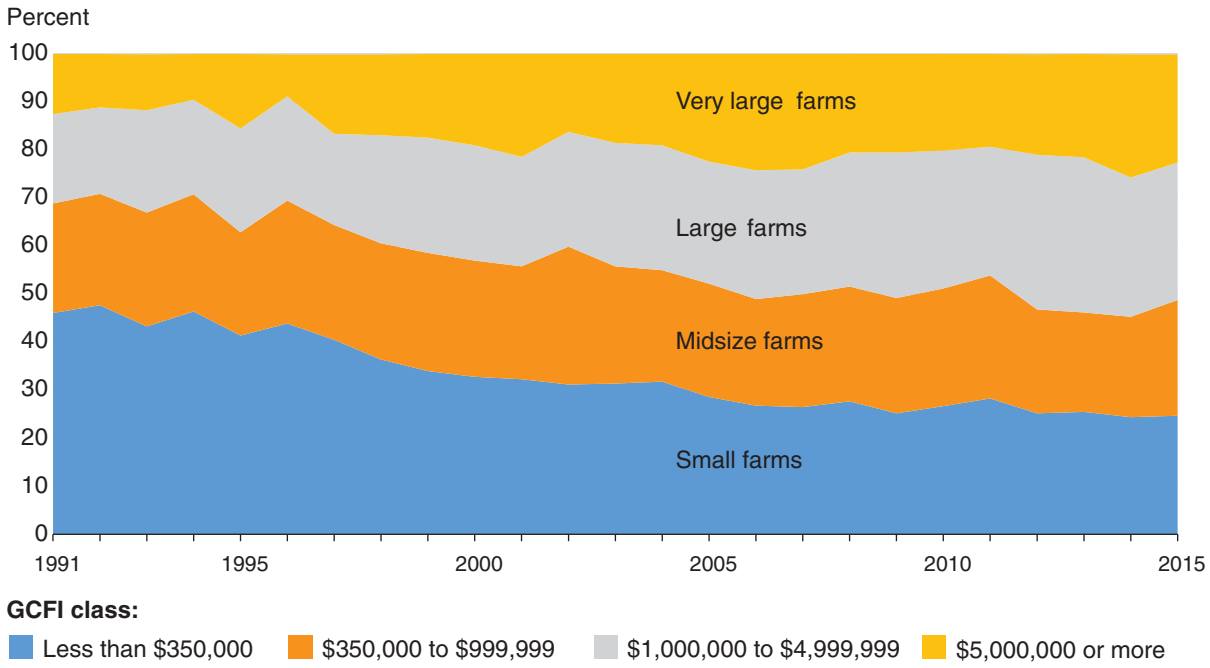
There is a clear and substantial shift of sales to larger farms over time.[11] Small farms accounted for 37.2 percent of MVAPS in 1987, and just 14.5 percent in 2012 after a steady decline. In contrast, farms with at least $1 million in sales, with 38.3 percent of total MVAPS in 1987, held 66.4 percent by 2012. Sales also shifted away from midsize farms, whose share fell by a fifth between 1987 and 2012.

It appears, however, that consolidation slowed in the 2000s. Farms with at least $1 million in sales increased their share of total MVAPS by 22.8 percentage points between 1987 and 2002, or 7.6 percentage points in each 5-year intercensus period. Between 2002 and 2007, their share increased by 4.6 percentage points, and they added just 0.7 percentage point to their share between 2007 and 2012.

We can extend the census-based MVAPS sales analysis with GCFI sales from 1991 to 2015, based on annual ARMS and FCRS data, with the value of commodity production sorted among four sales classes; because the ARMS/FCRS has a much smaller sample than the census, we place all very large farms (with at least $5 million in sales) in a single class. We adjust for price changes again using the Producer Price Index for Farm Products, but in this case we adjust to 2015 dollars, the terminal year of the ARMS data.

The ARMS-based GCFI analysis tells a similar story (figure 8). Commodity production shifted sharply to larger farms after 1991. However, the shift appears to slow after 2007 and reverse after 2012 as the small-farm share stabilized and the midsize farm share increased.

Figure 8
Distribution of the value of production by GCFI class, 1991-2015
Production shifted to farms with GCFI of $1 million or more



GCFI = Gross cash farm income. GCFI is expressed in constant 2015 dollars, using the Producer Price Index for farm products to adjust for price changes.
Note: The value of production measures the value of commodities produced in a given year, without the effects of inventory change. It is calculated by multiplying the quantity of each commodity produced by the price of the commodity.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

[11] Important changes to census of agriculture methodology, introduced in 1997, complicate temporal comparisons of pre-1997 census estimates to later measures. See appendix A.

Adjusting for Inflation: Impact on Measuring Consolidation

To measure consolidation in farm sales, we must adjust for changes in commodity prices over time. In recent years, this has become more challenging as, overall, commodity prices have risen, but with sharp fluctuations and with sharp divergences among commodities.

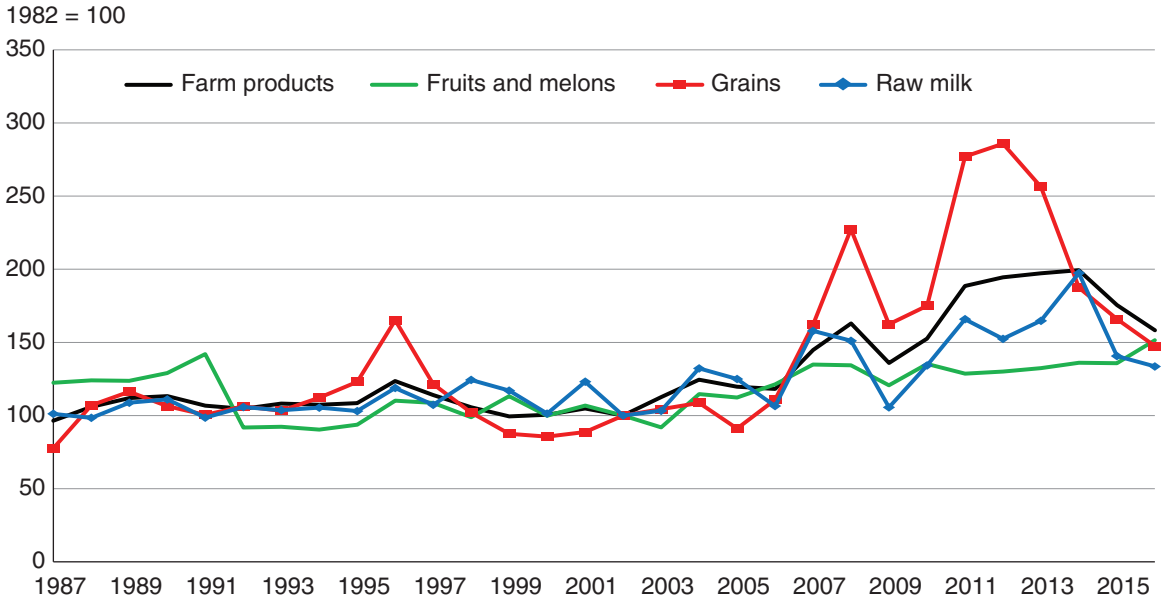
Prices for agricultural commodities fluctuated between 1987 and 2003, but showed no trend and no long-term divergence from each other (figure 9). However, disaggregated PPIs for grains, fruits/melons, and milk diverged sharply from each other and from the overall Farm Products PPI after 2003 (we show only the three disaggregates, for clarity, but others also diverged from the aggregate after 2003).

The measure of inflation matters. A sectorwide price index like the Farm Products PPI may not be an effective deflator for farm-specific sales when component price indexes diverge and when farms produce diversified commodity mixes.

During 2006-12, when commodity prices were diverging sharply for different commodity categories, deflation of the value of production and GCFI by the Farm Products PPI may have understated price increases, and therefore overstated real production increases, for grains, because the Farm Products PPI generally rose by less than grain prices. In that case, the share of real, inflation-adjusted production held by midsize and large farms would have increased, because grain production accounts for a large share of their production (figure 3).

By the same token, deflation with the Farm Products PPI may have overstated price increases, and understated production increases, for fruit/melon commodities and (less so) for dairy. Since very large farms dominate dairy and high-value crop production, deflation with the overall Farm Products PPI may have understated real production growth by very large farms, and therefore understated consolidation.

Figure 9
Producer Price Indexes, 1987-2016
Prices diverged after 2003



Source: U.S. Bureau of Labor Statistics, Producer Price Indexes.

Financial Incentives Support Consolidation

Despite the apparent slowing of consolidation in the last decade, the financial incentives for consolidation continue to be quite strong. We compared average rates of return on assets for farms in five different GCFI classes—very large, large, and midsize farms, with small farms now split into two classes—less than $100,000, and $100,000-$349,999. We compare rates of return over the 20 years of ARMS data from 1996 through 2015 (see box, "Measuring Rates of Return in ARMS").

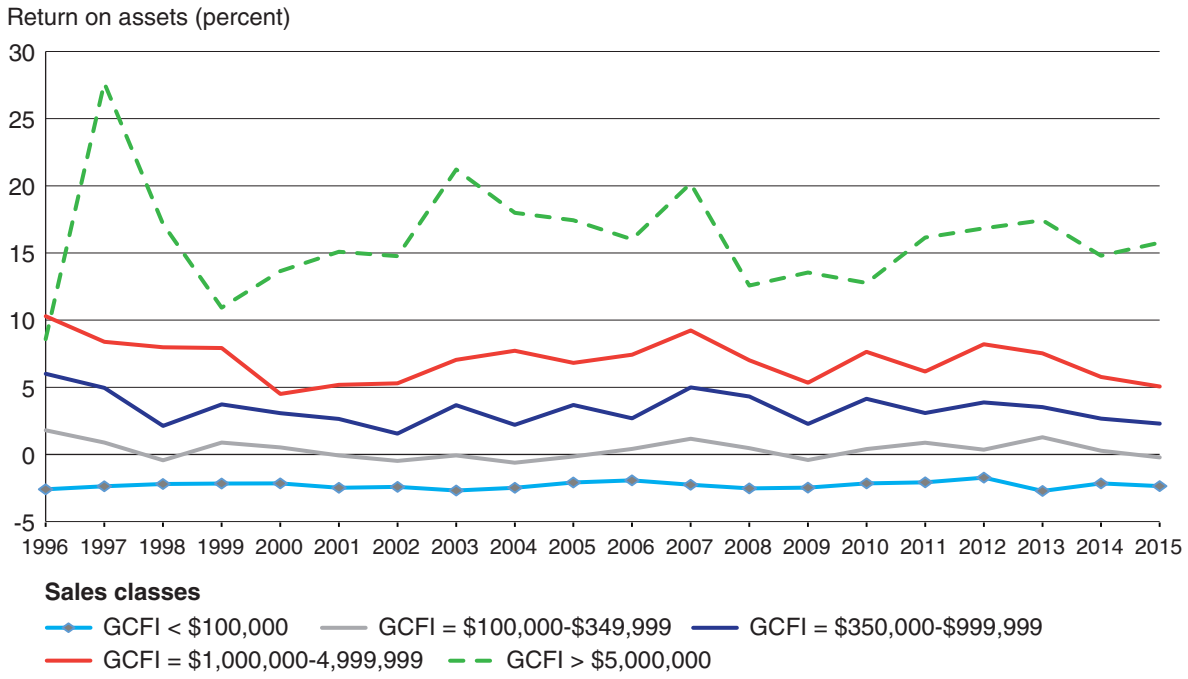
While rates of return vary over time, the differences among GCFI classes are persistent (figure 10). Farms with at least $5 million in GCFI earn rates of return that exceed each of the other four classes in every single year, except for the next highest class in 1996. Similarly, farms with $1-$5 million in GCFI have estimated average returns that exceed those for the three smaller classes in every year. The smallest class—farms with less than $100,000 in sales—consistently earns the lowest returns.[12]

Profit measures can vary widely across farms within each class, and some small and midsized farms can be quite profitable. However, the average differences are persistent and pronounced, with striking average differences between the largest farms and others. The ARMS-based evidence indicates that there were strong financial incentives to create larger farming businesses in the 1990s and 2000s and that those incentives have not diminished, despite an apparent slowing in consolidation, in recent years.

Figure 10

Average farm return on assets persistently higher in larger sales classes, 1996-2015

Over time, the rate of return on assets has consistently been higher for larger farm



Note: Sales classes are based on instrumented gross cash farm income in 2015 dollars. ROA is the ratio of total returns in a sales class to total assets.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 1996-2015 Agricultural Resource Management Survey.

[12]Some small-farm households may not aim to earn the highest possible profits, but instead derive most of their income from off-farm activities, while taking a loss on farm activities pursued for enjoyment. Consequently, average rates of return for the smallest farms are often negative.

Over several decades, farm production has shifted to much larger operations, a trend that appears to have slowed in the last decade. However, the persistence of high returns, combined with price fluctuations and imperfect adjustment for price changes, creates some uncertainty in our judgment of trends in farm consolidation over the last decade. We use the physical measures of farm size—acreage, disaggregated by State and commodity, and livestock headcounts, disaggregated by species—to supplement our evidence on long-term trends, to help assess consolidation in detailed crop and livestock categories, and to provide a further check on recent developments.

Measuring Rates of Return in ARMS

The rate of return on assets is defined as the ratio of adjusted net farm income to the assets of the farm business. Net farm income is adjusted by adding interest payments, subtracting an imputed value for unpaid farm operator and unpaid worker labor, and subtracting a further imputed value for farm operator management. The imputed values are derived from regional average hired labor wage rates—for unpaid labor—and a constant share of net value added for management. Thus, the adjusted return on assets encompasses debt service and a return on owned land and capital, after accounting for operating expenses and the opportunity cost of the labor and management contributed primarily by operators and their families.

ARMS financial accounts are based on cash accounting, and this creates two challenges for estimating temporal profit trends. First, some farms will incur expenses in 1 year for inputs used in other years. That will tend to reduce measured profits in 1 year, and raise them in the subsequent years in which inputs are used but expenses are not incurred. The effect is exacerbated on farms that rent or lease most assets (and hence have an especially low denominator). As a result, we see a wide variance of measured profits across farms, with some exceptionally high or low values—enough in some instances to materially affect mean values.

Second, revenue can also be shifted among years, if farms are paid in 1 year for production that occurred in previous or subsequent years. This will raise measured returns in the years in which the revenue is received, and reduce returns in the relevant production years; it will also cause a bias for our profit analyses because measured profits will then be relatively high in years in which reported sales are also relatively high, and will be low in years in which reported sales are low. We handle this challenge by generating an estimate of expected GCFI, given the farm's value of production in each of nine broad commodity classes in a given year (the value of production is based on commodity production in a year, times a State-level average price for that year). In turn, this estimate is simply the predicted value from a regression of GCFI on the value of production for fruits, vegetables, nursery crops, field crops, all other crops, poultry, hogs, dairy, cattle, and all other livestock (that is, we generate an instrument for GCFI, based on current production). We use expected GCFI, adjusted to 2015 dollars using the Farm Products PPI, to assign farms to sales classes in each year. The effect of the GCFI adjustment is to reduce the spread of estimated returns on assets, across classes, by 1-3 percentage points (that is, the gap between returns on assets for very large farms and returns for other classes in figure 10 would be 1-3 percentage points greater if we did not remove transitory components with this adjustment).

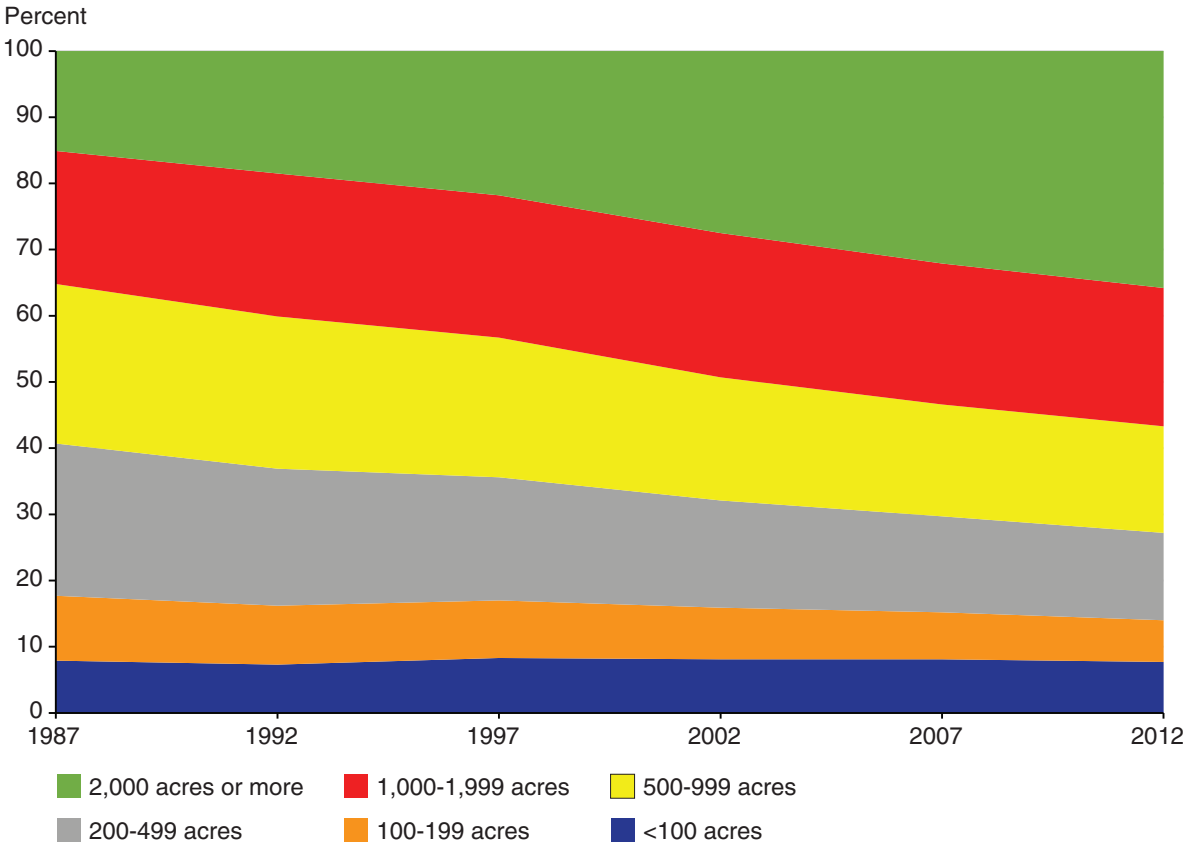
Consolidation in Land and Livestock

Land and livestock shifted toward larger farms from the 1930s through the 1970s (Gardner, 2002; Hart, 2003). The nature of consolidation has since become more complicated, although some clear patterns stand out. We use census data to track consolidation since the 1980s, taking account of heterogeneity in land use and quality by reporting on narrowly defined commodities and by distinguishing farmland according to use.[13]

Farmland Consolidation

Cropland has shifted toward larger farms since the early 1980s. However, the other major component of farmland—permanent pasture and rangeland—has shifted to smaller farms, thus complicating the overall story for land.[14] Specifically, farms with at least 2,000 acres of cropland accounted for 36 percent of U.S. cropland in 2012, up from 15 percent in 1987, while the share held by midsized farms, with 100-999 acres, fell by 21 percentage points (figure 11). In contrast, the share of U.S. pasture and rangeland operated by the largest farms and ranches (at least 10,000 acres of such land) fell by 7 percentage points between 1987 and 2012 (figure 12). Twenty-eight million acres shifted to farms operating less than 500 acres.

Figure 11
Shifts in cropland among acreage size classes, 1987-2012
Cropland shifted to farms with at least 2,000 acres of cropland



Source: USDA, Economic Research Service, compiled from census of agriculture data.

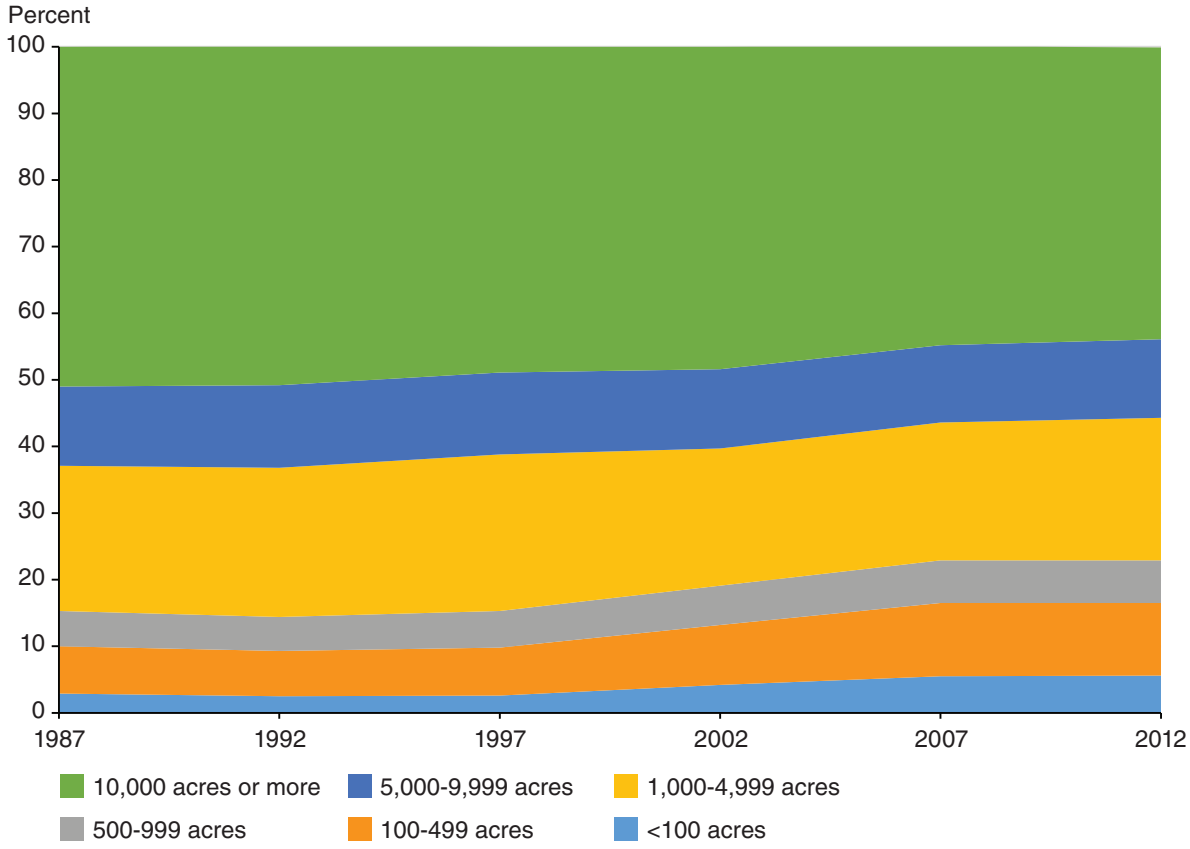
[13]Changes in census of agriculture methodology, introduced in 1997, also affect these comparisons. See appendix A.

[14]Cropland accounted for 43 percent of all farmland in the 2012 Census of Agriculture, while pasture and rangeland accounted for 45 percent. Other uses include farmland in forests; farmland used for roads, ponds, and farmsteads; and other miscellaneous uses.

Figure 12

Shifts of pasture and rangeland among size classes, 1987-2012

Pasture and rangeland shifted to farms with fewer than 500 acres of grazing land



Source: USDA, Economic Research Service, compiled from census of agriculture data.

The pace of consolidation was even greater in harvested cropland than in all cropland (figure 13).[15] There, farms with at least 2,000 acres of harvested cropland, which accounted for 8 percent of all harvested cropland in 1987, held 33 percent by 2012, while the share of farms with 100-499 acres fell from 40 percent to less than 20 percent.

Cropland consolidation followed a complex pattern (table 6). Between 1987 and 2012, the number of farms with cropland fell by 16 percent, while total cropland acreage fell by 13 percent, so mean farm size—measured as cropland acres per farm—rose only from 241 acres in 1987 to 251 acres in 2012. However, that modest change hid some stark developments.

The number of large crop farms (at least 2,000 acres of cropland) nearly doubled, while the number of midsize farms (100-999 acres) nearly halved, in line with the shifts of cropland noted above.

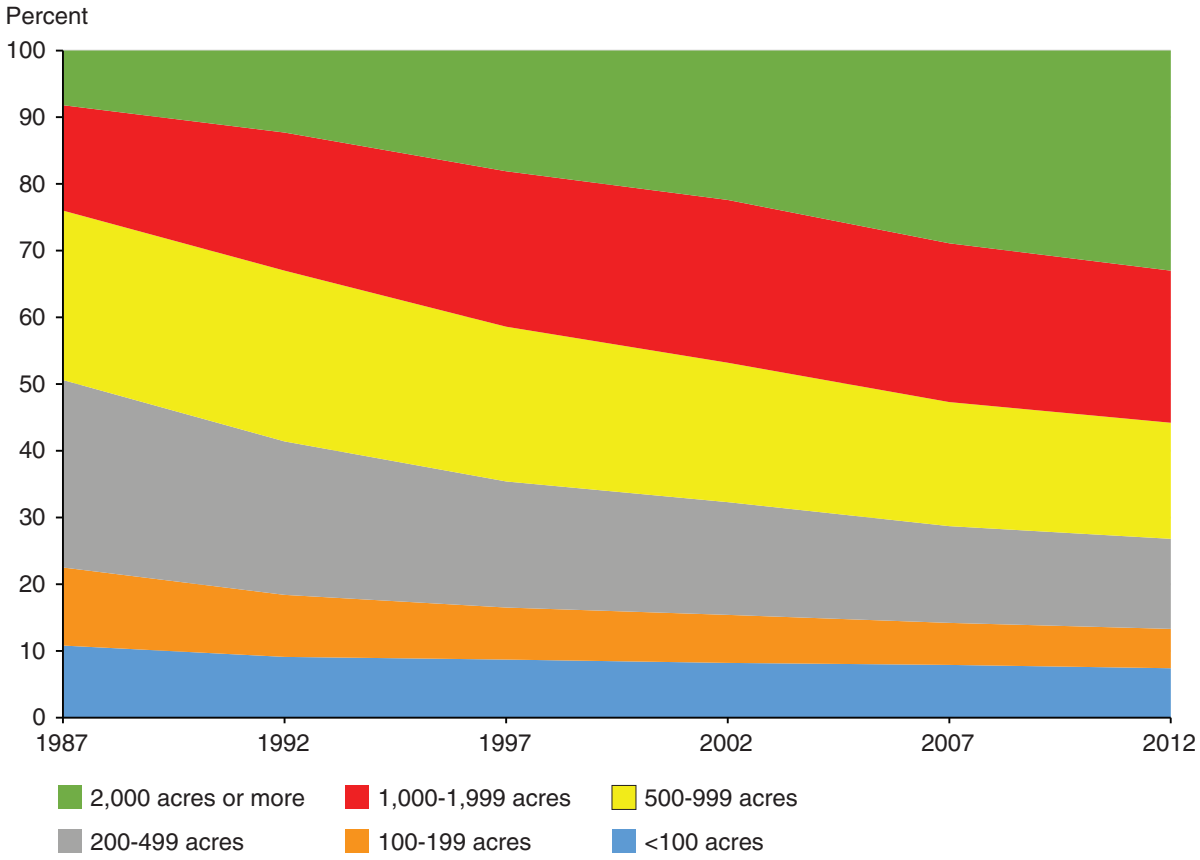
[15]Harvested cropland accounts for about three-quarters of all cropland. It is generally of higher quality, and is more intensively farmed, than cropland used for pasture, left to fallow, or otherwise idled.

Farm numbers actually *rose* among the smallest acreage classes (1-9 and 10-49 acres of cropland), although not by enough to offset the decline in midsize farms.

Figure 13

Shifts of harvested cropland among size classes, 1987-2012

The share of harvested cropland on farms harvesting at least 2,000 acres tripled between 1987 and 2012



Source: USDA, Economic Research Service, compiled from census of agriculture data.

Table 6

U.S. farms, by number of cropland acres operated, 1987 and 2012

Cropland acres operated	1987	2012
	Number of farms	
Any cropland	1,848,574	1,551,654
1-9	186,761	250,394
10-49	486,778	547,273
50-99	302,671	225,321
100-999	785,180	431,300
1,000-1,999	66,546	59,161
≥ 2,000	20,638	38,205
	Number of acres	
Total cropland	445,362,028	389,690,414

Note: Cropland acres operated includes cropland owned and rented, and excludes cropland that is rented out.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

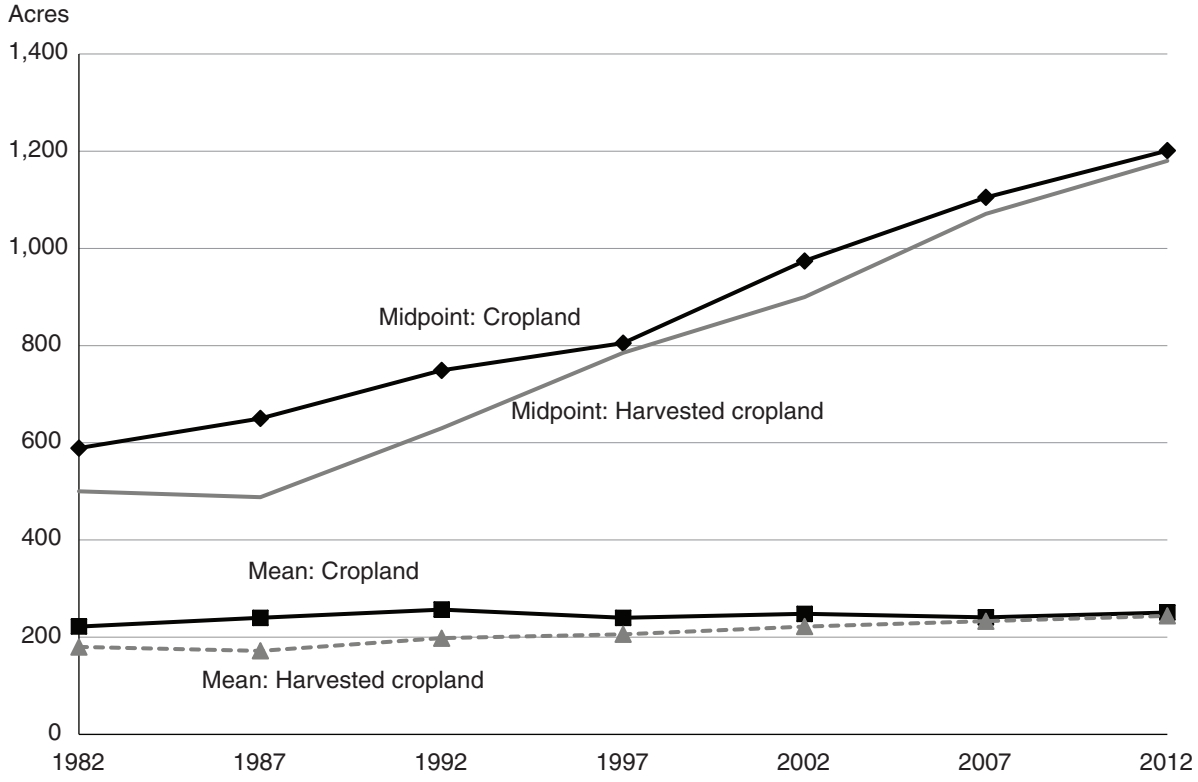
The increasing number of small crop farms may reflect greater opportunities for fruit, vegetable, and horticultural production, which can be done on small acreages. However, the farm definition also matters. The $1,000 sales standard in the farm definition, set in 1974, is not adjusted for inflation. Consequently, as farm prices and the value of a given amount of farm output rise, more places will be defined as farms over time, and will be counted in farm statistics. In addition, changes in census reporting methodology in 2002 led to improved, and higher, counts of farms, especially of small farms, compared to previous methods (see Appendix A).

In contrast to the stability of mean acreage, the cropland midpoint grew steadily, from 589 acres in 1982 to 1,201 acres in 2012 (figure 14). The rising midpoint captures the major shift of cropland to larger operations shown in figures 11 and 13, and stands in sharp contrast to the falling midpoint for pasture and rangeland (figure 15). In 1982, many farms had some pasture/rangeland, usually in small amounts—the median was 58 acres. But most U.S. pasture/range was on very large ranches—the midpoint was 11,185 acres. Most of this acreage was—and still is—in the arid West, and used for livestock grazing, where many acres may be required to support an animal.[16] The pasture/rangeland midpoint fell steadily after 1982, to 6,969 acres in 2012 (a 38-percent decline in 30 years). The simple median has also declined, from 58 acres in 1982 to 33 acres in 2012. The two trends are related, as some large ranches have sold land, often in relatively small plots for vacation and retiree homes, to buyers who may continue to graze some animals.

Figure 14

Increasing midpoint acreages for cropland, 1982-2012

Midpoint acreages for cropland and harvested cropland roughly doubled between 1982 and 2012



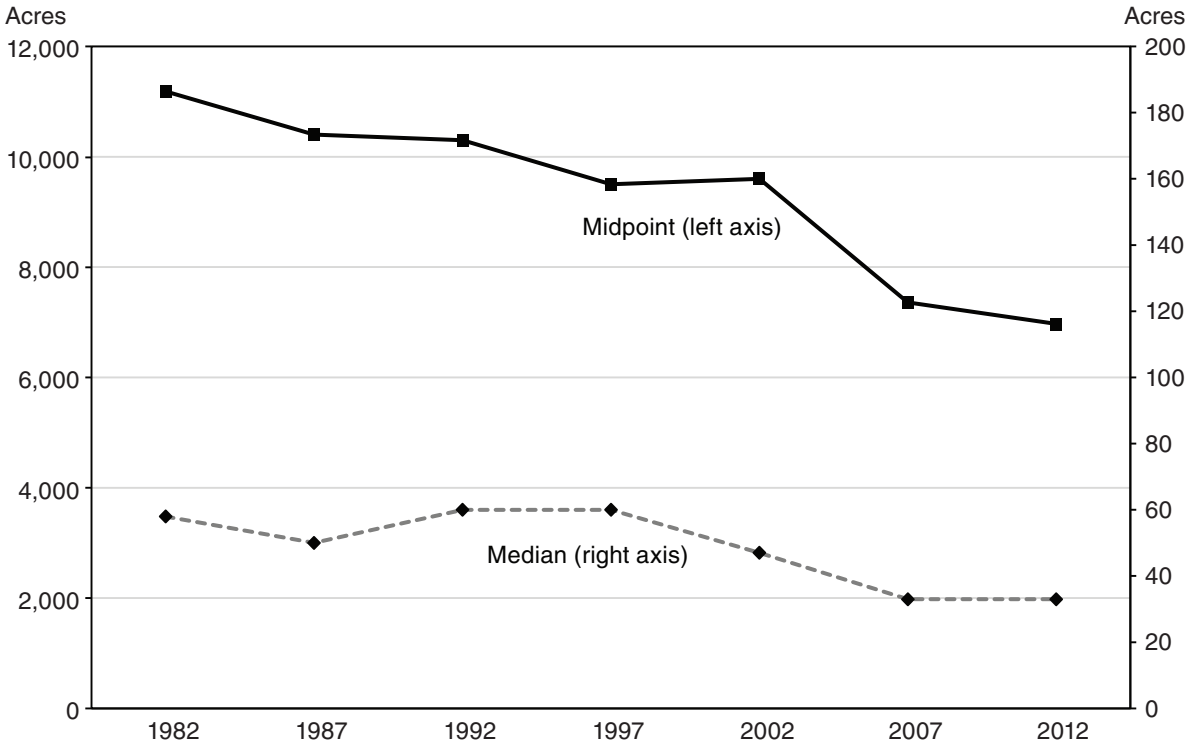
Source: USDA, Economic Research Service, compiled from census of agriculture data.

[16]Nine Western States (Arizona, Colorado, Montana, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming) encompass most U.S. pasture and rangeland—300 million acres, or 70 percent of the total. Those same States hold 101 million acres (26 percent) of cropland.

Figure 15

Shrinking average farm sizes in pasture and rangeland, 1982-2012

The midpoint acreage for pasture and rangeland fell by 4,200 acres between 1982 and 2012



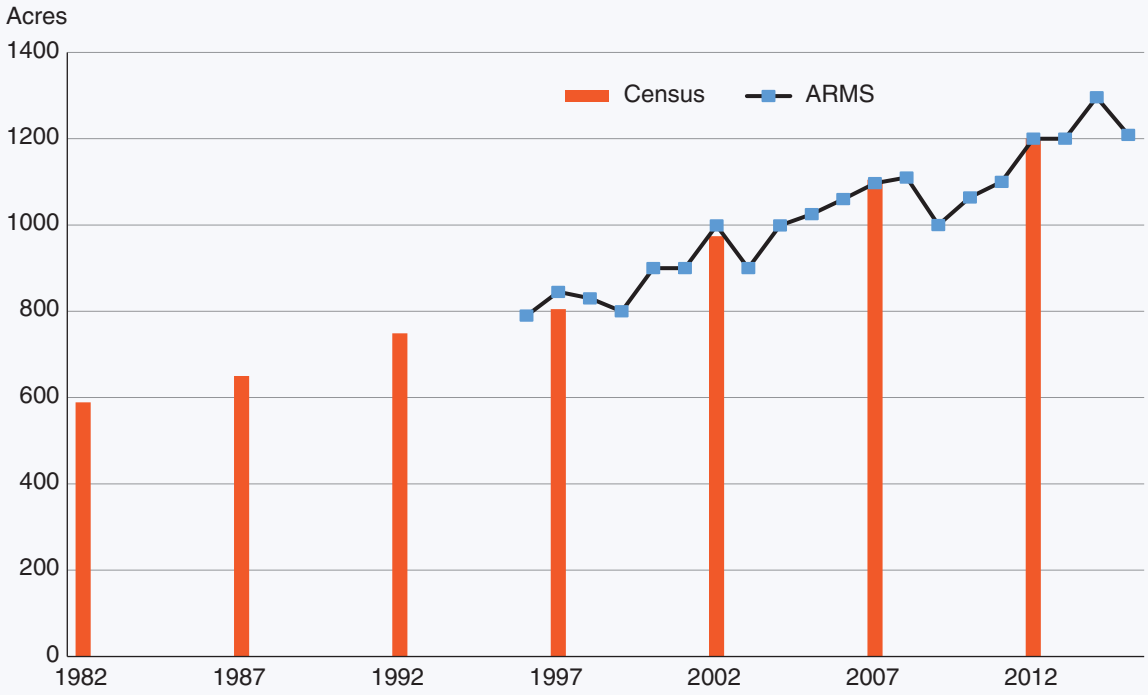
Source: USDA, Economic Research Service, compiled from census of agriculture data.

The cropland series shows some evidence of slowing consolidation after 2007. The midpoint increased by about 9 percent in 2007-12, from 1,105 acres to 1,201, which is the second smallest percentage increase of the 6 intercensus periods displayed in figure 14. In addition, a cropland midpoint based on USDA's Agricultural Resource Management Survey (ARMS) shows some further slackening in 2012-15 (see box, "Tracking Cropland Consolidation in Census and ARMS").

Tracking Cropland Consolidation in Census and ARMS

The trends in figure 14 are derived from census of agriculture data, and extend from 1982 through 2012, the last census year in our report. The ARMS can be used to provide annual estimates of cropland midpoints from 1996 through 2015 (see figure).

Midpoint values for cropland acres, 1982-2015
ARMS estimates of the midpoint track those from the census



Source: USDA, Economic Research Service, compiled from census of agriculture data, and USDA, National Agricultural Statistics Service and Economic Research Service, 1996-2015 Agricultural Resource Management Survey.

The two sources show very similar trends: 2.4-percent annual growth (ARMS) and 2.7 percent (census). The 2015 ARMS estimate matches that for 2012, suggesting that consolidation abated in 2012-15. However, the ARMS-based estimates also show the year-to-year variation that one would associate with sample variation. While the ARMS estimates closely track census trends, the ARMS-based estimate of no net change in the cropland midpoint between 2012 and 2015 is merely suggestive, not definitive.

Geography: Cropland Consolidation in the States

Cropland consolidation was ubiquitous and persistent across the States. We calculated cropland midpoints for each of the 50 States for 7 census years: 1982, 1987, 1992, 1997, 2002, 2007, and 2012 (for midpoints for each year and State, see Appendix B, table B-1).

State midpoint values vary widely, from 2,000-3,000 acres in North Dakota and Montana to around 1,200 acres in Indiana and Illinois to 300 acres in Vermont and Virginia (all for 2012). Between 1982 and 2012, cropland midpoints fell in just four States (Connecticut, Massachusetts, West Virginia, and Hawaii), while they rose by less than 10 percent in three others (Nevada, New Hampshire, and Rhode Island). Those seven States collectively accounted for just 0.36 percent of U.S. cropland in 2012. Consolidation proceeded rapidly in more agricultural States and was particularly pronounced in major field crop regions such as the Corn Belt, the Great Plains, and the Mississippi Delta, where midpoints increased by 123 percent, on average, from 1982 to 2012.[17] Cropland consolidation proceeds more rapidly in regions with dense agglomerations of cropland in large, flat, contiguous fields (MacDonald, et al., 2013).

Consolidation was persistent: midpoint farm sizes increased in every intercensus period in 24 States that together accounted for nearly 77 percent of all U.S. cropland—Corn Belt, Delta, and Northern Plains States with dense concentrations of production (appendix table B-1). Thirteen other States, encompassing 20 percent of U.S. cropland, experienced increased midpoints in 5 of 6 intercensus periods; these States include California, Texas, Oklahoma, and major southeastern and eastern States with field crop and fruit/vegetable production.

Consolidation in Specific Crops

Consolidation also appears to be ubiquitous across crops. We calculated harvested acreage midpoints for 55 different crops—15 field crops, 20 vegetable/melon crops, and 20 fruit, tree nut, and berry crops—for census years from 1987 to 2012.[18]

We first track midpoints for five major field crops: corn, cotton, rice, soybeans, and wheat (figure 16). For each, the 2012 value is more than twice as large as the 1987 value. The increases are also persistent: each crop shows an increase in every 5-year intercensus period, except for cotton in 2007-12.

We expand coverage to 10 more field crops in figure 17: alfalfa, barley, canola, dry edible beans, dry edible peas, peanuts, sorghum (for grain), sugarbeets, sunflowers, and tobacco. We report end values (1987 and 2012); other years are in appendix table B-2. Consolidation is also clear here: midpoints more than doubled for 9 of 10 crops (except alfalfa). The increases were persistent: seven of the ten crops showed increases in every intercensus period, and two others showed increases in four of five intercensus periods. Across all 15 field crops, the median increase in midpoint acreage was 148 percent over 1987-2012, while the mean was 206 percent.

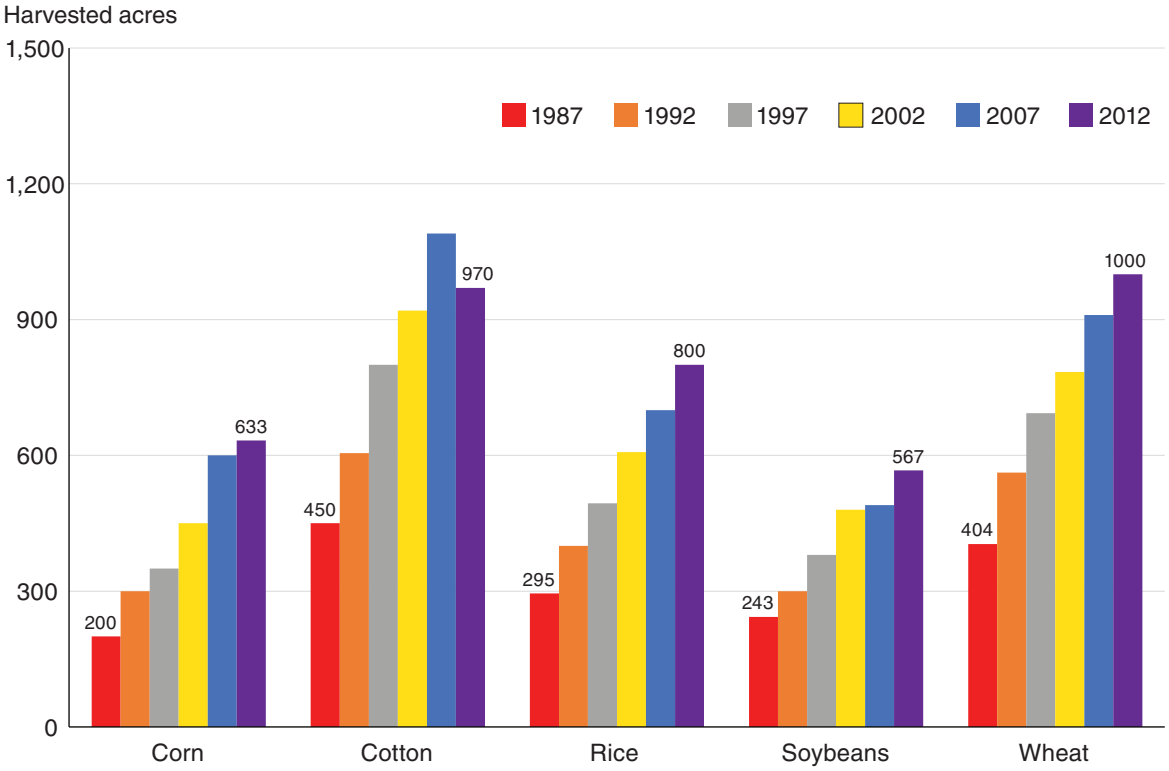
[17]The Corn Belt includes IA, IL, IN, MI, MN, MO, OH, and WI; the Great Plains include KS, NE, ND, OK, SD, and TX; and the Delta States include AR, LA, and MS.

[18]The census of agriculture reports harvested acreage for specific crops, with more crops in 1987 than in 1982, so we start with 1987.

Figure 16

Midpoint acreage for major field crops, 1987-2012

Midpoint acreages more than doubled for all five major field crops

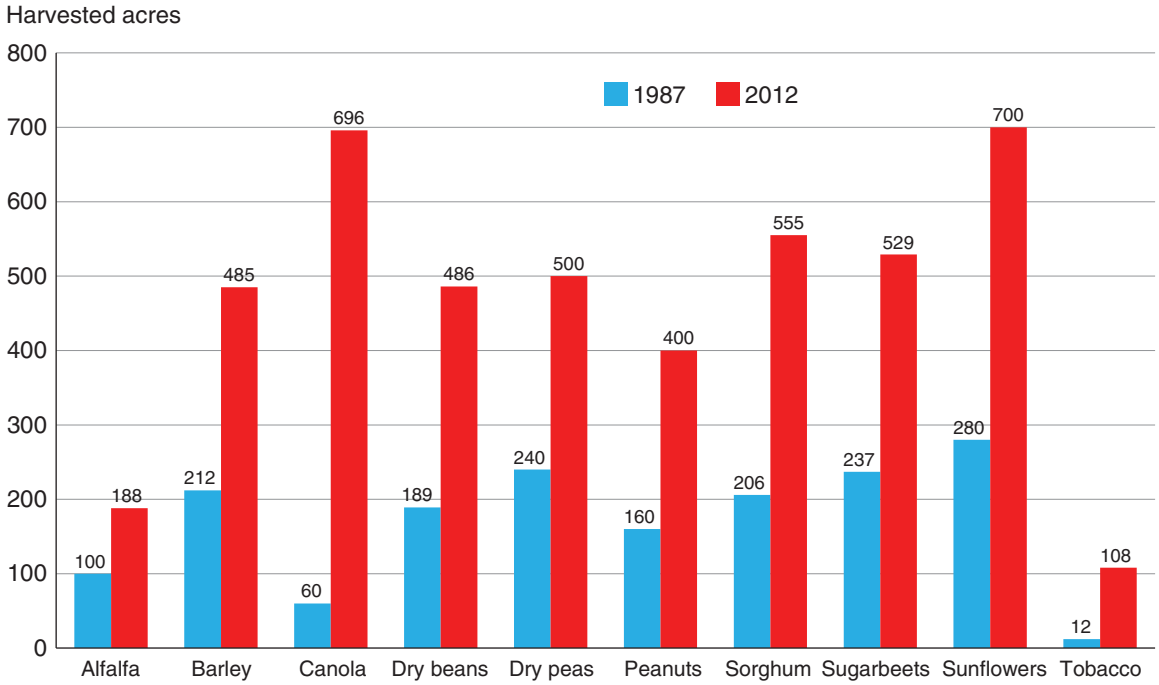


Note: Half of all harvested acres are on farms that harvest more than the midpoint, and half are on farms that harvest less.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

Figure 17

Midpoint acreage for minor field crops, 1987 and 2012

Except for alfalfa, midpoint acreages for the minor field crops also more than doubled



Note: Half of all harvested acreage are on farms that are at least the midpoint size, and half are on farms that are no larger.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

In table 7, we report midpoint acreages for 20 fruit, nut, and berry crops; to save space, we provide midpoints for 1987 and 2012 in order to show longrun trends, and we also report 2007 estimates in order to highlight recent movements (data for all census years are reported in appendix table B-3). Midpoint values vary widely across crops, from 50 acres for avocadoes in 2012 to 240 acres for walnuts to 961 acres for oranges. Midpoints increased for 19 of the 20 crops (all except lemons) between 1987 and 2012; the median increase was 110 percent while the mean was 153 percent.

Table 7
Land consolidation in fruits, nuts, and berries, 1987-2012

Crop	Midpoints: Harvested acreage			Change (percent)	
	1987	2007	2012	1987-2012	2007-2012
Noncitrus fruits					
Apples	83	146	179	116	23
Avocadoes	40	40	50	25	25
Cherries, Sweet	32	65	80	150	23
Cherries, Tart	65	150	175	169	17
Grapes	205	320	420	105	31
Nectarines	70	186	239	241	28
Peaches	92	120	130	41	8
Pears	50	75	76	52	1
Plums/prunes	179	160	300	68	88
Citrus fruits					
Grapefruit	320	556	573	79	3
Lemons	176	176	147	-16	-16
Oranges	450	1113	961	114	-14
Tangerines	55	154	336	511	118
Tree nuts					
Almonds	203	450	547	169	22
Pecans	102	117	272	167	132
Pistachios	465	627	926	99	48
Walnuts	85	172	240	182	40
Berries					
Blueberries	50	75	100	100	33
Cranberries	90	99	120	33	21
Strawberries	24	120	180	650	50

Note: Bearing acreage for fruits and nuts; harvested acreage for berries.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

Between 1987 and 2012, midpoint acreages increased for 19 of the 20 vegetable and melon crops in census records (table 8), with cantaloupes being the exception. (Data for all census years appear in appendix table B-4.) As in other categories, midpoints cover a wide range, from 40 acres for pumpkins in 2012 to 300 acres for sweet corn and cabbage and 1,275 acres for lettuce. The average increase over 1987-2012 was also large: the median increase was 139 percent while the mean was 146 percent.

Vegetable and melon crops demonstrate a clear slowing of consolidation in 2007-12. Midpoints declined for 6 of the 20 crops, while the mean 2007-12 increase was just 10 percent, compared to an average of 20 percent per intercensus period over the whole of 1987-2012. Consolidation in field crops also slowed in 2007-12, to 13 percent on average, from 25 percent across all 1987-2012 intercensus periods. One crop (cotton) showed a midpoint decline in 2007-12, while five others—including corn—clearly slowed the pace of midpoint increase. Fruit, tree nut, and berry crops generally do not show a slowing of consolidation in 2007-12.

Consolidation in crop production was widespread over 1987-2012, with 53 of 55 crops showing increases in acreage midpoints, and the increases were substantial, with 40 of the 55 crops at least doubling midpoint values. Consolidation was also persistent, in that midpoints increased in most 5-year census periods. Consolidation appears to have slowed after 2007, as the annualized growth in midpoints fell for field crops and for vegetable/melon crops.

Table 8
Land consolidation in vegetables and melons, 1987-2012

Crop	Midpoints: Harvested acreage			Change (percent)	
	1987	2007	2012	1987-2012	2007-2012
Vegetables					
Asparagus	160	240	200	25	-17
Beans, Snap	221	323	318	44	-2
Broccoli	440	1,000	1,050	139	5
Cabbage	113	300	300	165	0
Carrots	350	600	1,053	201	76
Cauliflower	240	400	425	77	6
Cucumbers	115	505	450	291	-11
Lettuce, all	949	1,815	1,275	34	-30
Onions, Dry	115	320	348	203	9
Peas	100	179	198	98	11
Peppers, Bell	88	300	210	139	-30
Potatoes	350	990	1,054	201	6
Pumpkins	20	30	40	100	33
Spinach	162	423	687	324	62
Squash	35	72	75	114	4
Sweet corn	100	250	300	200	20
Sweet potatoes	140	474	560	300	18
Tomatoes	400	820	930	133	13
Melons					
Cantaloupe	400	388	350	-12	-10
Watermelons	80	150	200	150	33

Source: USDA, Economic Research Service, compiled from census of agriculture data.

Consolidation in Livestock

Livestock production has consolidated since the 1980s, in some cases dramatically, with one important exception—beef cow-calf operations. The patterns differ from those observed in crop production in several ways: consolidation, as measured by the growth in midpoints, has been greater in livestock; it has occurred in discrete major episodes, rather than unfolding steadily through time; and it has often encompassed major changes in industry organization.

As in crop production, the skewed distribution of livestock operations—many very small operations managing just a few animals, with production concentrated in a relatively few large farms—creates challenges for measuring trends in farm size. Because we are interested in trends in the consolidation of livestock production, we use census of agriculture records to track changes in midpoints over time. We track seven livestock commodities. For three of them—beef cows, egg layers, and milk cows—we track end-of-year inventories (herd and flock sizes). We track annual sales and removals for broilers, fed cattle, hogs and pigs, and turkeys.[19] See appendix table B-5 for livestock midpoints for all census years between 1987 and 2012.

Midpoints increased for each commodity over 1987-2012, but the rate of increase varies widely, with dramatic long-term changes in egg, hog, and dairy production (table 9). The midpoint flock size in egg layers increased to 925,975 birds in 2012 from 117,839 in 1987 (and just over 62,000 in 1982); the midpoint for hog removals rose to 40,000 in 2012 from 1,200 in 1987; and the midpoint dairy cow herd rose to 900 cows in 2012 from 80 in 1987. The broiler and fed cattle industries show continued consolidation, with 2012 midpoints a bit more than double their values in 1987. However, each underwent striking changes in organization and technology well before the series starts in 1987 (MacDonald and McBride, 2009).

Table 9
Consolidation in livestock sectors, 1987-2012

Commodity	1987	1997	2007	2012	Change (percent)	
					1987-2012	2007-2012
Sales midpoint: Number of head sold or removed						
Broilers	300,000	480,000	681,600	680,000	127	-0.1
Fed cattle	17,532	38,000	35,000	38,369	119	10
Hogs and pigs	1,200	11,000	30,000	40,000	3,233	33
Turkeys	120,000	137,246	157,000	160,000	33	2
Inventory midpoint: Number of head in herd/flock						
Beef cows	89	100	110	110	24	0
Egg layers	117,839	300,000	872,500	925,975	686	6
Milk cows	80	140	570	900	1,025	58

Source: USDA, Economic Research Service, compiled from census of agriculture data.

[19]Dairy farms, egg production enterprises, and cow-calf enterprises all produce products—milk, eggs, and calves—from herds or flocks onsite, so inventories are an effective basis for measuring size. In the other sectors, young animals are often placed on site to be raised under contract by the farm, and are then removed at the end of a production stage. Some of those operations may have no animals onsite at the end of the year, so annual "sales and removals" is a better basis for measuring size than inventories.

The contrast in consolidation between dairy and beef cow-calf operations is particularly striking.[20] Cow-calf enterprises are widespread: in 1987, 841,778 farms had beef cows. The midpoint cow-calf operation had a herd of 89 cows in that year, a bit larger than the midpoint milk cow herd. While the midpoint dairy herd grew over 1,000 percent from 1987 to 2012, the midpoint beef cow herd grew only marginally, to 110 cows, and 727,906 farms still had beef cows. Because cow-calf operations graze their animals, and often need a large land area to do so, they are a primary user of permanent pasture and rangeland in the United States. Recall that land consolidation is concentrated in cropland; consolidation in pasture and rangeland is less evident.

Overall, consolidation appears to have slowed in 2007-12. While midpoints for milk cows and hogs/pigs continued to grow sharply in absolute and percentage terms, their annual rate of growth slowed compared to the full 1987-2012 period. Midpoints for the other five commodities leveled. Average annual midpoint growth for the seven livestock sectors fell to 3.3 percent over 2007-12 from 6.3 percent over the 1987-2007 period.[21]

Consolidation and Farm Specialization

While production shifted to larger crop and livestock enterprises, many farms also became more specialized. They reorganized to focus on either livestock or crop production, and on a more limited set of crops, livestock species, or livestock production stages. Specialization can allow farmers to expand in the commodities that they continue to produce as they develop more specialized skills and acquire more specialized capital equipment.

Specialization affects our understanding of consolidation. An increase in harvested acreage for any given crop could reflect increased farm size, with a farm harvesting more acres of all its crops, or it could reflect increased specialization as the farm concentrates existing acreage on greater production of fewer crops. Recent commodity consolidation reflects each.

We summarize recent developments in commodity specialization from 1996 to 2015, the initial and most recent years of data drawn from ARMS. We first report on specialization for selected field crops, and defined according to the share of a crop's production carried out on farms that also produce (a) livestock, and (b) crops other than the reference crop (table 10).

Field crop farms were considerably less likely to produce livestock in 2015 than in 1996. For example, 46 percent of corn production was carried out on farms that also produced livestock in 1996; by 2015, just 33 percent of corn production was on farms that also produced livestock. Among other major and minor field crops, only potatoes saw increased linkages with livestock—all other crops listed saw declines, many of them sharp, in associated livestock production. That decline reflects the shift of hog production to specialized hog facilities that rely on purchased feed, but it also reflects declines in cattle and dairy production on field crop farms. Across all crops, including specialty as well as field crops, 22 percent of the value of production occurred on farms that also had livestock production in 2015, down from 33 percent in 1996.

[20]Beef production occurs in three stages: calves are born on cow-calf operations; after weaning, they may be moved to stocking/backgrounding operations where they may receive some grain rations but are still largely grazed; finally, they move to cattle feedlots where they are confined in pens with other feeder cattle and fed a grain-based ration until ready for slaughter.

[21]This calculation is based on the weighted average of commodity growth weights, with weights equal to each commodity's 2012 value of cash receipts.

Table 10
Diversification in U.S. crop production, 1996 and 2015

Crop category	Year	Share (%) of value of crop production originating on farms with: 1 crop	2 crops	3 crops	4 crops	>4 crops	Livestock
All crops							
	1996	23	23	25	16	13	33
	2015	28	32	21	11	8	22
Major field crops							
Corn	1996	4	33	36	19	8	46
	2015	4	53	28	10	5	33
Cotton	1996	14	22	25	16	23	23
	2015	17	28	28	16	11	17
Hay	1996	27	27	18	17	11	58
	2015	45	17	18	14	6	33
Rice	1996	12	25	41	16	6	9
	2015	24	43	20	17	3	2
Soybeans	1996	3	32	37	20	8	42
	2015	4	50	29	12	5	31
Wheat	1996	7	15	33	25	20	47
	2015	14	19	28	22	17	36
Minor field crops							
Barley	1996	0	17	34	21	28	48
	2015	0	15	10	19	56	22
Canola	1996	0	0	21	23	56	45
	2015	0	6	19	21	54	25
Oats	1996	0	19	24	36	21	60
	2015	1	14	22	30	33	54
Peanuts	1996	4	10	26	11	49	57
	2015	3	35	27	14	21	28
Potatoes	1996	0	20	20	20	40	12
	2015	9	11	19	27	34	27
Sorghum	1996	5	18	37	23	17	55
	2015	2	19	50	16	13	28
Tobacco	1996	22	21	28	16	10	45
	2015	7	24	28	22	22	42

Notes: “Crops” are the 21 categories specified in the ARMS Phase III questionnaire, section B: barley; canola; corn (grain and silage combined); cotton; beans, peas, and lentils (combined); fruits, nuts, and berries (combined); hay (alfalfa and all other combined); nursery and greenhouse crops; oats; peanuts; potatoes; rice; sorghum (grain and silage combined); soybeans; sugar beets; sugar cane; tobacco; vegetables and melons (combined); wheat; other oilseeds; and all other crops (combined).
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 1996 and 2015 Agricultural Resource Management Survey..

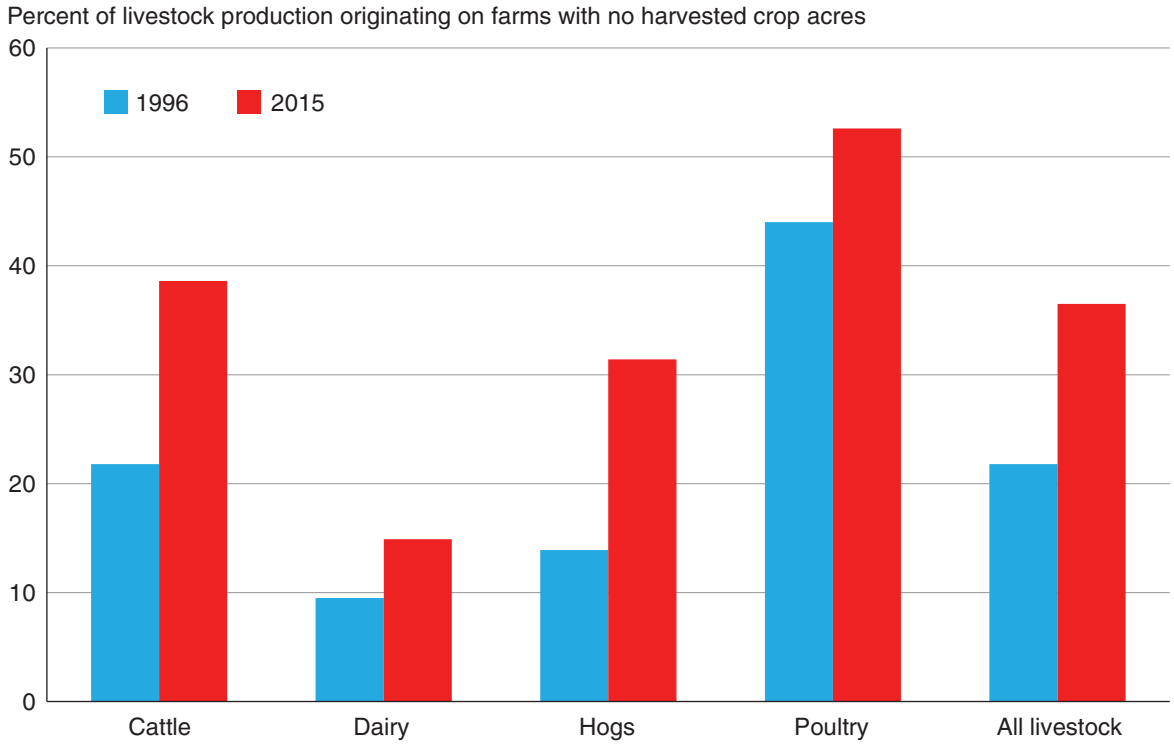
Farms also shifted toward greater crop specialization.[22] Few farms produce only a single crop, but a growing number focus on just two (think of corn and soybeans, on farms that previously also produced wheat). We sorted the value of production for a crop according to the number of other crops grown on farms that produce the reference crop. In 2015, 57 percent of corn production occurred on farms that produced no more than two crops, compared to 37 percent in 1996. A similar pattern occurs, not surprisingly, in soybeans, but increased specialization also appears in cotton, hay, peanuts, rice, and wheat, as field crop farms shifted away from three, four, and five crops to one, two and three. Consolidation, as measured by growing crop midpoints, followed from greater specialization as well as increasing farm size.

Livestock also shows increased specialization (figure 18). Thirty-seven percent of all livestock (measured by the value of production) were produced on farms that had no crop production in 2015, up from 22 percent in 1996. Specialization grew in each major livestock commodity in 1996-2015, and is highest in poultry, where over 52 percent of 2015 production occurred on farms with no crop production. Poultry manure is lighter than other manure and easier to transport, which makes it more likely that a contract poultry operation could dispose of all its manure off the farm, further discouraging the growth of onfarm crops. Specialization also increased sharply in hog production, where 31 percent of production occurred on farms with no crops in 2015, up from 14 percent in 1996.

Figure 18

Increasing specialization in livestock production, 1996 and 2015

Larger shares of livestock producers grow no crops



Note: We use the value of commodity production, in dollars.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 1996 and 2015 Agricultural Resource Management Survey.

[22]ARMS reports harvested acres and production value by crop for 21 crop classes, including aggregates of all vegetable crops and all fruit crops. The survey is therefore not very useful for assessing diversification within vegetables or fruits. The classification provides reasonable detail for field crops—separately identifying barley, canola, corn, cotton, hay, oats, peanuts, potatoes, rice, sorghum, soybeans, and wheat.

Drivers of Crop and Livestock Consolidation

Consolidation occurred widely in agriculture over 1987-2012. The common patterns suggest that there are likely to be common factors driving change. Agricultural policy, through commodity and crop insurance programs, focuses heavily on field crops, and much research has examined whether commodity and crop insurance programs have led to larger farms. However, policy cannot completely explain consolidation, since widespread and persistent consolidation has occurred in almost all commodities, not just in those that are the focus of commodity and crop insurance programs.

In our earlier report (MacDonald et al., 2013), we argued that technology played a major role. Specifically, the equipment used in field tasks—for ground preparation, planting, spraying, and harvesting—has gotten steadily larger and faster, allowing a single farmer or farm family to manage more acres. Other innovations in field practices—for example, the widespread adoption of no-till techniques, partly tied to the adoption of herbicide-tolerant seeds—reduces the time spent by farmers on field tasks, thus increasing the amount of land that they can manage. In recent years, the technologies encompassed by precision agriculture—GPS-assisted vehicle guidance systems, yield and soil mapping, and variable-rate applications of inputs—appear to have spurred further increases in farm size.[23] Vehicle guidance systems allow field operators to manage more acres with less physical and mental stress. The equipment supporting precision agriculture carries substantial fixed costs and is far more likely to be adopted on larger farms (Schimmelpfennig, 2016).

Our discussion emphasizes labor-saving technologies that allow a single farmer or farm family to manage more acres or animals. However, as Sumner (2014) emphasizes, some of these same technologies may allow highly capable farm operators/managers to expand and operate larger businesses and to use their workforces to farm more acres or manage more animals.

In livestock, the continued development of confinement feeding practices has been an important driver of consolidation (Allen and Lueck, 2002). Producers moved poultry and hog production into climate-controlled housing, and then steadily improved their disease control, reproduction, nutrition/feeding, and transportation technologies to realize substantial improvements in productivity (MacDonald, 2014; McBride and Key, 2013). Climates are not as tightly controlled in dairy production, where cows are kept in open-sided barns, or in cattle feeding, where the cattle are sorted into pens, but those sectors have also realized gains from sorting animals by attributes, some degree of climate control, and continued improvements in the related practices noted above.

These technological developments, which greatly regularized livestock production, allowed farmers to manage larger herds and flocks. But some of the technologies important in confinement feeding are also subject to important economies of scale, leading to lower per-unit production costs among larger operations and further encouraging consolidation.[24] Moreover, many of the practices are replicable across farms, leading to the widespread use of integrated and routinized operations, particularly in poultry and hogs, where single firms operate many farms or control flows of animals across a network of farms connected through contracts.

[23]GPS stands for Global Positioning Systems.

[24]See, for example, MacDonald and Wang (2011), for broiler grow-out; Mosheim and Lovell (2009), for dairy; and McBride and Key (2013) for hog finishing.

Technologies have led to increased farm size and greater consolidation. However, that does not have to be the case. Consider the further extension of precision agriculture to robotics: with the rapid improvement and diffusion of GPS guidance, driverless tractors and other field equipment are being tested and introduced. Without a driver, the design criteria for equipment changes radically, to much smaller and lighter pieces of equipment (Lowenberg-DeBoer, 2015). Instead of large and expensive sprayers, seeders, and combines in single units, farms would deploy many much smaller robotic units. Autonomous robots appear to be a constant-returns-to-scale technology; since larger farms would simply purchase and use more robots, they would not have lower per-acre costs than smaller farms.

An emerging example appears in dairy production, where one source of large-farm cost advantages lies in current milking systems: a single large rotary milking parlor with a crew of 4-5 workers can handle 2,500 to 3,000 cows 3 times a day, and realize significant unit cost advantages over smaller farms. Smaller operations are, however, starting to adopt robotic milking machines, which free labor (usually family labor on smaller farms) to work on herd management and crop production. A single robot serves about 70 cows, and larger farms simply add more machines. Thus, robotic milkers appear to be "constant returns" technologies, beyond 70 cows, and therefore can reduce per-unit costs more on small than on large farms, thus favoring smaller operations. More broadly, robotic systems may enhance farm productivity in the future without providing substantial scale advantages to larger farms.

Farm Organization

Large farms use a different mix of business organizations than small farms. Most are still family farms, even as agriculture consolidates, although a larger share of large farm operations are nonfamily businesses. Some are connected to other farms through common ownership, while others are connected to larger organizations through contractual relationships.

Legal and Family Status of Farms

Most U.S. farms are organized as sole proprietorships, which are preponderant among small farms (table 11). The second most common type of legal organization is a partnership, and that is the single most common type among very large farms, accounting for nearly 41 percent of farms with at least $5 million in sales. Corporations account for nearly 4 percent of all farms, and about one-fourth of farms in large and very large sales classes.

Table 11
Legal and family status of U.S. farms, 2015

Item	Gross cash farm income				All farms
	<$350,000	$350,000-$999,999	$1,000,000-$4,999,999	$5 million or more	
	Number of farms				
Total farms	1,863,442	130,578	57,880	7,373	2,059,272
	Percent of group				
Farms by organization:					
Sole proprietorship	91.0	73.7	52.0	30.0	88.6
Legal partnership	5.5	11.2	23.3	40.9	6.5
C-corporation	0.7	5.5	9.5	13.4	1.3
S-corporation	1.6	8.9	14.0	13.8	2.5
Other	1.1	0.7	1.2	2.0	1.1
LLC					
Share of farms	4.6	12.2	21.0	39.0	5.6
Share of production	9.9	14.8	25.1	34.5	20.9
Family farms					
Share of farms	99.1	96.7	92.0	78.0	98.7
Share of production	97.9	94.3	90.7	73.0	89.4

Notes: Legal partnerships include only partnerships registered under State law. A C-corporation is legally separate and distinct from its owners, shareholders, or stockholders, and is formed by filing articles of incorporation. An S-corporation or small business corporation provides the benefits of incorporation while being taxed like a partnership or sole proprietorship. "Other" forms of legal organization include estates, trusts, cooperatives, and grazing associations. LLCs are limited liability companies, and assume any of the legal organizations noted above for tax purposes. Family farms are farms where the majority of the business is owned by the principal operator and people related to the principal operator.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

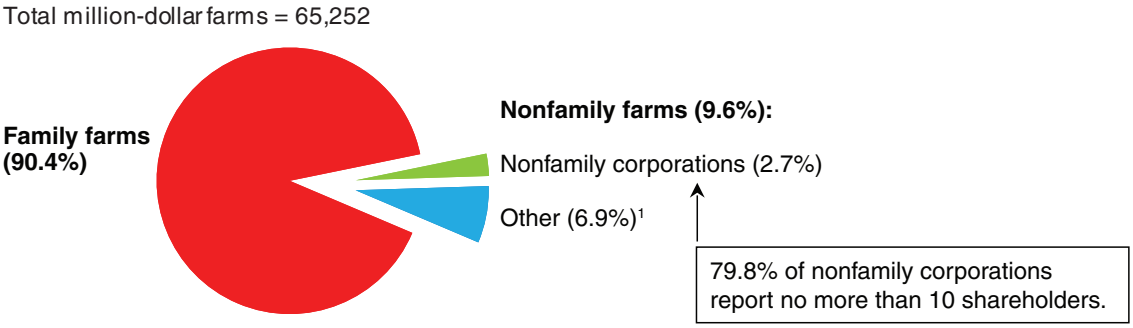
However, legal status does not reflect family ownership or operation; families can organize their farming business as a corporation—for legal, tax, and management purposes—or in other forms. ERS defines family farms independently of their legal status: on a family farm, the principal operator—and people related to the principal operator by blood, adoption, or marriage—owns more than half the assets of the farm business (or the shares of the corporation). That is, the family that makes day-to-day farm operating decisions also controls the farm through ownership.

Family farms, so defined, constitute nearly 99 percent of all farms and contribute over 89 percent of all farm production (table 11). The importance of family businesses remains a distinctive feature of agriculture, even among the largest farms. Nonfamily farms account for only 9.6 percent of farms with $1 million or more in GCFI in 2015 (figure 19). That is little changed since the first ARMS survey in 1996, when nonfamily farms were 9.8 percent of farms with $1 million or more in sales in (2015 dollars).

Many nonfamily farms with sales that high are partnerships or closely held corporations owned and operated by a small group of unrelated people. Others are operated by hired managers on behalf of an unrelated absentee owner (sometimes a family that owns but does not operate multiple farms). About 28 percent of large nonfamily farms are organized as corporations, but 80 percent of those are closely held, with no more than 10 shareholders. Large public corporations have, on the whole, a minor direct presence in U.S. farm production.

Some widely held corporations do operate very large farms, although they tend to have a larger impact on agriculture through their contractual relationships with independent farms (usually family farms). Similarly, some close partner groups—unrelated to one another and organized as partnerships or corporations—may operate multiple farms and contract with others. Finally, some families may own multiple farms operated by hired managers (that is, nonfamily farms) and they may contract with others.

Figure 19
Organization of farms with GCFI of $1,000,000 or more, 2015
Most million-dollar farms are family farms



GCFI = Gross cash farm income.
1Farms other than nonfamily corporations where the principal operator and individuals related to the operator do not own a majority of the farm. For example, farms equally owned by two unrelated business partners, as well as farms operated by a hired manager for a family of absentee owners.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2015 Agricultural Resource Management Survey.

Firms That Operate Multiple Farms

Census and ARMS data focus on individual farms, and do not link across farms that share common ownership. However, businesses that operate multiple farms play an important role in some parts of agriculture. We first describe a number of such firms, drawing on information from company websites, corporate reports, and media articles, with an emphasis on distinguishing several canonical types.[25] We then combine that information with a large private dataset to assess the overall importance of multi-farm firms in U.S. agriculture.

Examples of Firms That Operate Multiple-Farm Businesses

Production to meet commitments to retailers. Black Gold Farms raises 20,000 acres of potatoes, sweet potatoes, and rotation crops on 11 farms in 9 States ranging from North Dakota east to Maryland and south to Texas. The range of locations allows the firm to better meet contractual commitments with retailers by harvesting and delivering fresh products over a longer time period, and by better tying product attributes—which may be specific to a location—to buyer needs. Similarly, Frey Farms raises 15,000 acres of pumpkins, watermelons, cantaloupes, and sweet corn on farms in seven States, much of it to meet contractual commitments with a major retail chain. While there are other large multi-farm potato operations, there are few businesses like this in most field crops, which are still dominated by single-farm businesses.

Produce production, packing, and marketing. Large multiple-farm businesses, with many specific crops, are important in vegetable production. Grimmway Farms operates 58,000 acres in California, Colorado, and Washington, while Growers Express operates 40,000 acres in three States, Duda Farm Fresh Foods operates 39,000 acres in five States, and Tanimura and Antle operates 26,000 acres in three States. Bolthouse Farms, D'Arrigo Brothers, and Ocean Mist all operate 25,000-50,000 acres on multiple farms in California. Many of these businesses got their start by developing fresh products for shipment to retail clients in eastern and midwestern markets, which required innovations in marketing, production, packing, and transportation. The companies continue to develop new products (such as pre-cut vegetables and packaged salad mixes, as well as some processed products such as juices), and they frequently pack and distribute for other growers as well as themselves.

Linking operations across farms in the same business. Davis Family Dairies operates three large dairy farms in Minnesota, with about 8,000 milk cows in total. The farms are managed in an integrated manner under hired managers, with cows moving among farms and births occurring on one. While some other dairy businesses operate in this way, it is unusual. Most dairy farms, even very large ones, operate independently of one another.

Cattle feeding. Cattle feedlots purchase yearling cattle and also provide feeding services for customers who retain ownership. Feedlots purchase and mill feed ingredients, provide veterinary services, and market slaughter-weight cattle to packers. While some cattle are fed in small farmer-feedlots, most are fed in a few hundred large commercial feedlots with professional staff to handle feeding, cattle purchase and marketing, and veterinary services. Firms with multiple feedlots can provide opportunities to staff and can reduce their own risks by sourcing cattle and feed in several

[25]Farm-level records in the ARMS and the census of agriculture are kept confidential; identifying information is stripped from the records made available for ERS analyses, and reports are closely monitored for disclosure of confidential information. All of the companies named in this section have public websites, and we have drawn on those websites—along with media sources and annual reports for public corporations—for all information reported.

regions. Major feeding firms include Cactus Feeders, with 10 feedlots (capacity of 520,000 head); Friona Industries, with 6 feedlots and a capacity of 420,000 head; Five Rivers, with 11 feedlots (980,000 head); Cattle Empire (5 feedlots, 243,000 head); and Oppliger Companies (6 feedlots, 230,000 head). Large feedlot companies are important in cattle feeding but not dominant: these 5 firms have a combined capacity of 2.39 million head, while 9 other firms with multiple feedlots have a combined capacity of 1.06 million head. If they operate at 85 percent of capacity, then these 14 firms would account for just over one-quarter of all U.S. cattle on feed in 2016.

Integrated hog firms. Iowa Select Farms owns 165,000 sows on 42 farms, producing 3.6 million hogs in a year. The firm also owns other farms that produce replacement sows, raise weaned pigs to feeder weight, and raise feeder pigs to market weight. Other integrator firms operate sow farms, like Iowa Select, but contract with independent operations to raise weaned and feeder pigs, and then market the finished hogs to packers, while some large integrators, such as Smithfield Foods or Seaboard, also operate packing plants. Integrators coordinate most hog production, through the operation of sow farms and through contracting for hog finishing, but most production still occurs on independent contract and noncontract farms.

Integrated poultry firms. Tyson Foods owns and operates 62 broiler hatcheries. Chicks from the hatcheries are delivered to broiler grow-out operations that raise the birds to market weight under contract. Tyson provides the contract growers with chicks and feed from Tyson facilities and delivers the finished birds to Tyson processing facilities. Almost all broiler production is coordinated through 20 firms that follow this model, although as with hog production, independent contract growers account for most of the production sold by these integrated businesses.

Egg and turkey production follow somewhat different models, with major firms more likely to own and operate production facilities. For example, Butterball, which accounts for 20 percent of U.S. turkey production, operates its own hatcheries and production facilities. Cal-Maine Foods, the Nation's largest egg producer, operates 44 egg production facilities as well as hatcheries, breeding operations, and processing plants.

Multiple-Farm Firms: Aggregate Data

Firms that operate multiple farms are important in some parts of agriculture, but account for a small part of overall production. We supplement our information on multiple-farm ownership with industry information from the National Establishment Time Series (NETS), a dataset derived from Dun and Bradstreet credit reporting. NETS links the establishments owned by a firm to a common headquarters, and so links the establishments to each other. The file reports the location of each establishment and its industry, using the same coding system (the North American Industry Classification System, or NAICS) used in the census of agriculture. The system assigns farms to one of 49 commodity codes, and also includes estimates of employment and sales for each establishment, although these are often imputed and sometimes of doubtful reliability.[26]

[26]Aggregate employment estimates for NETS farms most closely approximate census estimates of full-time hired labor, and miss much of operator-provided labor. NETS also reports sales estimates, but they are often imputed based on industry averages for sales-to-employment ratios; because agriculture relies heavily on unpaid family labor and purchased custom services (whose labor is not reported in NETS or in USDA sources), actual sales per hour of hired labor varies widely across farms.

The NETS dataset includes about 622,000 farms, far less than the 2.1 million reported in the census of agriculture. However, the overlap between NETS and the census is much stronger for farms with at least $25,000 in sales. The NETS data are derived from credit reports, and farms with less than $25,000 in sales are far less likely to have a credit report. In the 2012 Census of Agriculture, about 670,000 farms had at least $25,000 in sales. NETS coverage works well for our purposes, as it is highly unlikely that the farms we are interested in have sales of less than $25,000.

We identified all farms in NETS: after deleting headquarters establishments with 100 or more employees, we were left with 621,812 farms (table 12).[27] About 0.5 percent of those (3,095 farms) were *subsidiary farms*: they were owned by firms that also owned other establishments, either in agriculture or in other industries. Some subsidiary farms (851) were owned by firms that owned no other farms, but did own establishments in other industries, while another 1,068 farms were owned by 534 firms that owned exactly 2 farms, and may also have owned establishments in other industries. Finally, 212 NETS firms owned 3 or more farms, covering 1,176 farms in total, with an average of 5.5 each. By way of comparison, we estimate that there were 65,252 farms with at least $1 million in sales in 2015, of whom 7,373 had at least $5 million in sales. Many of the subsidiary farms appear to be large operations, according to their NAICS codes and employment, and likely fall into the $5-million-plus range of sales.

The NETS dataset also assigns establishments to NAICS farming codes. Consistent with the narrative above, multiple-farm firms play a very limited role in field crops, dairy, and cattle (cow-calf and stocker) production. They play important roles in vegetables, fruits, and nursery/horticulture (especially in wholesale businesses that sell stock to other nursery and horticulture operations). Multiple-farm firms, including large public corporations, also play a major role in hogs, poultry, and cattle feeding. Contract poultry and hog producers are almost all family operations, but they operate under contracts with integrators, who provide them with feed and young animals, and who set production guidelines for the producers. Integrators sometimes operate farms directly—typically hatcheries and some breeding operations.

Table 12
Counting farms in the NETS dataset

	Farms	Firms that own farms
	--Number--	
All farms	621,812	620,319
Independent farms	618,717	618,717
Subsidiary farms	3,095	1,597
Firms with 1 farm	851	851
Firms with 2 farms	1,068	534
Firms with 3 or more farms	1,176	212

Notes: Independent farms are standalone firms and not part of firms that own multiple farms or other establishments. Subsidiary farms are part of firms that own at least two establishments, at least one of which is a farm.
Source: National Economic Time Series (NETS) data.

[27]NETS lists a number of obvious headquarters and administrative establishments in NAICS agriculture (farming) codes—for example, an establishment listed as a broiler operation, employing a staff of 380, which was also headquarters for 40 subsidiary farms, mostly hatcheries.

Conclusion: Families, Farms, and Businesses

One of the distinctive features of agriculture is the importance of family farms; even as farm production has shifted to much larger operations, family farms continue to account for nearly 90 percent of agricultural production. That estimate actually understates the role of family businesses in agriculture, because many large nonfamily farms are part of businesses owned and run by families. For example, Iowa Select Farms is still owned and led by the family that started the business, but we would likely class many of their farms as nonfamily farms because the farms are managed by hired managers; recall that our definition of a family farm emphasizes ownership by the family that makes day-to-day operating decisions. Many other integrators—and other multiple-farm firms in cattle feeding, poultry, and crops—often have a strong family presence, in that family members are still active in management of the larger integrated business, while the individual farms that they own are usually operated by hired managers.

Large public corporations do own and operate U.S. farms—Tyson Foods, JBS Swift, and Seaboard Corporation are active in poultry and livestock feeding/processing, and Campbell Soup Company owns the carrot producer Bolthouse Farms. However, the more extensive corporate impact on agriculture operates through a coordination role, via contracts with independent farms to produce or market agricultural commodities and through the provision of inputs to farmers.

Several features of agriculture support family businesses. While scale economies matter in agriculture, they are not so extensive as to require large diversified corporations to exploit them. Agriculture is also highly seasonal work, and families have been able to reallocate their labor to other tasks on and off the farm to accommodate seasonality and unexpected variability in agricultural production needs. Finally, most agricultural production requires an intimate knowledge of local soil, nutrient, pest, and weather conditions, along with the flexibility to quickly adapt to changes in the production environment, and those are all strengths of family businesses. Family farmers have to be able to adapt quickly as sudden changes in weather, pest populations, and commodity markets demand quick and informed decisions. As long as localized knowledge, flexibility, and modest scale requirements remain hallmarks of U.S. agriculture, family businesses will have organizational advantages.

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Appendix A: Coverage Adjustment in the Census of Agriculture and Estimates of Consolidation

The census of agriculture aims to enumerate all farms in the United States. To do this, USDA's National Agricultural Statistics Service (NASS) creates a census mail list (CML) of agricultural operations that potentially meet the farm definition. NASS aims to keep an updated CML to form the basis of data collection for the census of agriculture and other NASS survey instruments.

However, the CML does not cover all U.S. farms. Some legitimate farm operations may not be captured in the CML (NML, or *not on the mail list*). Farms on the CML may also be misclassified, as farms or as nonfarms, and a farm could appear on the CML more than once, under different names, leading to double-counting.

The census has estimated the extent of coverage errors. Misclassification and double-counting can be identified with followup surveys and evaluation of operations on the CML. NASS has used another survey, the June Agricultural Survey (JAS), to estimate the extent of NML farms. In the JAS, NASS develops a sample of over 11,000 U.S. land segments and identifies all agricultural activity within them. Some farms that appear in the JAS do not appear on the CML. The incidence of NML farms in the JAS varies with farm size and with attributes of the land segments. NASS uses the findings from the JAS to estimate the incidence of CML undercoverage across States and farm types.

In published reports from 1982 through 1997, the census (then part of the Census Bureau) reported estimates of coverage in "statistical methodology" appendixes, but the published census estimates (of farm numbers, cropland/farmland acres, and market value of agricultural products sold (MVAPS), for example) were based upon the CML and were not adjusted for coverage. However, in the reports from the 2002, 2007, and 2012 Censuses, the published estimates *were* adjusted for coverage. In the methodology appendixes to the reports, NASS also provided estimates of the effect of coverage adjustments on published estimates for those years. In addition, starting with the 2002 report, NASS also published selected adjusted and unadjusted estimates for the 1997 Census.

Coverage adjustment affects census estimates. The adjusted farm count for 1997 added 304,017 farms to the unadjusted count of 1,911,859 farms, an increase of 15.9 percent. Most of the added farms were small so that the effects of the coverage adjustment on MVAPS and on cropland acres were much smaller, at 2.3 percent and 3.3 percent, respectively.

The introduction of the coverage adjustment affects the evaluation of consolidation over time. In this report, we report coverage-adjusted estimates for 1997-2012, and unadjusted estimates for 1982-1992.[28] The coverage-adjusted census estimates report more small farms—and more land and sales in small farms—than would have been captured in the methodology used in earlier years. However, in our judgment, the effect of the change in methodology on our estimates of consolidation is small, and we therefore decided to report adjusted values for 1997, leaving the discussion of coverage to this appendix instead of the main text and tables.

[28]A limited number of adjusted census estimates were published for 1997. However, the 1997 census data file used in this report had two sets of weights that allowed us to produce adjusted and unadjusted estimates for all data items.

Appendix table A-1 reports the effects of the coverage adjustment on the distribution of MVAPS and of cropland acres across size classes, using data as reported in figures 3-1 (MVAPS) and 4-1 (cropland), with the unadjusted 1997 estimates added for comparison. The effect of the 1997 coverage adjustment was to shift some sales to smaller classes—small and midsize sales shares rose by 0.2 and 0.3 percentage points, respectively, while shares in the two largest sales classes fell by a corresponding amount. But these shifts are quite small compared to 1992-97 and 1997-2002 shift, as well as the long-term (1987-2012) shifts. Small and midsize farms' sales shares fell by 14.6 percentage points in 1992-97, by another 8.7 percentage points in 1997-2002, and by 28.1 percentage points over 1987-2012, changes that dwarf the modest adjustments from coverage. The effects of the coverage adjustment on cropland shares are larger, adding 0.9 percentage point to the less-than-100-acre class in 1997, and 0.3 percentage point to the 100-to-199-acre class, but those adjustments are again swamped by the temporal shifts. The census coverage adjustment—while providing a more accurate enumeration of farms, production, and land—had only minor effects on estimates of the farm size distribution and on our interpretation of consolidation.

The coverage adjustment also affects midpoint estimates (see the adjusted and unadjusted 1997 midpoints, for States and the United States, in appendix table B-5). In figure 4-4, the 1997 cropland midpoint, adjusted for coverage, is 805 acres. The unadjusted midpoint was 820 acres, so the coverage adjustment reduced the midpoint by 1.8 percent, a relatively small adjustment in comparison to the adjacent temporal changes covering 1992-1997 (9.5 percent), 1997-2002 (21 percent), or the long-term shift covering 1982-2012 (104 percent).

Table A1
Coverage adjustment and the estimated size distribution of MVAPS and acreage

Size classes	1992 unadjusted	1997 unadjusted	1997 adjusted	2002 adjusted
MVAPS (2012$)	Shares (%) of MVAPS, by sales class			
<350,000	37.2	24.1	24.3	18.4
350,000-999,999	24.5	23.0	23.3	20.5
1,000,000-4,999,999	19.1	27.3	27.3	29.4
5,000,000-9,999,999	4.4	6.6	6.5	7.7
≥10,000,000	14.8	19.0	18.6	24.0
Cropland acres	Shares (%) of cropland acres, by acreage class			
<100	7.3	7.4	8.3	8.1
100-199	8.9	8.5	8.7	7.8
200-499	20.7	18.9	18.6	16.2
500-999	23.0	21.6	21.1	18.6
1,000-1,999	21.6	21.7	21.5	21.8
≥2,000	18.5	21.9	21.8	27.6

Note: MVAPS is market value of agricultural products sold.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

Appendix B: Midpoints for States and Commodities by Census Year

This appendix presents the midpoints for States and various crop/livestock commodities. The coverage of the five appendix tables is summarized below:

- B1—Cropland midpoints by State, all censuses from 1982 to 2012.
- B2—Midpoints for 15 field crops (harvested acres), all censuses from 1987 to 2012.
- B3—Midpoints for 20 fruit, tree nut, and berry crops (bearing acreage for fruits and tree nuts, harvested acreage for berries), all censuses from 1987 to 2012.
- B4—Midpoints for 20 vegetable and melon crops (harvested acres), all censuses from 1987 to 2002.
- B5—Midpoints for 7 livestock commodities, all censuses from 1987 to 2012.

Appendix table B-1

Cropland midpoints (acres), by State and census year

	Not adjusted for coverage				Adjusted for coverage			
State	1982	1987	1992	1997	1997	2002	2007	2012
ALABAMA	385	353	351	300	325	320	360	473
ALASKA	550	612	1,410	1,030	1,030	869	1,000	1,010
ARIZONA	1,202	1,063	1,233	1,438	1,500	1,845	2,160	2,150
ARKANSAS	746	800	872	950	965	1,190	1,600	1,950
CALIFORNIA	1,020	898	936	1,000	1,040	1,089	1,120	1,400
COLORADO	1,333	1,400	1,570	1,781	1,657	2,196	2,128	2,223
CONNECTICUT	183	172	190	135	165	175	127	170
DELAWARE	550	682	875	1,000	1,000	1,103	1,054	1,200
FLORIDA	611	635	785	845	840	1,250	1,250	1,600
GEORGIA	440	462	500	575	590	573	675	863
HAWAII	5,803	3,932	3,800	9,598	9,598	1,950	3,980	2,942
IDAHO	845	920	1,000	1,100	1,100	1,457	1,500	1,548
ILLINOIS	488	574	680	778	784	920	1,100	1,160
INDIANA	429	500	630	700	725	910	1,118	1,200
IOWA	395	454	515	600	598	708	778	869
KANSAS	900	1,033	1,155	1,340	1,285	1,460	1,610	1,800
KENTUCKY	210	224	240	247	260	263	286	427
LOUISIANA	770	778	825	965	1,000	1,147	1,455	1,685
MAINE	195	215	250	255	282	313	300	400
MARYLAND	320	370	438	490	493	553	600	696
MASSACHUSETTS	136	125	125	106	123	112	100	100
MICHIGAN	321	391	460	499	524	623	687	774

continued—

Appendix table B-1

Cropland midpoints (acres), by State and census year—continued

	Not adjusted for coverage				Adjusted for coverage			
State	1982	1987	1992	1997	1997	2002	2007	2012
MINNESOTA	430	499	580	734	687	845	900	1010
MISSISSIPPI	799	851	954	1,000	1,080	1,330	1,500	1,545
MISSOURI	404	448	500	507	528	560	657	797
MONTANA	1,902	1,987	2,190	2,170	2,220	2,460	2,620	2,840
NEBRASKA	640	700	808	850	854	1,030	1,174	2,000
NEVADA	1,219	1,040	1,200	1,400	1,400	1,810	1,600	1,275
NEW HAMPSHIRE	135	150	150	120	142	140	140	144
NEW JERSEY	265	260	300	300	306	330	349	371
NEW MEXICO	937	873	975	846	900	1,348	1,192	1,155
NEW YORK	257	282	300	309	326	340	372	437
NORTH CAROLINA	241	313	395	450	470	609	800	1000
NORTH DAKOTA	1,172	1,249	1,474	1,619	1,632	1,915	2,130	2,600
OHIO	315	368	433	473	487	572	646	681
OKLAHOMA	567	617	658	640	640	685	776	844
OREGON	980	1,040	1,113	1,140	1,145	1,390	1,710	1,985
PENNSYLVANIA	181	195	211	199	225	210	212	221
RHODE ISLAND	104	100	100	93	108	100	79	114
SOUTH CAROLINA	440	480	480	423	483	488	570	820
SOUTH DAKOTA	870	989	1,100	1,260	1,259	1,501	1,650	1,911
TENNESSEE	231	242	252	225	250	258	360	550
TEXAS	746	750	801	800	840	1,000	1,238	1,232
UTAH	460	480	560	529	549	691	700	647
VERMONT	220	225	233	248	250	278	265	310
VIRGINIA	229	260	275	265	290	260	275	300
WASHINGTON	1,514	1,551	1,779	1,814	1,862	1,985	2,160	2,327
WEST VIRGINIA	140	148	150	135	150	125	92	86
WISCONSIN	228	246	269	274	295	335	385	515
WYOMING	789	807	900	950	943	1,100	1,000	1,000
UNITED STATES	589	650	749	820	805	974	1,105	1,201

Note: At the midpoint, half of all cropland is on farms with at least the midpoint amount of cropland, and half is on farms with no more than the midpoint.

Adjusted for coverage: see appendix A.

Source: USDA, Economic Research Service, compiled from census of agriculture data.

Appendix table B-2

Midpoints (harvested acres) for field crops, 1987-2012

Crop	1987	1992	1997	2002	2007	2012
Alfalfa	100	100	125	160	188	188
Barley	212	256	350	417	426	485
Canola	60	130	290	500	576	696
Corn for grain	200	300	350	450	600	633
Cotton	450	605	800	920	1090	970
Dry beans	189	205	290	370	451	486
Dry edible peas	240	300	332	325	460	500
Peanuts	160	215	235	300	362	400
Rice	295	400	494	607	700	800
Sorghum for grain	206	300	334	400	532	555
Soybeans	243	300	380	480	490	567
Sugarbeets	237	275	334	450	500	529
Sunflowers	280	300	387	412	500	700
Tobacco	12	18	32	32	80	108
Wheat	404	562	693	784	910	1,000

Note: At the midpoint, half of all harvested acres is on farms with at least the midpoint amount of acres, and half is on farms with no more than the midpoint.

Source: USDA, Economic Research Service, compiled from census of agriculture data.

Appendix table B-3

Midpoints (harvested acres) for fruit, tree nut, and berry crops, 1987-2012

Crop	1987	1992	1997	2002	2007	2012
Noncitrus fruits						
Apples	83	94	122	129	146	179
Avocadoes	40	35	54	50	40	50
Cherries, sweet	32	35	40	46	65	80
Cherries, tart	65	72	89	128	150	175
Grapes	205	245	306	316	320	420
Nectarines	70	91	120	123	186	239
Peaches	92	95	100	200	120	130
Pears	50	54	66	82	75	76
Plums, prunes	179	236	250	242	160	300
Citrus fruits						
Grapefruit	320	424	478	395	556	573
Lemons	176	167	177	180	176	147
Oranges	450	732	769	1015	1113	961
Tangerines	55	75	115	76	154	336
Tree nuts						
Almonds	203	234	292	361	450	547
Pecans	102	90	125	100	117	272
Pistachios	465	410	627	830	627	926
Walnuts	85	100	126	153	172	240
Berries						
Blueberries	50	45	54	60	75	100
Cranberries	90	92	96	96	99	120
Strawberries	24	40	60	80	120	180

Note: At the midpoint, half of all harvested acres is on farms with at least the midpoint amount of acres, and half is on farms with no more than the midpoint. Bearing acreage for fruits and tree nuts; harvested acreage for berries.

Source: USDA, Economic Research Service, compiled from census of agriculture data.

Appendix table B-4

Midpoints (harvested acres) for vegetable and melon crops, 1987-2012

Crop	1987	1992	1997	2002	2007	2012
Vegetables						
Asparagus	160	200	200	236	240	200
Snap beans	221	191	225	300	323	318
Broccoli	440	536	780	952	1000	1050
Cabbage	113	150	162	250	300	300
Carrots	350	427	900	656	600	1053
Cauliflower	240	400	400	500	400	425
Cucumber	115	170	250	355	505	450
Lettuce	949	1168	1461	2225	1815	1275
Onions, dry	115	150	220	250	320	348
Peas	100	100	125	140	179	198
Peppers, bell	88	130	180	200	300	210
Potatoes	350	422	556	810	990	1054
Pumpkins	20	23	24	27	30	40
Spinach	162	180	242	400	423	687
Squash	35	45	60	66	72	75
Sweet corn	100	120	173	222	250	300
Sweet potatoes	140	175	250	300	474	560
Tomatoes	400	450	589	700	820	930
Melons						
Cantaloupe	400	214	431	322	388	350
Watermelons	80	90	100	120	150	200

Note: At the midpoint, half of all harvested acres is on farms with at least the midpoint amount of acres, and half is on farms with no more than the midpoint.
Source: USDA, Economic Research Service, compiled from census of agriculture data.

Appendix table B-5

Midpoints for livestock commodities, 1987-2012

	1987	1992	1997	2002	2007	2012
			Animals sold or removed			
Broilers	300,000	384,000	480,000	520,000	681,600	680,000
Fed cattle	17,532	23,891	38,000	34,494	35,000	38,369
Hogs & pigs	1,200	1,880	11,000	23,400	30,000	40,000
Turkeys	120,000	127,088	137,246	150,000	157,000	160,000
			Herd/flock inventories, end of year			
Beef cows	89	94	100	110	110	110
Milk cows	80	100	140	275	570	900
Egg layers	117,839	193,836	300,000	667,125	872,500	952,201

Note: At the midpoint, half of all animals are on farms with at least the midpoint amount of animals, and half are on farms with no more than the midpoint.
Source: USDA, Economic Research Service, compiled from census of agriculture data.