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# Major Uses of Land in the United States, 2012

Daniel P. Bigelow and Allison Borchers





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## Abstract

The United States has a total land area of about 2.3 billion acres. In 2012, the major land uses were grassland pasture and rangeland at 655 million acres (29 percent of U.S. total); forest-use land at 632 million (28 percent); cropland at 392 million acres (17 percent); special uses (primarily parks and wildlife areas) at 316 million acres (14 percent); miscellaneous uses (such as wetlands, tundra, and unproductive woodlands) at 196 million acres (9 percent); and urban land at 70 million acres (3 percent). This study presents findings from the most recent (2012) inventory of U.S. major land uses, drawing on data from USDA, the U.S. Census Bureau, public land management and conservation agencies, and other sources. The data are collected for each State to estimate the use of several broad classes and subclasses of agricultural and nonagricultural land over time. National and regional trends in land use are compared with earlier major land-use estimates.

**Keywords:** Land use, land-use change, agricultural land, nonagricultural land, cropland, forest-use land, forestland, pasture, rangeland, rural residential land, urban land

## Acknowledgments

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## About the authors

Daniel Bigelow is an economist with USDA, Economic Research Service (ERS). Allison Borchers is an economist with USDA, Forest Service, but was with ERS when this research commenced.

## Preface

USDA's Economic Research Service (ERS) has provided major land-use (MLU) estimates for the United States for over 60 years, offering the only consistent accounting of all major uses of public and private land in the United States. Prior to the initiation of the current MLU series in 1945, Francis Marschner made earlier contributions (1922-40) in the *Atlas of American Agriculture* when he was with ERS's predecessor agency, the Bureau of Agricultural Economics. A consistent series was started in 1945 and has since been published at intervals coinciding with the Censuses of Agriculture. Marschner was also involved in the 1945 land-use inventory (Reuss et al., 1948). A wide range of researchers, policy analysts, and organizations have used the data in empirical analyses of land-use patterns and trends. The annual cropland portion of the series has been maintained since 1910.

To ensure comparability with earlier estimates in the series, researchers rely on a standardized set of procedures to measure land use (Barnard and Hexem, 1988). Even so, comparability is sometimes hindered by changes in the types of data available over time. This change is inevitable because the estimates are not drawn from a single source but are derived by reconciling several data sources.

Economic analyses often require consistent acreage estimates of land use. Before 1945, area estimates of major land uses were not consistently available for all States. Various Government agencies had data on land use that differed widely in definition, collection criteria, and acreage. No single agency provided data on all land uses that would sum to the total land in the United States. For example, USDA's Forest Service had data on forestland, while the Bureau of Land Management maintained data on public grazing land acreage. The Census of Agriculture collected information on cropland and rangeland but only if the acreage was included in "land in farms," omitting agricultural land not in farms. Various other Federal and State agencies provided data on parks, fish and wildlife areas, roads, railroads, defense installations, and other categories.

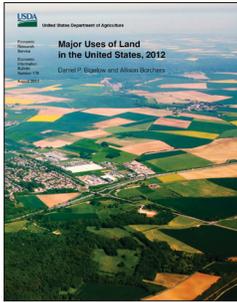
Data availability has continued to improve due to new data collection efforts and advances in technology, such as satellite imaging and geographic information systems (GIS). For example, the U.S. Geological Survey produced a satellite-based National Land Cover Database (NLCD), which covered the 48 contiguous States for 1992, 2001, 2006, and 2011. Similarly, USDA's National Agricultural Statistics Service publishes the Cropland Data Layer (CDL), which provides crop-specific, 30-meter land-cover estimates at an annual time step. The CDL has covered the extent of the continental United States since 2008, though earlier estimates are available for some States. Both the NLCD and CDL offer coverage of the entire continental United States and unparalleled detail on the distribution and pattern of land cover and crop plantings, as well as aggregate acreage statistics. Satellite data, however, are sometimes limited in their ability to provide information on land use, as opposed to land cover. For example, the NLCD does not distinguish between grazed and ungrazed forests—both of which have tree cover but have different uses—or between hay (a crop) land and pasture (used for grazing).

Since 1982, USDA's Natural Resources Conservation Service has published the National Resources Inventory (NRI), a successor to the Conservation Needs Inventory. The NRI is based on a survey of all privately owned land and includes agricultural land not covered by the Census of Agriculture. The NRI, however, does not cover Federal land, which accounts for about 28 percent of total U.S. land area. Also, the 2012 NRI covered the 48 contiguous States and Hawaii but not Alaska and its 365 million acres (16 percent of total U.S. land area). ERS remains the only public source of comprehensive major land-use estimates for all 50 States.

*Data files and additional summary tables with historical data are available on the ERS website as part of the data product "Major Land Uses." This data product includes data by region and State (1945-2012) for major uses of land, major uses of cropland, pasture and range, land in special-use areas, forestland by major class, and urban area.*

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# Major Uses of Land in the United States, 2012

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## What Is the Issue?

ERS's Major Land Uses (MLU) series is the only inventory of all major uses of public and private land in all 50 States. Since 1945, these estimates have been published at roughly 5-year intervals, coinciding with the Census of Agriculture. Land uses and land-use changes have important economic and environmental implications for commodity production and trade, provision of ecosystem services, soil and water conservation, and other policy issues. Although land-use decisions are typically made by landowners at the level of individual land plots (or parcels), a consistent series of aggregate statistics over time is useful for benchmarking broader shifts and trends. This study presents the results of the latest inventory (2012) of U.S. major land uses and examines national and regional trends in land use over time.

## What Did the Study Find?

The U.S. land area totals just under 2.3 billion acres. Major land uses in 2012 included grassland pasture and rangeland at 655 million acres (29 percent of the U.S. total), forest-use land at 632 million acres (28 percent), cropland at 392 million acres (17 percent), special uses (primarily parks and wildlife areas) at 316 million acres (14 percent), miscellaneous uses (such as wetlands, tundra, and unproductive woodlands) at 196 million acres (9 percent), and urban land at 70 million acres (3 percent).

**Cropland.** Total cropland includes land planted for crops (87 percent of total cropland), cropland used for pasture, and idled cropland (including acreage removed from production under Government programs, such as USDA's Conservation Reserve Program). Between 2007 and 2012, total cropland decreased by 16 million acres to its lowest level since this series began in 1945. However, harvested cropland (which accounts for most land planted to crops) increased by 3 million acres due to favorable market conditions for several major commodities (including corn). A 23-million-acre decrease in cropland pasture contributed to the overall decline in cropland. The drop partly stemmed from changes in the methodology used in the Census of Agriculture in 2007 and 2012. As a result, it is likely that some land formerly identified as cropland pasture is categorized as permanent grassland pasture and range in this study.

**Grassland pasture and range.** Grassland pasture and range increased by 41 million acres (almost 7 percent) between 2007 and 2012, resulting in the highest estimate for this land-use class since 1945. The recent increase more than offsets the 23-million-acre decline in cropland pasture over the same period. Based on acreage for *all* grazing land (the sum of grassland pasture and range, cropland used for pasture, and grazed forests), land available for grazing

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.

increased from 777 million acres in 2007 to 798 million acres in 2012, reversing a downward trend observed from 1945 through 2007.

**Forest-use land.** Forest-use land in 2012 included 130 million acres of grazed forests but excluded an estimated 135 million forest acres in parks, wildlife areas, and other special uses where commercial timber harvests are rare. Forest-use land decreased 40 million acres (6 percent) from 2007 to 2012, reversing an uptick from 1997 to 2007.

**Urban and rural residential areas.** Urban land area increased by a factor of 4.7 from 1945 to 2012, growing at more than twice the rate of population growth over this period. Land in urban areas was estimated at 70 million acres in 2012, up 10 million acres since 2002. This category excludes rural acreage used for residential purposes outside of urban areas. Rural residential land increased from 103 million to 106 million acres between 2007 and 2013 (the year closest to 2012 for which rural residential acreage data were available). The 3-million-acre increase reflects a slower rate of growth than in previous periods, which is likely due, in part, to the mortgage crisis that marked the Great Recession. Although farmland loss between 2002 and 2012 was concentrated in metro counties, more rural nonmetro counties also experienced declines, illustrating that farmland conversion can occur outside of urban areas.

**Special-use areas.** Special-use areas include land for rural transportation, national and State parks, wilderness and wildlife areas, national defense and industrial areas, and farmsteads and farm roads. Across all 50 States, special-use areas more than doubled since 1959, including a fourfold increase in rural parks and fish and wildlife areas. Over 2007-12, special-use areas exhibited a net increase of more than 2 million acres (less than 1 percent). The growth was driven by a nearly 5-million-acre increase in defense/industrial land and a 2-million-acre increase in rural parks and wilderness areas, though these gains were offset by a 4-million-acre reduction in farmstead areas.

**Regional patterns.** Regional land-use patterns vary based on differences in soil, climate, Federal and local policies and programs, topography, and population. Relatively stable patterns of land use at the national level obscure larger land-use changes at regional and State levels. For example, between 1969 and 2012, cropland used for crops increased by 7 million acres nationally—an increase of nearly 13 million acres in the Corn Belt was offset by a net decline of 6 million acres across all other regions. Over this 43-year period, the distribution of acreage used for crops across major crop-producing regions remained about the same.

**Ownership.** About 60 percent (1.37 billion acres) of the land in the United States is privately owned. The Federal Government owns approximately 28 percent (644 million acres), over a third of which is in Alaska. State and local governments own just over 8 percent (189 million acres). The remainder, about 3 percent (63 million acres), is held in trust by the Bureau of Indian Affairs. Total federally owned land declined by 9 million acres between 2007 and 2012. About 2 percent (25 million acres) of U.S. farm and forestland was foreign owned in 2012.

## How Was the Study Conducted?

Data from USDA's Forest Service and National Agricultural Statistics Service, the U.S. Census Bureau, public land management and conservation agencies, and other sources were compiled by State and used to estimate the uses of several broad classes and subclasses of land in 2012. ERS researchers used standardized procedures to develop the estimates. Estimates of cropland, urban area, and special uses are based largely on census data and administrative data and were developed first. Estimates of forest-use land, grassland pasture and range, and miscellaneous land uses followed. Though all land-use categories require reconciliation among sources at the State level, some categories in the MLU series were adjusted more than others based on the residual amount of land after other uses were tabulated. These categories include miscellaneous land and, to some extent, grassland pasture and range—categories for which less reliable data sources are available relative to those for cropland and forest-use areas.

# Major Uses of Land in the United States, 2012

## Introduction

### How Land Is Used

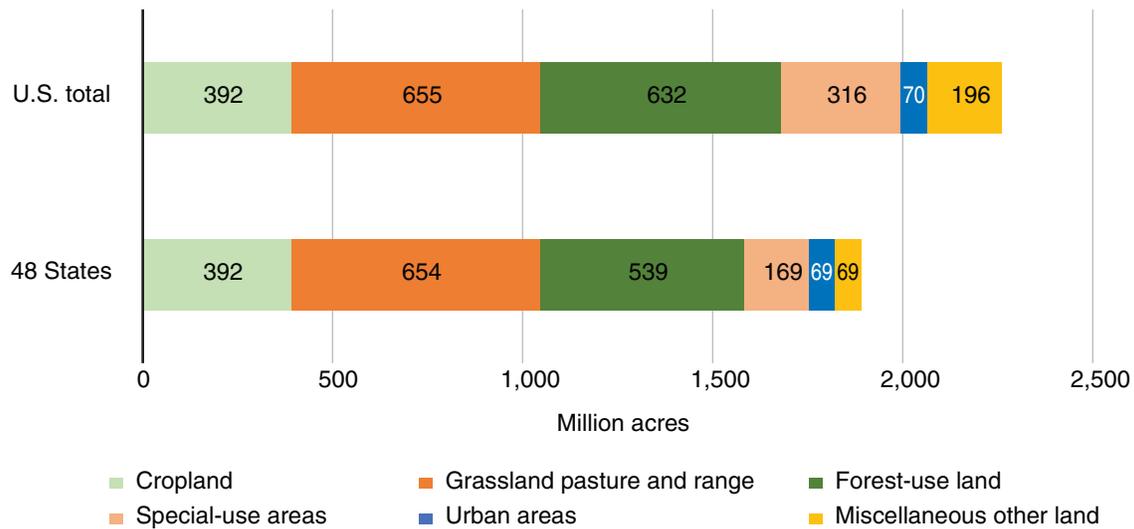
The United States has a total land area of about 2.3 billion acres, which is allocated among a variety of uses (fig. 1). In 2012, the largest shares of the Nation's land were allocated to **grassland pasture and range**, **forest use**, and **cropland** (see appendix 1 for detailed descriptions of terms in **bold** in this report). About 17 percent of the U.S. land area was cropland in 2012, 29 percent was permanent grassland pasture and range, and 28 percent was forest-use land.<sup>1</sup> **Urban areas** accounted for 3 percent of U.S. land, while a variety of **special uses**—including parks, wildlife refuges, wilderness areas, transportation corridors, and national defense areas—accounted for 14 percent. **Miscellaneous other** uses made up the remaining 9 percent. These land-use percentages are affected greatly by the inclusion or exclusion of Alaska, which, relative to the rest of the United States, has small amounts of cropland and pasture and large areas of special-use and miscellaneous other land. Prior to this study, the last comprehensive inventory of major land uses in the United States was undertaken for the year 2007 (see Nickerson et al., 2011). The full set of historical estimates and summary tables for 2012, by region and State, are available as an ERS data series, Major Land Uses.<sup>2</sup>

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<sup>1</sup>The definition of forest use adopted in this report is intended to reflect land that is either: (1) used to produce timber and other forest products or (2) covered by forest and used for grazing. This definition excludes about 134 million acres of land considered to be forest by USDA's Forest Service (FS) (Oswalt et al., 2014). These lands are either reserved and accounted for in the Major Land Uses special-use category or considered to be unproductive forests and are, thus, included in the miscellaneous land category. Using the less restrictive FS definition, forestland used for all purposes in 2012 totaled 766 million acres, roughly a third of the land area of the United States.

<sup>2</sup>See the Major Land Uses data series on the ERS website.

Figure 1  
**Major uses of U.S. land, 2012**



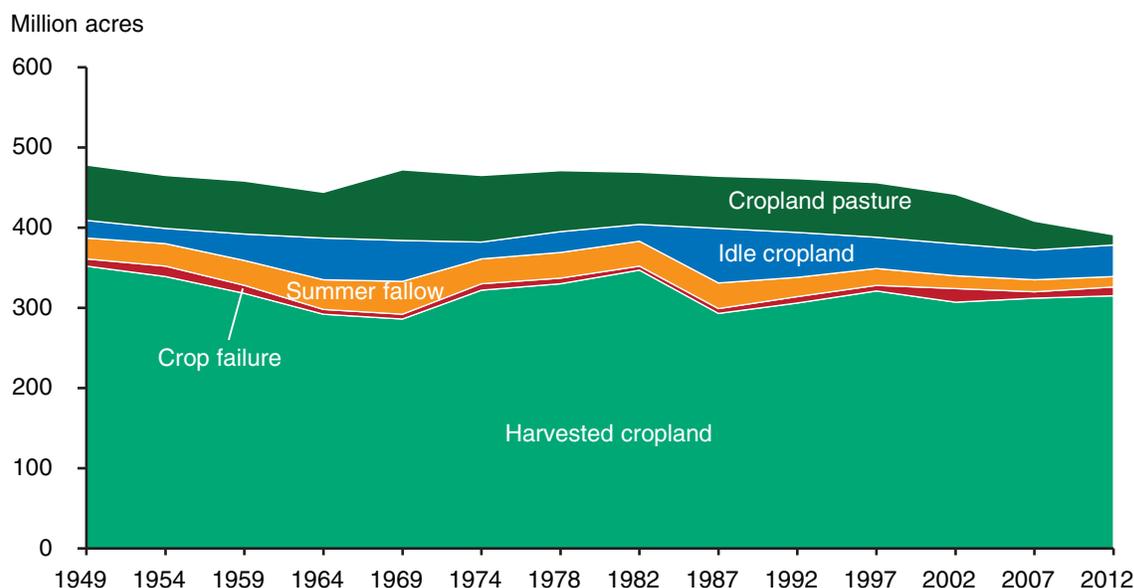
Notes: Data on land uses in Alaska and Hawaii are excluded in the bar labeled “48 States.” Cropland includes all land considered to be in crop rotation: cropland used for crops, idle cropland, and cropland used only for pasture. Land in USDA’s Conservation Reserve Program is classified as idle cropland. Grassland pasture and range includes permanent grassland and other nonforested pasture and range. Forest-use land is total forestland as classified by USDA’s Forest Service (FS), excluding land used primarily for parks, wildlife areas, and other uses, as well as land that meets the FS forest definition but is not classified as forest-use for the purpose of this study due to the land’s lack of timber production or grazing potential. Special-use land includes areas used for rural transportation, recreation and wildlife, various public installations and facilities, farmsteads, and farm roads. Some of this land may be forested. Miscellaneous land includes areas in various uses not inventoried, marshes, open swamps, bare rock areas, desert, tundra, and other land generally of low agricultural value. The land base includes streams and canals less than an eighth of a mile wide, and ponds, lakes, and reservoirs covering less than 40 acres. Distributions by major use may not add to totals due to rounding. See appendix for more complete descriptions of the different land-use categories.

Sources: USDA, Economic Research Service calculations using data from USDA, National Agricultural Statistics Service (2014b); USDA, National Agricultural Statistics Service (2014a); USDA, National Agricultural Statistics Service (2012); USDA, Farm Service Agency (2014); USDA, Natural Resources Conservation Service (2015); USDA, Natural Resources Conservation Service (2014a); U.S. Department of the Interior, Bureau of Land Management (2013); Oswalt et al. (2014); USDA, Forest Service (2012a); USDA, Forest Service (2016); U.S. Department of the Interior, Bureau of Land Management (2012); USDA, Forest Service (2012b); U.S. Department of Commerce, Census Bureau (2014a); U.S. Department of Defense (2012); U.S. Department of Energy (2012); U.S. Department of Transportation, Federal Highway Administration (2013); U.S. Department of Transportation, Bureau of Transportation Statistics (2015); U.S. Department of Transportation/Federal Aviation Administration (2011); U.S. Geographic Data Technology (2007); U.S. Department of Transportation, Bureau of Transportation Statistics (2007); U.S. Department of Commerce, Census Bureau (2012); U.S. Department of the Interior, Fish and Wildlife Service (2012); U.S. Department of Commerce, Census Bureau (2014c); U.S. Department of the Interior, National Park Service (2012), and additional information gathered through personal communication with numerous State agencies responsible for managing fish, wildlife, and game areas.

Land classified as cropland totaled about 392 million acres in 2012 (fig. 1) and represents all land in crop rotation, including **cropland pasture** (fig. 2). **Cropland used for crops—cropland harvested, cropland failure, and cultivated summer fallow**—totaled 340 million acres, or 87 percent of total U.S. cropland acreage (table 1). Three percent of total cropland was used only for pasture, and the remaining 10 percent of cropland was classified as **idle cropland**. Acreage enrolled in USDA’s Conservation Reserve Program (CRP) accounts for a large share of land in the idle cropland category. The CRP, established by the Food Security Act of 1985, is the largest Federal land retire-

ment program. Farm owners and operators that participate in the program are offered annual rental payments to voluntarily retire environmentally sensitive land from crop production under 10- to 15-year contracts.<sup>3</sup> In 2012, the CRP covered nearly 30 million acres of land, with program expenditures totaling over \$1.8 billion.

Figure 2  
**Major uses of U.S. cropland**



Note: See appendix for definitions of the different cropland categories.

Sources: USDA, Economic Research Service estimates using data from USDA, National Agricultural Statistics Service (2012, 2014a, and 2014b); USDA, Farm Service Agency (2014); and USDA, Natural Resources Conservation Service (2015). Estimates prior to 2012 are based on Nickerson et al. (2011); Lubowski et al. (2006b); Vesterby and Krupa (2001); Daugherty (1991 and 1995); Frey (1973, 1979, and 1982); Frey and Hexem (1985); Frey et al. (1968); Wooten et al. (1962); Wooten and Anderson (1957); and Wooten (1953).

In 2012, land used for agricultural purposes—cropland, grassland pasture and range, grazed forestland, land in farmsteads, and the area occupied by farm roads and lanes—totaled 1.18 billion acres, or 52.5 percent of total U.S. land area (table 1). By comparison, USDA’s National Agricultural Statistics Service (NASS) estimates that “land in farms” during the same period totaled 914 million acres (USDA, NASS, 2013b). The NASS definition of a farm only covers land in operations that are capable of earning at least \$1,000 of revenue in a given year and, thus, may not include all low-value land used for agricultural purposes, such as grazing (both forested and nonforested). This accounts for the difference in the two estimates for 2012.

<sup>3</sup>Some Conservation Reserve Program (CRP) land is planted to trees. These lands are considered idle cropland because CRP contracts are short term and the land could revert to cropland at the expiration of the contract. However, some research has shown that tree-covered CRP land may be less likely to revert to cropland once the contract expires (Petrolia and Iben-dahl, 2008).

Table 1

**Agricultural and nonagricultural uses of U.S. land, 2012**

Land use	Acreage		Share of total	
	48 States	United States	48 States	United States
	Million acres		Percent	
<b>Agricultural</b>				
Cropland				
Cropland used for crops <sup>1</sup>	340	340	18.0	15.0
Idle cropland	39	39	2.1	1.7
Grazing land				
Cropland used only for pasture	13	13	0.7	0.6
Grassland pasture and range	654	655	34.6	29.0
Forestland grazed	130	130	6.9	5.7
Special uses				
Farmsteads, farm roads	8	8	0.4	0.4
Total agricultural land <sup>2</sup>	1,184	1,186	62.6	52.5
<b>Nonagricultural</b>				
Forest-use land not grazed	409	502	21.6	22.2
Special uses				
Transportation <sup>3</sup>	26	27	1.4	1.2
Recreation and wildlife areas <sup>4</sup>	109	254	5.8	11.2
National defense areas <sup>5</sup>	25	27	1.3	1.2
Urban land	69	70	3.7	3.1
Miscellaneous other land <sup>6</sup>	69	196	3.6	8.7
Total nonagricultural land <sup>2</sup>	707	1,075	37.4	47.5
Total land area <sup>2</sup>	1,891	2,260	100.0	100.0

<sup>1</sup>Cropland harvested, crop failure, and cultivated summer fallow. <sup>2</sup>Distributions may not add to totals due to rounding.

<sup>3</sup>Rural highways, roads and railroad rights-of-way, and rural airports. <sup>4</sup>National and State parks and related recreational areas, national and State wildlife refuges, and national wilderness and primitive areas. <sup>5</sup>Federal land administered by the U.S. Department of Defense for military purposes and land administered by the U.S. Department of Energy.

<sup>6</sup>Includes areas in miscellaneous uses not inventoried, marshes, open swamps, bare rock areas, desert, and tundra.

Sources: USDA, Economic Research Service calculations using data from USDA, National Agricultural Statistics Service (2014b); USDA, National Agricultural Statistics Service (2014a); USDA, National Agricultural Statistics Service (2012); USDA, Farm Service Agency (2014); USDA, Natural Resources Conservation Service (2015); USDA, Natural Resources Conservation Service (2014a); U.S. Department of the Interior, Bureau of Land Management (2013); Oswalt et al. (2014); USDA, Forest Service (2012a); USDA, Forest Service (2016); U.S. Department of the Interior, Bureau of Land Management (2012); USDA, Forest Service (2012b); U.S. Department of Commerce, Census Bureau (2014a); U.S. Department of Defense (2012); U.S. Department of Energy (2012); U.S. Department of Transportation, Federal Highway Administration (2013); U.S. Department of Transportation, Bureau of Transportation Statistics (2015); U.S. Department of Transportation, Federal Aviation Administration (2011); U.S. Geographic Data Technology (2007); U.S. Department of Transportation, Bureau of Transportation Statistics (2007); U.S. Department of Commerce, Census Bureau (2012); U.S. Department of the Interior, Fish and Wildlife Service (2012); U.S. Department of Commerce, Census Bureau (2014c); U.S. Department of the Interior, National Park Service (2012), and additional information gathered through personal communication with numerous State agencies responsible for managing fish, wildlife, and game areas.

Livestock grazing was the primary use of an estimated 655 million acres of permanent grassland pasture and range in 2012, accounting for 29 percent of all U.S. land and more than half of all agricultural land. Livestock also graze on cropland pasture (13 million acres) and forested grazing land (130 million acres). Total grazing land accounted for 798 million acres in 2012, 35 percent of the total U.S. land area and approximately two-thirds of all agricultural land.

Forest-use land that is not grazed (total forestland minus land grazed and in special uses, such as national and State parks) amounted to 502 million acres, nearly half of all nonagricultural land (table 1). Nonagricultural special-use areas (excluding 8 million acres of special-use land in farmsteads and farm roads) totaled 308 million acres, about 14 percent of the Nation's land area. Of this amount, Federal and State parks, wildlife refuges, and related lands occupied 254 million acres, 11 percent of the total land base. **Rural transportation land** accounted for another 27 million acres, so, too, did land for defense and other public installations and facilities.

Seventy million acres were classified as urban areas in the United States, with all but 423,000 acres located in the contiguous 48 States. Urban areas accounted for 3 percent of the total U.S. land area and just under 4 percent of the land area of the lower 48 States.

The remaining 196 million acres (9 percent) of the U.S. land area accounted for various miscellaneous uses that could not be separately inventoried, including tundra, deserts, bare rock areas, snow and ice fields, swamps, marshes, and other areas not independently categorized in the MLU series, such as wetlands and rural residential land. The land classified under other miscellaneous uses in 2012 included some of the estimated 106 million acres of land used for rural housing lots.<sup>4</sup>

## Historical Trends in Major Land Uses

The areas of land in the top land-use categories have fluctuated over time. Total **cropland** area decreased about 18 percent between 1949 and 2012, though several periods during this timeframe were marked by increases (table 2).<sup>5</sup> Total cropland area in 2012 was 392 million acres, the lowest level since estimates for all 50 States began in 1949 and 16 million acres (4 percent) below the previous low observed in 2007. The decline over this 5-year period stemmed from a 23-million-acre reduction in **cropland pasture**. **Grassland pasture and range** increased through the early 1960s but then entered a long-term decline; by 2007, estimated acreage in the category had increased to 614 million acres but was still 3 percent below that in 1949. Between 2007 and 2012, grassland pasture and range increased 41 million acres. **Forest-use** area generally declined from 1949 to 1997, increased by more than 4 percent from 1997 to 2007, and declined again by 6 percent over 2007-12. The most consistent trends during 1945-2012 are observed in the expansion of **special-use** and **urban** areas. Acreage classified under **miscellaneous other** uses declined from 301 million to 197 million over 1974-2012, partly due to improvements in methods used by Government agencies to measure land use.

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<sup>4</sup>Given the data used to define rural residential area, it is not possible to distinguish rural housing lots from land classified under other uses, such as forests or grassland pasture and range. For further discussion of rural residential land uses, see "Urban and Rural Residential Uses."

<sup>5</sup>Major land-use estimates for the 48 contiguous States began in 1945, but estimates for the entire United States did not begin until 1949. Estimates for 1945 are indicative of total acreages in cropland, grassland pasture and range, and urban areas, which are concentrated in the contiguous 48 States. The 1945 estimates do not cover forest, special uses, and other miscellaneous uses, which account for 99 percent of Alaska's land area.

The changes in acreage in the different MLU categories reflect true shifts between land uses as well as changes in methods and definitions employed by the MLU data sources. For example, the reduction in cropland pasture and some of the increase in grassland pasture and range over 2007-12 are partly due to a change in the way information on cropland pasture and other pasture on farms was measured and elicited in the 2007 and 2012 Censuses of Agriculture (see box “Cropland Pasture in the Census of Agriculture” on page 15). Likewise, changes in forest area reflect a combination of actual land-use changes and alterations to the definition of forestland.<sup>6</sup> Because of these changes in methodology, not all estimate categories are strictly comparable across years (see box “Comparability of Land-Use Estimates”). In general, the longer term land-use trends may be more reliable as indicators than the changes for specific 5-year intervals, especially in cases where a definitional or methodological change has been noted.

## Comparability of Land-Use Estimates

In maintaining the Major Land Uses series, USDA’s Economic Research Service (ERS) attempts to use a consistent methodology for measuring land use, but tradeoffs are sometimes necessary between consistency and accuracy. As source agencies improve methodologies and more accurate data become available, the estimates are amended to incorporate the new data. When historical estimates cannot be adjusted, however, ERS reports, where possible, those changes in the source data that cause estimates to reflect differences on paper rather than differences in actual land use. For example, land in urban areas was estimated at 60 million acres in 2002, compared with an estimated 66 million acres in 1997. This decline is due to a change in the criteria used to define urban areas in the 2000 Census of Population. The U.S. Census Bureau estimates that if the same criteria had been used in 1990 and 2000, the urban area estimates would reflect a 13-percent increase over the period. However, when data sources do not quantify how changes in methodology affect historical results, ERS can neither adjust historical MLU estimates nor report on the extent to which land-use estimates have changed due to actual changes in land use. In these instances, ERS notes that the change has occurred but that the effect cannot be quantified.

Changes in land-use estimates for one category necessarily imply changes in estimates for other land uses, given the fixed amount of total land. Though all land-use categories require reconciliation among sources at the State level, some categories in the MLU series are adjusted more than others based on the residual amount of land after other uses are tabulated. These categories include miscellaneous land and, to some extent, grassland pasture and range—categories for which less reliable data sources are available relative to cropland and forest-use areas.

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<sup>6</sup>For more information on how to interpret the forest-use estimate, see “Forest-Use Land and Total Forested Land.”

Table 2

**Major U.S. land uses**

Land use	1945	1949	1959	1964	1969	1974	1978	1982	1987	1992	1997	2002	2007	2012
	Million acres													
<b>Cropland</b>	451	478	458	444	472	465	471	469	464	460	455	442	408	392
Cropland used for crops	363	383	359	335	333	361	369	383	331	338	349	340	335	340
Idle cropland	40	26	34	52	51	21	26	21	68	56	39	40	37	39
Cropland pasture <sup>2</sup>	47	69	66	57	88	83	76	65	65	67	68	62	36	13
<b>Grassland pasture and range<sup>2</sup></b>	659	632	633	640	604	598	587	597	591	591	580	587	614	655
<b>Forest-use land<sup>3</sup></b>	602	760	728	732	723	718	703	655	648	648	642	651	671	632
Grazed forest-use land	345	320	245	225	198	179	172	158	155	145	140	134	127	130
Other forest-use land	257	440	483	507	525	539	531	497	493	503	501	517	544	502
<b>Special-use areas<sup>4</sup></b>	85	87	123	144	141	147	158	270	279	281	286	297	313	316
<b>Urban areas<sup>5</sup></b>	15	18	27	29	31	35	45	50	57	59	66	60	61	70
<b>Miscellaneous other land<sup>6</sup></b>	93	298	293	277	291	301	301	224	227	224	236	228	197	196
<b>Total land area<sup>1,7</sup></b>	1,905	2,273	2,271	2,266	2,264	2,264	2,264	2,265	2,265	2,263	2,263	2,264	2,264	2,260

<sup>1</sup>The estimates for 1945, and for special uses until 1959, only account for the 48 contiguous States. The estimates for all other years include all 50 States. <sup>2</sup>The 2007 and 2012 cropland pasture estimates are not directly comparable with estimates in prior years due to a methodological change by the source agency in estimating cropland pasture and other pasture on farms. The grassland pasture and range estimate excludes cropland used only for pasture and grazed forestland. <sup>3</sup>Excludes forestland in parks and other special uses of land. <sup>4</sup>Includes land specified in table 10. <sup>5</sup>The 2002, 2007, and 2012 urban acreage estimates are not directly comparable with estimates in prior years due a change in the definition of urban areas in the 2000 Census of Population and Housing. The decrease in Major Land Uses "urban" acreage estimates between 1997 and 2002 should be viewed as a consequence of this definitional change, rather than reflecting a decline in acreage. <sup>6</sup>Includes areas in miscellaneous uses not inventoried, marshes, open swamps, bare rock areas, desert, tundra, and other land generally with low value for agricultural purposes. <sup>7</sup>Totals differ over time due to remeasurement of the land area. Distribution of land uses may not add to totals due to rounding.

Sources: USDA, Economic Research Service calculations using data from USDA, National Agricultural Statistics Service (2014b); USDA, National Agricultural Statistics Service (2014a); USDA, National Agricultural Statistics Service (2012); USDA, Farm Service Agency (2014); USDA, Natural Resources Conservation Service (2015); USDA, Natural Resources Conservation Service (2014a); U.S. Department of the Interior, Bureau of Land Management (2013); Oswald et al. (2014); USDA, Forest Service (2012a); USDA, Forest Service (2016); U.S. Department of the Interior, Bureau of Land Management (2012); USDA, Forest Service (2012b); U.S. Department of Commerce, Census Bureau (2014a); U.S. Department of Defense (2012); U.S. Department of Energy (2012); U.S. Department of Transportation, Federal Highway Administration (2013); U.S. Department of Transportation, Bureau of Transportation Statistics (2015); U.S. Department of Transportation, Federal Aviation Administration (2011); U.S. Geographic Data Technology (2007); U.S. Department of Transportation, Bureau of Transportation Statistics (2007); U.S. Department of Commerce, Census Bureau (2012); U.S. Department of the Interior, Fish and Wildlife Service (2012); U.S. Department of Commerce, Census Bureau (2014c); U.S. Department of the Interior, National Park Service (2012), and additional information gathered through personal communication with numerous State agencies responsible for managing fish, wildlife, and game areas. Estimates prior to 2012 are based on Nickerson et al. (2011); Lubowski et al. (2006b); Vesterby and Krupa (2001); Daugherty (1991 and 1995); Frey (1973, 1979, and 1982); Frey and Hexem (1985); Frey et al. (1968); Wooten et al. (1962); Wooten and Anderson (1957); and Wooten (1953). The estimates are not strictly comparable.

Changes in land use occur for various reasons, and some changes are less reversible than others. Commodity prices, environmental factors (e.g., soil quality and weather patterns), Government policies and programs (e.g., CRP), population growth, and bioenergy demand can affect land-use decisions because they influence the relative economic returns to different uses. Economic theory suggests that profit-maximizing landowners put land to the use (or uses) that maximizes the discounted sum of current and future net returns. While this may not always hold in practice, changes in the relative profitability of one land use over another, along with idiosyncratic landowner objectives and preferences, can influence transitions between uses (Lubowski et al., 2008). Increases in demand for residential, commercial, and industrial development can cause agricultural and forestland to be converted to urban uses when the expected returns from farming or timber harvests are no longer large enough to offset the potential gains from development. Once developed, however, land rarely transitions back to a less intensive agricultural or forest use. Urban land has increased continuously since 1945, and according to USDA, NRCS (2014b), more than 98 percent of land that was developed in 1982 remained that way in 2012.<sup>7</sup> In contrast, land-use changes from cropland to pasture, and vice versa, are more common and less costly to reverse.

While they are informative, trends in individual land-use categories can mask offsetting changes into and out of different uses. Although it does not paint a complete picture of changes in all land uses, the National Resources Inventory (NRI), a recurring dataset maintained by USDA's Natural Resources Conservation Service (NRCS), identifies plot-level changes in privately owned land over time in the 48 contiguous States. Because the same plots are sampled over time, NRI data allow for the construction of land-use transition matrices (see table 3).<sup>8</sup>

Table 3  
**National Resources Inventory transition matrix for 2007-12**

	To land use/cover, 2012					
	Cropland/ CRP	Pasture/ range	Forest	Developed	Other rural	Water
From land use/cover, 2007	Percent of land converted, 2007-12					
Crop/CRP	N/A	85	17	21	28	20
Pasture/range	91	N/A	68	33	48	37
Forest	4	7	N/A	42	22	41
Developed	1	1	5	N/A	2	1
Other rural	2	5	7	4	N/A	1
Water	1	2	3	0	0	N/A
Percent no change	99	98	99	97	97	100

Note: CRP=Conservation Reserve Program. N/A=not applicable. The numbers in the main body of the table represent the percentage of land that changed from the use shown in the first column to the corresponding use shown in the first row. The percentages are taken only over the land in a given use that changed uses between 2007 and 2012. The percentage of land in a given use that remained in the same use over 2007-12 is shown in the last row of the table. For "water," the numbers sum to greater than 100 due to rounding.

Source: USDA, Economic Research Service using data from USDA, Natural Resources Conservation Service (2014b).

<sup>7</sup>Note that the decline in urban land between 1997 and 2002 reflects a change in census methodology rather than a true decline in the U.S. urban-land footprint.

<sup>8</sup>While the wide coverage and repeat sampling make the National Resources Inventory (NRI) attractive as a data source for developing Major Land Uses (MLU) estimates, NRI does not account for all land uses (e.g., Federal land and estimates for land in Alaska and Hawaii have been omitted). However, NRI data are used in the construction of the MLU grassland pasture and range and grazed forest estimates in the 48 contiguous States.

The NRI data show that between 2007 and 2012, of the total amount of land that was converted to a developed use, 42 percent was previously in forest use/cover. An additional 33 percent was previously in pasture or range use, while 21 percent was cropland (or enrolled in the CRP) in 2007.<sup>9</sup> In addition to land development, land-use changes can also occur between undeveloped uses. Between 2007 and 2012, the majority (85 percent) of new pasture and rangeland came from land that was previously used for crops (or enrolled in the CRP). Similarly, 91 percent of new cropland/CRP acreage was formerly in pasture or range use (USDA, NRCS, 2014b).<sup>10</sup> The NRI data also illustrate the relative infrequency of changes in land use/cover. For example, roughly 99 percent of the NRI cropland/CRP land identified in 2007 remained in that use in 2012.

## Basic Regional Land-Use Patterns

Land-use patterns vary widely across regions, reflecting differences in soils, climate, topography, and general economic activity. For example, **cropland** accounts for just 11 percent of land in the Northeast but 55 percent in the Corn Belt (table 4; see fig. 3 for USDA Farm Production Regions used in this report). Land use also varies among States within a region (fig. 3). For example, in the Corn Belt, cropland accounts for 75 percent of land use in Iowa but just 36 percent in Missouri.

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<sup>9</sup>NRI uses a more restrictive definition of forestland, relative to that used by USDA's Forest Service, the main source of the MLU forest-use estimates. The NRI cropland category roughly corresponds to the sum of the MLU categories of cropland used for crops plus cropland pasture.

<sup>10</sup>The NRI cropland and CRP categories are combined to stay consistent with the definition of cropland used in the MLU. Most new CRP land came from land that was previously cropland. The vast majority of pasture/range conversions to cropland/CRP was from pasture/range to cropland, not CRP.

Table 4

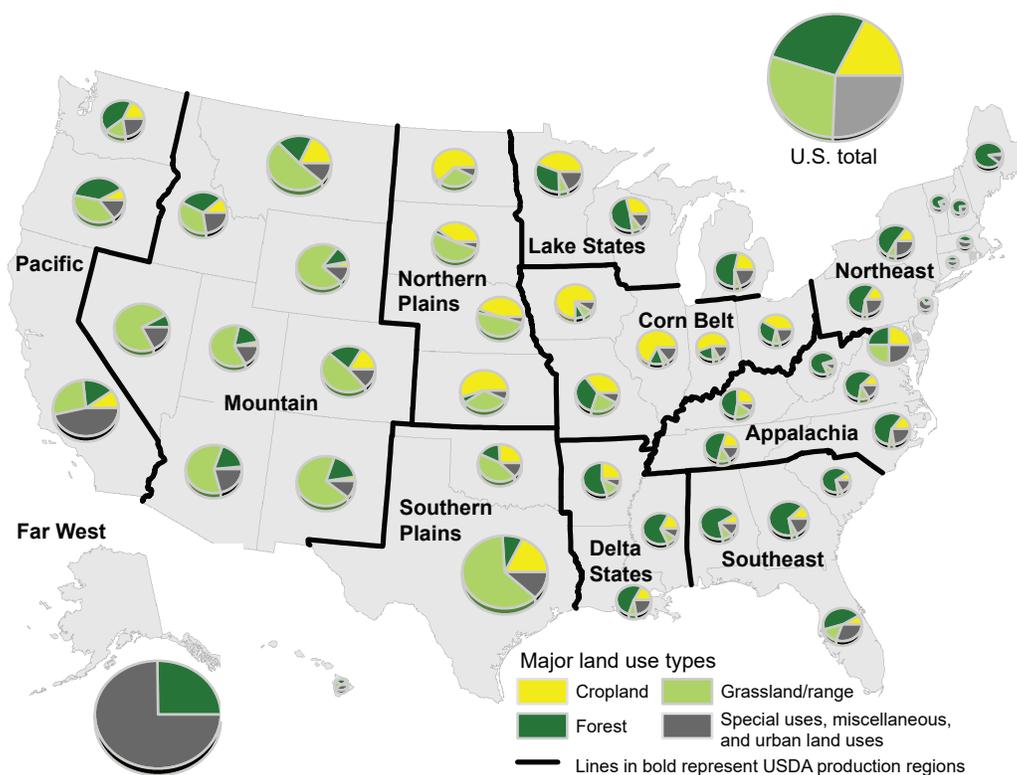
**Major land uses, by U.S. region, 2012**

Region <sup>1</sup>	Cropland <sup>2</sup>		Grassland pasture and range <sup>3</sup>		Forest-use land <sup>4</sup>		Special-and- miscellaneous- use land		Urban		Total land <sup>5</sup>	
	Million acres (percent of regional total)											
Northeast	12.2	(11.0)	4.9	(4.4)	65.7	(59.1)	15.0	(13.5)	13.3	(12.0)	111.1	(100.0)
Lake States	40.3	(33.1)	8.4	(6.9)	51.9	(42.6)	16.5	(13.5)	4.7	(3.9)	121.8	(100.0)
Corn Belt	89.8	(54.6)	18.2	(11.1)	35.4	(21.6)	11.8	(7.2)	9.1	(5.5)	164.4	(100.0)
Northern Plains	96.9	(49.9)	79.8	(41.1)	6.2	(3.2)	10.0	(5.2)	1.3	(0.6)	194.2	(100.0)
Appalachian	19.9	(16.1)	13.9	(11.3)	70.6	(57.2)	10.9	(8.9)	8.1	(6.6)	123.4	(100.0)
Southeast	11.9	(9.7)	10.6	(8.7)	76.0	(61.9)	13.0	(10.6)	11.2	(9.1)	122.8	(100.0)
Delta States	18.0	(19.8)	9.1	(10.0)	52.7	(57.9)	8.4	(9.3)	2.8	(3.0)	91.0	(100.0)
Southern Plains	40.5	(19.2)	124.4	(58.9)	22.0	(10.4)	17.6	(8.3)	6.7	(3.2)	211.1	(100.0)
Mountain	40.2	(7.3)	326.9	(59.7)	98.8	(18.0)	77.0	(14.1)	4.8	(0.9)	547.7	(100.0)
Pacific	21.8	(10.7)	57.8	(28.4)	59.2	(29.1)	57.3	(28.1)	7.6	(3.7)	203.7	(100.0)
<b>48 States</b>	391.5	(20.7)	654.0	(34.6)	538.6	(28.5)	237.5	(12.6)	69.4	(3.7)	1891.1	(100.0)
Alaska	0.1	(0.0)	0.7	(0.2)	91.8	(25.1)	272.5	(74.6)	0.2	(0.0)	365.2	(100.0)
Hawaii	0.4	(9.1)	0.8	(18.7)	1.3	(31.6)	1.4	(34.4)	0.3	(6.2)	4.1	(100.0)
<b>U.S. total</b>	392.0	(17.3)	655.5	(29.0)	631.7	(27.9)	511.4	(22.6)	69.9	(3.1)	2260.4	(100.0)

<sup>1</sup>See figure 3 for a map of USDA farm production regions used in this report. <sup>2</sup>Total cropland including cropland used for crops, cropland used only for pasture, and idle cropland. <sup>3</sup>Open permanent pasture and range, both in farms and not in farms, excluding cropland pasture. <sup>4</sup>Total forestland, including forests grazed but excluding an estimated 80 million forest acres in parks and other special uses of land. <sup>5</sup>Distribution of land uses and percentages may not add to totals due to rounding.

Sources: USDA, Economic Research Service calculations using data from USDA, National Agricultural Statistics Service (2014b); USDA, National Agricultural Statistics Service (2014a); USDA, National Agricultural Statistics Service (2012); USDA, Farm Service Agency (2014); USDA, Natural Resources Conservation Service (2015); USDA, Natural Resources Conservation Service (2014a); U.S. Department of the Interior, Bureau of Land Management (2013); Oswald et al. (2014); USDA, Forest Service (2012a); USDA, Forest Service (2016); U.S. Department of the Interior, Bureau of Land Management (2012); USDA, Forest Service (2012b); U.S. Department of Commerce, Census Bureau (2014a); U.S. Department of Defense (2012); U.S. Department of Energy (2012); U.S. Department of Transportation, Federal Highway Administration (2013); U.S. Department of Transportation, Bureau of Transportation Statistics (2015); U.S. Department of Transportation, Federal Aviation Administration (2011); U.S. Geographic Data Technology (2007); U.S. Department of Transportation, Bureau of Transportation Statistics (2007); U.S. Department of Commerce, Census Bureau (2012); U.S. Department of the Interior, Fish and Wildlife Service (2012); U.S. Department of Commerce, Census Bureau (2014c); U.S. Department of the Interior, National Park Service (2012), and additional information gathered through personal communication with numerous State agencies responsible for managing fish, wildlife, and game areas.

Figure 3  
**Shares of land in major uses, by State, 2012**



Notes: The size of the pie charts is proportional to the land area in each State. The miscellaneous, special-use, and urban category shares were too small to be distinguished as separate slices.

Sources: USDA, Economic Research Service calculations using data from USDA, National Agricultural Statistics Service (2014b); USDA, National Agricultural Statistics Service (2014a); USDA, National Agricultural Statistics Service (2012); USDA, Farm Service Agency (2014); USDA, Natural Resources Conservation Service (2015); USDA, Natural Resources Conservation Service (2014a); U.S. Department of the Interior, Bureau of Land Management (2013); Oswalt et al. (2014); USDA, Forest Service (2012a); USDA, Forest Service (2016); U.S. Department of the Interior, Bureau of Land Management (2012); USDA, Forest Service (2012b); U.S. Department of Commerce, Census Bureau (2014a); U.S. Department of Defense (2012); U.S. Department of Energy (2012); U.S. Department of Transportation, Federal Highway Administration (2013); U.S. Department of Transportation, Bureau of Transportation Statistics (2015); U.S. Department of Transportation, Federal Aviation Administration (2011); U.S. Geographic Data Technology (2007); U.S. Department of Transportation, Bureau of Transportation Statistics (2007); U.S. Department of Commerce, Census Bureau (2012); U.S. Department of the Interior, Fish and Wildlife Service (2012); U.S. Department of Commerce, Census Bureau (2014c); U.S. Department of the Interior, National Park Service (2012), and additional information gathered through personal communication with numerous State agencies responsible for managing fish, wildlife, and game areas. State estimates are summarized in ERS's Major Land Uses data series on the ERS website.

When looking at the relative prevalence of different land uses across the Nation, regional patterns emerge. Cropland is largely concentrated in the central regions of the contiguous United States. A majority of land in the Northern Plains and Corn Belt is cropland, and shares of cropland in the Southern Plains, Lake States, and Delta States regions are also above the national average. Grassland pasture and range is concentrated in the Mountain and Southern Plains regions, where it accounts for more than half of the land. The Northern Plains and Pacific regions also have relatively high shares of grassland pasture and range acreage, with 41 and 28 percent of their land area, respectively, allocated to this use (table 4). Forest-use land is most prevalent in Eastern regions, specifically

the Northeast, Appalachia, Southeast, and Delta States, which have a majority of their land in **forest uses**. However, in terms of total acreage, most forest-use land is located in Alaska and the Mountain region. The Northeast and Southeast regions have the highest relative areas devoted to **urban** uses, while the Lake States, Corn Belt, Appalachia, Pacific, and Southern Plains regions also have urban-use shares above the national average. Special-use land, most of which is devoted to rural parks and wilderness areas, is largely concentrated in Alaska and the Mountain and Pacific regions.

## Cropland

Total **cropland** has five components (see table 5). The sum of three components—**cropland harvested**, **crop failure**, and **cultivated summer fallow**—constitute **cropland used for crops**, or the acreage devoted to crop production, in a given year.<sup>11</sup> The other two components, **cropland pasture** and **idle cropland**, are not directly used for crop production in a given year but may rotate into production in other years. Total U.S. cropland was estimated at 392 million acres in 2012.

Table 5  
Major uses of cropland, selected years

Year	Cropland used for crops						
	Harvested	Failed	Fallowed <sup>1</sup>	Total <sup>2</sup>	Idle <sup>3, 5</sup>	Cropland pasture <sup>4</sup>	Total cropland <sup>2</sup>
Million acres							
1949	352	9	26	387	22	69	478
1954	339	13	28	380	19	66	465
1959	318	10	31	359	33	66	458
1964	292	6	37	335	52	57	444
1969	286	6	41	333	51	88	472
1974	322	8	31	361	21	83	465
1978	330	7	32	369	26	76	471
1982	347	5	31	383	21	65	469
1987	293	6	32	331	68	65	464
1992	306	8	24	338	56	67	460
1997	321	7	21	349	39	68	455
2002	307	17	16	340	40	62	442
2007	312	8	15	335	37	36	408
2012	315	11	13	340	39	13	392

<sup>1</sup>Cultivated summer fallow. <sup>2</sup>Distribution may not add to totals due to rounding. <sup>3</sup>Includes all acreage diverted from crops under the Acreage Reduction Program, the Conservation Reserve Program (CRP), and other Federal acreage-reduction programs shown in figure 5. <sup>4</sup>Cropland used only for pasture. <sup>5</sup>In 2012, idle cropland does not include CRP land diverted for emergency hay and grazing.

Sources: USDA, Economic Research Service estimates for 2012 derived from USDA, National Agricultural Statistics Service (2012, 2014a, and 2014b); USDA, Farm Service Agency (2014); and USDA, Natural Resources Conservation Service (2015). Estimates prior to 2012 are based on Nickerson et al. (2011); Lubowski et al. (2006b); Vesterby and Krupa (2001); Daugherty (1991 and 1995); Frey (1973, 1979, and 1982); Frey and Hexem (1985); Frey et al. (1968); Wooten et al. (1962); Wooten and Anderson (1957); and Wooten (1953).

<sup>11</sup>Cropland used for crops is the only component of ERS's Major Land Uses (MLU) data series that is updated annually. Although table 5 shows acreage estimates for cropland used for crops only for the years in which the full MLU series is published, annual estimates are currently available for each year from 1910 to 2016. Throughout this section, there are instances where we refer to estimates for cropland used for crops (or one of its components) for years not given in table 5. To conserve space, we do not report the full annual cropland used for crops data series here. For the full cropland used for crops dataset, see MLU data series Summary Table 3 on the ERS website.

## Cropland Used for Crops

At 87 percent of the Nation's cropland base, cropland used for crops (340 million acres in 2012) accounted for the vast majority of total cropland (see table 5).<sup>12</sup> Cropland harvested, the dominant component of cropland used for crops, totaled 315 million acres in 2012 and includes row and closely sown crops, tree fruits and nuts, and vegetables. Crop failure, or planted cropland that was intended to be harvested but was not, accounted for 11 million acres in 2012, with about 44 percent in the Southern Plains and more than 20 percent in the Northern Plains. The 2012 failure rate (3 percent of the acreage planted for harvest) is above the 20-year average but below the 2011 rate (4 percent) (not shown in table 5; see footnote 11). Crop failure stems from a variety of factors, including poor weather conditions, pest infestations, and plant disease. In other instances, crop failure reflects farm revenue losses due to inadequate labor supply, low crop prices, or other factors. Drought was a major factor in crop failures in 2011-12, with the Southern Plains and the Northern Plains regions hit particularly hard. How severe were the conditions? In late summer 2007, about 10 percent of the contiguous States were experiencing extreme or exceptional drought (U.S. Drought Monitor, 2016). By 2011 and 2012, the shares increased to approximately 17 and 24 percent, respectively.

Cultivated summer fallow refers to cropland in subhumid regions that is unplanted for a season or more to control weeds and accumulate moisture. Summer fallow is used extensively in the semi-arid West, and the MLU estimates are restricted to the regions in that area. The use of summer fallow has been decreasing since the late 1960s. In 2012, just over 13 million acres were devoted to summer fallow, less than a third of the area at its peak in 1969. Forty percent of 2012 summer fallow acres were in the Mountain region, 35 percent were in the Northern Plains region, and 25 percent were in the Pacific and Southern Plains regions, combined.

## Cropland Pasture and Idle Cropland

The remainder of total cropland in 2012 was used for **pasture** (13 million acres) or was **idle** (39 million acres). In contrast to permanent **grassland pasture** and **range**, **cropland pasture** is considered to be in crop rotation or could be used for crops without improvements. Much of the cropland used for pasture is rotated between crop and pasture use, although the length of the rotation period varies across farms.

In 2002, cropland pasture accounted for 14 percent of all U.S. cropland (62 million acres). This usage fell over 40 percent by 2007 to 9 percent of all cropland (36 million acres) and then declined again over the next 5 years to just over 3 percent of all cropland in 2012 (13 million acres). Furthermore, a decrease in cropland pasture acres was estimated for all regions in the 2002-07 and 2007-12 periods. However, because of methodological changes in cropland pasture data collection in the Census of Agriculture, the estimates for 2007 and 2012 are not strictly comparable with previous MLU estimates (see box "Cropland Pasture in the Census of Agriculture").

Idle cropland includes land that is completely idled, such as the area diverted from crops under the CRP (initiated in 1985) and other Federal acreage-reduction programs (in effect prior to 1996), as well as land seeded to cover or soil-improvement crops, such as buckwheat and clover, but not harvested or pastured. Idle cropland totaled 39 million acres in 2012, about 10 percent of U.S. crop-

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<sup>12</sup>See MLU data series Summary Table 2 on the ERS website for cropland acreage broken out by region and State.

land. Regionally, idle cropland ranged from 6 percent in the Corn Belt and Delta States to 18 percent in the Mountain States. In 2012, USDA's Farm Service Agency (FSA) and NRCS reported that 29.5 million acres and 2.6 million acres were held under CRP and Wetlands Reserve Program (WRP) contracts, respectively (USDA, FSA, 2014; USDA, NRCS, 2013). Due to the drought conditions in the United States in 2012, emergency haying (1.4 million acres) and grazing (1.4 million acres) were allowed on 9 percent of CRP acres. This portion of the CRP area is not included in the estimates of idle cropland, as it was either pastured or harvested in 2012 and, therefore, accounted for in those respective land-use categories (i.e., grassland pasture and range and cropland harvested, respectively). In addition to land idled through Government programs, some cropland is left idle each year for other reasons. The poor growing conditions attributable to the 2012 drought likely contributed to some of this additional cropland being left idle. Overall, the amount of idle cropland in 2012 was above the U.S. historical average of 38 million acres since 1945, but total amounts have fluctuated throughout the period.<sup>13</sup>

## Cropland Pasture in the Census of Agriculture

Pasture, or rangeland, can generally take one of two forms. Foremost, it includes land that is permanently used for animal grazing. Indeed, noncropped grassland pasture and range makes up the majority of grazing land reported in ERS's Major Land Uses (MLU) data series, accounting for at least two-thirds of the total since 1959. Land may also be grazed intermittently in rotation with other uses, such as crop farming or forestry. Cropland pasture estimates, one of two nonpermanent grazing uses tracked in MLU, declined nearly 80 percent in the past 10 years (2002-12) after exhibiting relative stability for more than 50 years. This decline is largely attributable to methodological changes in the collection of cropland pasture data in the Census of Agriculture, the data source of the cropland pasture category. In the 2002 Census of Agriculture, respondents were asked to report the acreage of "Cropland used **only** for pasture or grazing (*Include rotation pasture and grazing land that could have been used for crops without additional improvements*)." This was the second item in the land-use section of the census questionnaire, falling under the broad heading of "Cropland" and immediately following the question about harvested cropland. In 2007, the wording of the cropland pasture question was identical to that used in 2002, but the question was moved from the second (of five) items in the "Cropland" section to the last (of three) items in the "Pasture" section. In the 2012 census, additional changes were made. While the cropland pasture question remained in the same place as in 2007, the wording was changed to: "Other pasture and grazing land (including rotational pasture) that could have been used for crops without additional improvements." While there is no way to definitively determine the extent of the effects of changes in the placement and wording of the cropland pasture question, it seems likely, given the relatively stable cropland pasture acreage trend from 1949 to 2002, that the changes contributed to the large decrease between 2002 and 2012.

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<sup>13</sup>For regional and State-level data on idle cropland from 1945 to 2012, see the MLU data series on the ERS website.

## Trends in Cropland Uses

Total U.S. cropland acreage has been declining slowly in recent decades. A drop from 478 million acres in 1949 to 444 million acres in 1964 was largely the result of surplus production and subsequent acreage-reduction programs. Cropland acreage was at or above 455 million acres in each census year from 1969 to 1997 (see table 5). But between 2002 and 2007, total cropland dropped 34 million acres (about 8 percent) to 408 million acres and then dropped another 16 million acres (about 4 percent) from 2007 to 2012. From 2002 to 2012, cropland used for crops, the top cropland-use category, maintained an overall level of 340 million acres despite a midperiod decrease of 5 million acres. Thus, the sizable drop in cropland pasture over the last decade (see box on page 15) largely drove total cropland acres in 2012 to the lowest level since the MLU series began in 1945.

### *Changes in cropland used for crops and idled cropland*

Cropland used for crops declined between 1949 and 1969 and then rose to 383 million acres in 1982—close to the level attained when the MLU series began (see table 5). As a result of the U.S. farm crisis of the 1980s, cropland used for crops plummeted; after a slight rebound in the 1990s, it exhibited a more gradual downward trend. Over the most recent 5-year period, 2007-12, cropland used for crops increased 5 million acres (1.5 percent) to 340 million acres.

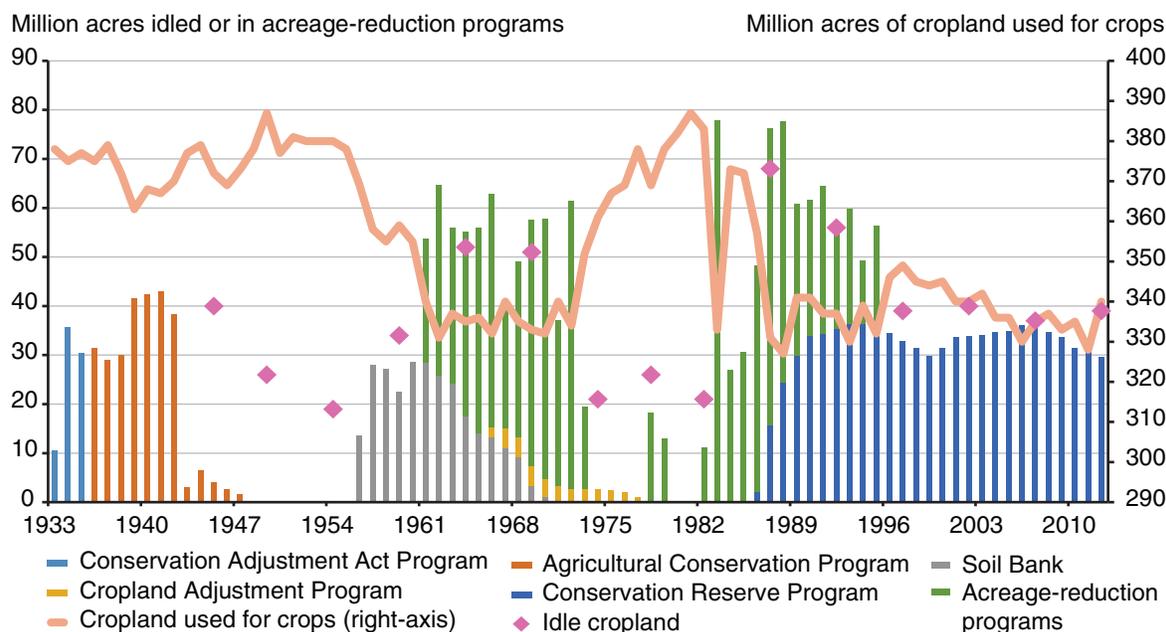
Historically, an inverse relationship exists between two of the components of total cropland: cropland used for crops and cropland idled (fig. 4). As cropland used for crops decreases, idled cropland increases and vice versa. However, between 2007 and 2012, both cropland used for crops and idled cropland increased, despite a 7-million-acre decrease in CRP acreage. The 2007-12 decrease in CRP land follows the trend in the CRP acreage enrollment cap, which was reduced to 32 million acres under the Food, Conservation, and Energy Act of 2008.<sup>14</sup> As noted earlier, however, 18 percent of cropland idled in 2012 came from land not enrolled in the CRP. While it runs counter to historical norms, it is plausible that the concurrent net increase in cropland idled and cropland used for crops is attributable to drought. On one hand, drought may cause some farmers to temporarily take some cropland out of production, increasing the area of cropland idled. However, with commodity prices increasing as they were between 2009-12, the lower-than-average yields could have driven some farmers to increase planted acreage to make up for revenue losses, driving up the area of cropland used for crops. Although we are not aware of any studies that have explicitly analyzed the land-use responses to the 2011-12 droughts and commodity market environment, such a study could be conducted with available plot-level data on weather and land-cover outcomes.

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<sup>14</sup>Although it extends beyond the period covered in this report, the Agricultural Act of 2014 further reduced the CRP acreage enrollment cap to 27.5 million acres in 2014, 26.0 million acres in 2015, 25.0 million acres in 2016, and, eventually, 24.0 million acres in 2017 and in 2018.

Figure 4

**Cropland enrolled in acreage-reduction programs, by program type**



Notes: For yearly detail of programs during 1974-95, see USDA, Economic Research Service (1997). “Acreage-reduction programs” include Acreage Conservation Reserve; 0, 50/85-82 programs; Paid Land Diversion; and Payment-in-Kind programs. Land under these programs is classified as idled cropland in Major Land Uses estimates.  
 Source: USDA, Economic Research Service calculations using data from Crosswhite and Sandretto (1991) and USDA, Farm Service Agency (2008 and 2014).

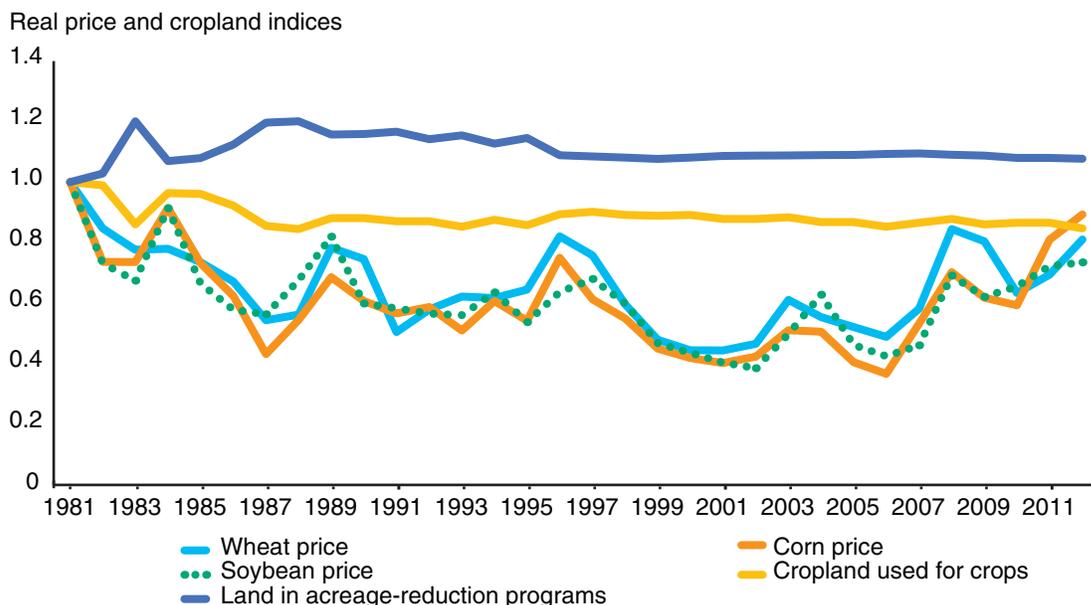
The relationship between cropland used for crops and cropland idled also closely follows fluctuations in commodity prices (fig. 5). From 1980 to 2002, declines in real commodity prices appear to have been followed by increases in idled acreage and corresponding decreases in cropland used for crops and vice versa. This relationship is consistent with a response by commodity producers to changing market incentives and Government efforts to manage commodity supplies and support farm incomes under adverse market conditions.<sup>15</sup> The relative changes in acreage, however, are smaller than the relative changes in prices, which makes sense if there is a positive option value associated with planting decisions. Furthermore, some of the supply-side response to price changes may come at the intensive margin of production (i.e., double cropping and other efforts to increase production on land already used for crops), as opposed to the extensive margin (i.e., changes in the acreage devoted to cropland used for crops).

Between 1980 and 2002, the prices of major commodities (e.g., wheat, corn, soybeans) declined by about 60 percent in inflation-adjusted terms, while total cropland used for crops dropped by about 12 percent. The variation in cropland used for crops in the 1990s was smaller than in the 1980s, despite significant variation in real prices. This pattern may reflect the phasing out and elimination of all Federal acreage-reduction programs aside from the CRP in 1996. Also, as the area of cropland used for crops declines, the remaining cropland is generally of higher average quality and less likely to move in and out of production with short-term price fluctuations. Since 2002, however, although

<sup>15</sup>See Roberts et al. (2004) for a discussion of the counter-cyclical nature of Federal farm payments and the role of Government farm programs in insuring producer risks.

prices of major commodities have continued to exhibit considerable variation along a clear upward trend, the area of cropland used for crops has remained relatively constant. Government programs aimed at minimizing the impact of price decreases, such as the Average Crop Revenue Election (ACRE) program, may have caused some farms (especially wheat farms, as wheat-producing counties had relatively high ACRE enrollment) to keep land in crop use despite price fluctuations (Mitchell et al., 2012).<sup>16</sup> The relative lack of an extensive margin response to price movements also may, in part, be due to increases in crop farm consolidation, where economies of scale give larger farms a greater ability to absorb the revenue losses from short-term price declines (e.g., the wheat price decline from 2008-10) without taking land out of production (MacDonald et al., 2013).

Figure 5  
**U.S. cropland used for crops and commodity prices of key crops**



Notes: Prices are plotted with a 1-year lag to better track incentives at the time of planting. Prices and land areas are indexed to 1 for 1980 to illustrate relative time trends. To construct the index for land in acreage-reduction programs, the acreage is scaled as a share of the acreage in cropland used for crops. As a result, equal percentage changes in the two cropland indices indicate equivalent changes in land area.

Source: USDA, Economic Research Service calculations using data from USDA's National Agricultural Statistics Service deflated with the producer price index for all commodities from the Bureau of Labor Statistics.

Crop insurance has gained prominence in recent years as a farm safety net program. The Federal Crop Insurance and Reform Act (FCIRA) of 1994 increased Federal crop insurance premium subsidies, and additional subsidy increases were introduced in 2000 (Glauber and Collins, 2002). Programs that help insure crops against losses could increase landowner incentives to expand crop production to less productive land. A study on the effect of crop insurance subsidy increases after 1994 estimated that the subsidies increased cultivated acreage in 1997 by about 1 percent, with most of the land coming out of hay and pasture (Lubowski et al., 2006b).<sup>17</sup> This issue has received some additional attention in recent years, as the Agricultural Act of 2014 largely phased out direct

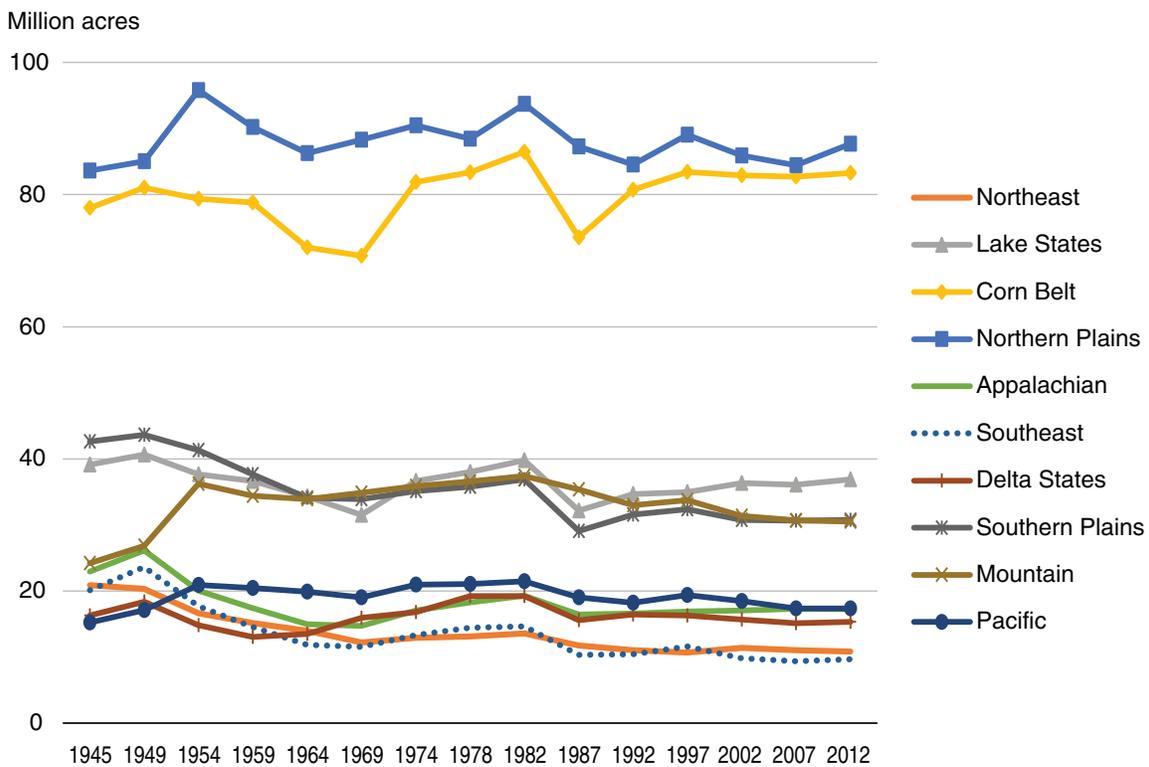
<sup>16</sup>The Average Crop Revenue Election program was introduced in the Food, Conservation, and Energy Act of 2008 but repealed in 2014 and replaced with the Price Loss Coverage and Agricultural Risk Coverage programs.

<sup>17</sup>The land-use changes induced by insurance subsidies were also found to increase annual wind and water erosion by an estimated 1.4 and 0.9 percent, respectively, in 1997 (Lubowski et al., 2006a).

payment programs in favor of expanding crop insurance subsidy programs. For example, both Claassen et al. (2016) and Miao et al. (2016) find that Federal crop insurance programs have a positive, albeit small, effect on the likelihood of noncropland being converted to cropland. However, findings in Weber et al. (2016) suggest that expanded insurance coverage had no effect on levels of cropland harvested over 2000-2013.

Relatively stable cropland trends at the national level can obscure large, offsetting changes at regional and State levels. Trends since 1964 suggest that cropland used for crops peaked in every region in 1982 and subsequently declined during the U.S. farm crisis of the 1980s (fig. 6). However, changes across regions varied following agriculture’s economic recovery. In 2012, cropland used for crops rebounded to 96 percent of its 1982 high in the Corn Belt due to atypically high corn prices but only about 65 percent of its 1982 high in the Southeast.

Figure 6  
**Cropland used for crops trends, by region, for contiguous United States**



Source: USDA, Economic Research Service calculations using data from USDA’s National Agricultural Statistics Service. Data by region are summarized in the Major Land Uses data series on the ERS website.

Some regional changes in cropland used for crops represent year-to-year fluctuations that tend to balance out over time, but both the Northeast and Southeast have experienced clear long-term declines. Urban pressures and a comparative disadvantage in cropland profitability resulted in the conversion of cropland to alternative, more profitable uses in these regions.<sup>18</sup> On the other hand,

<sup>18</sup>According to data collected by NASS (e.g., USDA, NASS, 2008), cropland cash rental rates in the Northeast and Southeast are among the lowest in the country; the Southern Plains is the only region with a lower average rate over 1998-2012. In addition, data from the U.S. Geological Survey’s Land Cover Trends project (accessible on the USGS Land Cover Trends website) indicate that conversion to forest use was a common driver of agricultural land-use change in the Southeast.

changes at the regional level resulted in little change in the concentration of acreage used for crops in major crop-producing regions over 1964-2012 (see the MLU data series on the ERS website for trends by region and State). The Corn Belt accounted for 25 percent of U.S. land used for crops in 2012, compared with 22 percent in 1964; other regions had smaller changes in shares of the U.S. total over the period.

### *Changes in cropland harvested*

Changes in cropland harvested parallel changes in cropland used for crops, except when the latter is driven by large changes in crop failure and cultivated summer fallow. The increase in cropland harvested from 312 million acres to 315 million acres between 2007 and 2012 partly stemmed from favorable economic conditions that induced farmers to increase area planted despite the drought.

### *Changes in failed cropland*

Land marked by crop failure has ranged between 5 million and 22 million acres since 1949. For farmers, large acreage failures are always possible. Crop failures in 1988, 1993, 1996, 1998, 2000, and 2001 averaged around 10 million acres and were attributed to severe drought, extensive flooding, or wet weather. In 2002, crop failure on 17 million acres was the highest in the United States since widespread droughts in 1956 wiped out 22 million acres. Moderate-to-extreme drought reached more than half of the contiguous United States during the summer of 2012 (U.S. Drought Monitor, 2016). Despite the extreme hot and dry weather that created the Nation's worst agricultural drought since 1988, crops failed on just 11 million acres, above the 20-year average but below the respective 17 million and 13 million acres that failed in 2002 and 2011, two recent years marked by significant droughts (see Summary Table 3 of the 2012 MLU data product). In addition, farmers could decide to harvest crops on drought-affected fields, suggesting that the effects of droughts are reflected in other production statistics aside from failed cropland, such as crop yields per harvested acre. Indeed, corn and soybean yields both declined substantially between 2010 and 2012 (USDA, NASS, 2013a).

### *Changes in fallowed cropland*

Summer fallow declined from its peak of 41 million acres in 1969 to about 13 million acres in 2012. Cultivated summer fallow occurs mostly in the Plains region, where it is used in alternate years with small grains, primarily wheat, to conserve moisture and control weeds. The long-term decline in the area used for cultivated summer fallow is partly attributed to the adoption of moisture-conserving soil conservation practices, such as no-till and mulch-till, that have reduced the need for summer fallow. With less summer fallow, farm operators can more intensively use cropland, increasing farm income potential.

### *Changes in cropland pasture*

At 13 million acres in 2012, cropland used for pasture reached its lowest level in the 60 years that ERS has reported land-use statistics. As noted earlier, the recent decline in cropland pasture was partly attributable to methodological changes in the Census of Agriculture that reclassified some cropland pasture to permanent grassland pasture (see box on pg. 15). Prior to 2007, the previous low for cropland pasture was 57 million acres in 1964, compared with a high of 88 million acres in 1969. In several regions (Northeast, Lake States, Corn Belt, Northern Plains, Appalachia), cropland pasture trended downward prior to the 2007 and 2012 Census of Agriculture changes, which is

consistent with trends observed in the dairy industry. Specifically, production has become increasingly concentrated on larger, more industrial farms, many of which purchase most of their feed rather than rely on homegrown forage or feed as is typical with smaller dairy farms (MacDonald and McBride, 2009; MacDonald et al., 2016). Therefore, on large livestock operations, which are becoming more prevalent, there is less of a need for pastureland that may be used in rotation with crop production.

## Trends in Irrigated Land

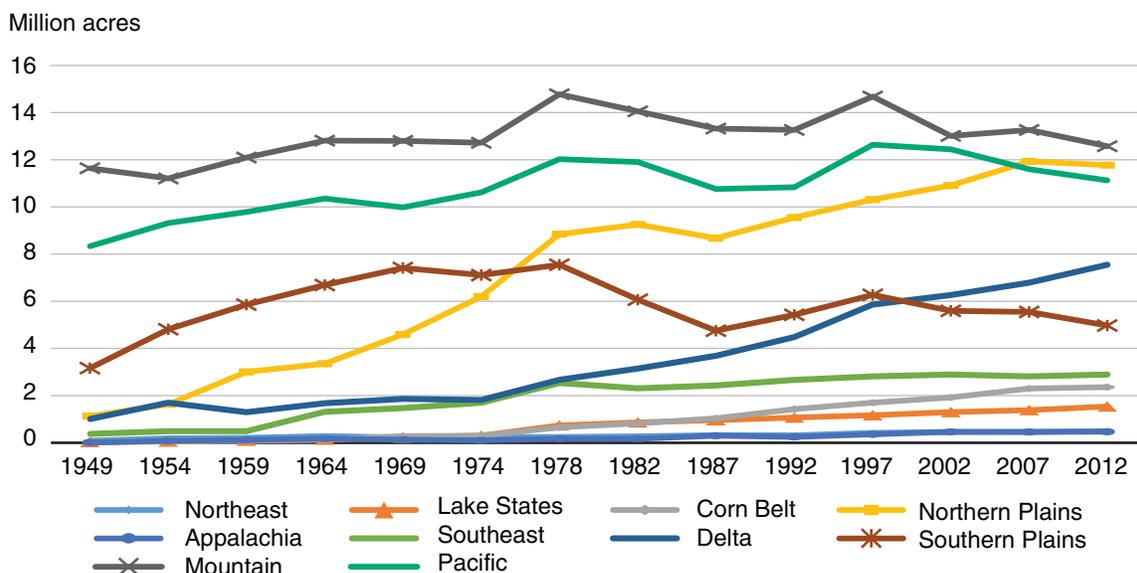
U.S. agriculture consumes about 80 percent of the water used in the United States (Schaible and Aillery, 2012). In 2012, 56 million acres, approximately 52 million of which were used for crops, were irrigated, yet roughly half the value of all crops sold was derived from irrigated land. Despite the importance of irrigation to U.S. agriculture, competing demands for water resources due to population growth, use by the energy sector, and environmental needs have intensified over the past few decades. The amount of irrigated land reported for 2012 dropped slightly from the record-high 57 million acres in 2007, a decline that coincided with the decreased availability of irrigation water during the 2011-12 drought.<sup>19</sup>

Sixty-four percent of irrigated acreage is located in the more arid Western United States (Northern Plains, Mountain, and Pacific regions). Though it contains less cropland than many other regions, the Pacific region is most dependent on irrigation, with 59 percent of its 17 million acres of cropland used for irrigated crops in 2012. The small net decrease (1.4 percent) in the total amount of irrigated land between 2007 and 2012 masks much larger changes observed across regions (fig. 7). Over the period, irrigated acreage made large gains in the Delta (up 765,000 acres, or 11 percent) and Lake States (up 154,000 acres, or 11 percent) regions and small net gains in the Northeast, Corn Belt, Southeast, and Appalachia regions. Irrigated acreage decreased in those regions most dependent on irrigation, with the largest drops in the Southern Plains (down 576,000 acres, or 10 percent) and Mountain (down 689,000 acres, or 5 percent) regions. Irrigated acreage in the Pacific and Northern Plains decreased by smaller amounts.

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<sup>19</sup>For more information on trends in U.S. irrigated agriculture, see the Farm Practices & Management topic page on the ERS website.

Figure 7  
**Irrigated cropland acres, by farm production region**



Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, Censuses of Agriculture, 1949-2012.

## Changes in Principal Crops Harvested

Like the broader trends in cropland used for crops, historical variability in the area of land on which principal crops are harvested is closely tied to the amount of cropland diverted from production through Federal programs.<sup>20</sup> In 1963, 56 million acres of cropland were diverted through the Soil Bank and other acreage-reduction programs. Between 1963 and 1982, harvested acreage of principal crops increased from 287 million to 350 million acres (table 6). In the early 1980s, harvested acreage was high and the amount of cropland diverted by acreage-reduction programs was negligible. Land on which principal crops were harvested declined by 17 percent to 289 million acres between 1982 and 1987 when Federal programs diverted a near record high of 76 million acres. Between 1987 and 1997, the phasing out of the Acreage Reduction Program coincided with an increase in harvested principal crops acreage of nearly 29 million acres. In the ensuing 10-year period, principal crops acreage declined as land enrolled in the CRP expanded, a trend that has reversed in the most recent 5-year-period (2007-12) as CRP enrollment declined. Although the factors driving the changes varied from crop to crop, the increases generally stemmed from some combination of changing prices, export growth, Government programs, and production technology.

The mix of principal crops changed noticeably between 1963 and 2012. Acreage for food crops, particularly wheat, increased substantially during the early part of this period but declined in subsequent decades (fig. 8). Total food crop acreage rose 33 percent between 1963 and 1982, from 55 million to 93 million, due to large increases in harvested wheat acreage. However, this gain was counterbalanced by a decline, nearly as large in acreage terms, from 1982 to 2012.

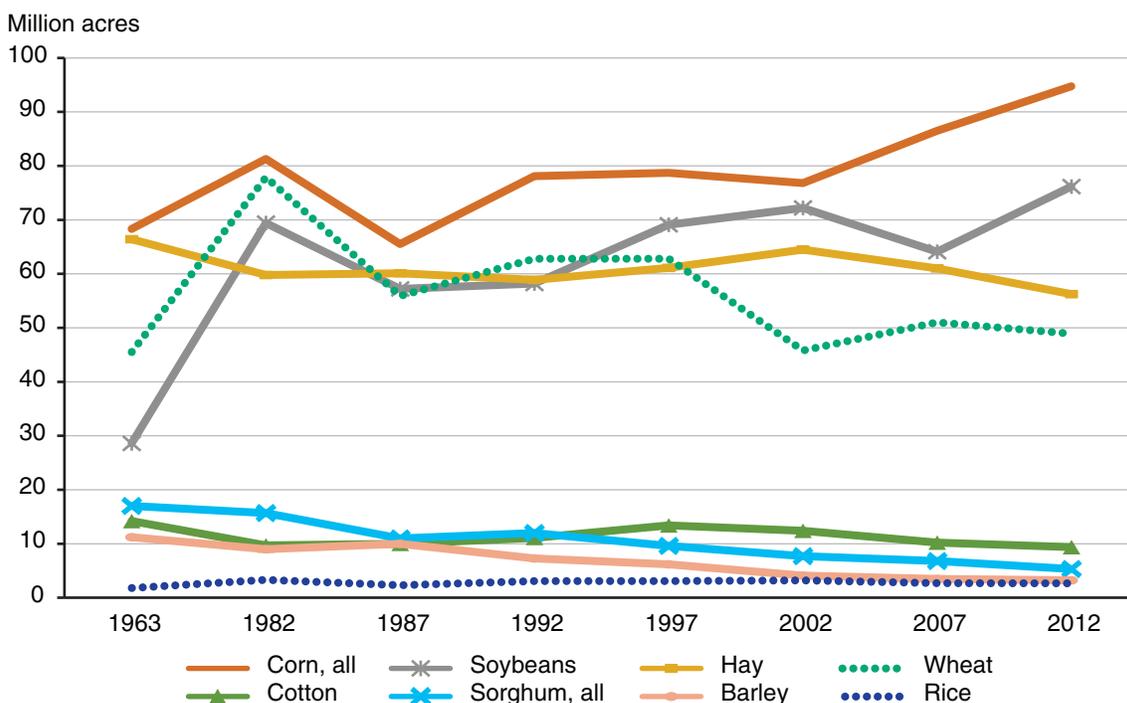
<sup>20</sup>For a complete list of all principal crops, see USDA, NASS (2014b). In table 6, we show the historical trends in the principal crops with the largest acreages or changes in acreage over time.

The largest change in food crops harvested during the period was the 52-percent decrease in wheat acreage from its historic high in the early 1980s (fig. 8). Factors contributing to this downward trend include a reduction in the relative profitability of wheat due to increased foreign competition, CRP participation in wheat-producing areas, and genetic refinements to corn and soybean varieties that allowed these crops to be planted in areas previously used primarily for wheat (Vocke et al., 2005; Vocke and Ali, 2013).

Feed crop acreage increased by an amount similar to that of food crops from 1963 to 1982, followed by a relatively sharp decline during the 1980s and a subsequent rebound over 1992-2012 (see table 6). The 11-percent increase in feed crop acreage over five decades stemmed from a combined 76-percent increase (74 million acres) in harvested soybean and corn acreage. A joint 50-million-acre reduction in land harvested for oats (down 95 percent), barley (down 71 percent), sorghum (down 69 percent), and hay (down 15 percent) partly offset the upward movement of soybean and corn acreage.

Soybean acreage more than doubled from roughly 29 million acres in 1963 to over 76 million acres in 2012. In 1997, soybeans surpassed wheat as the second-leading U.S. food and feed crop (behind corn) in terms of planted acreage. Between 1995 and 2013, the dollar value of U.S. soybean exports more than doubled, largely due to increases in demand from China, the leading destination for U.S. agricultural exports in 2012.<sup>21</sup>

Figure 8  
Trends in most common principal crops harvested, 48 contiguous States



Notes: The solid lines are feed and nonfood crops and the dashed lines are food crops. Some feed crops are used as inputs to food products and biofuels.

Source: USDA, Economic Research Service calculations using data from Daugherty (1995) and USDA, National Agricultural Statistics Service (1999b, 2005, 2009b, and 2014b).

<sup>21</sup>For more information on the destination and value of U.S. agricultural exports, see the International Markets & Trade topic page on the ERS website.

Table 6

**Principal U.S. crops harvested, 48 contiguous States, million acres**

Crop	1963	1982	1987	1992	1997	2002	2007	2012	Change	
									1963-1982	1982-2012
<b>Food crops</b>										
Wheat	45.5	77.9	55.9	62.8	62.8	45.8	51.0	48.9	32.4	-29.0
Sugar beets	1.2	1.0	1.3	1.4	1.4	1.4	1.2	1.2	-0.2	0.2
Potatoes	1.3	1.3	1.3	1.3	1.4	1.3	1.1	1.1	0.0	-0.2
Dry edible peas	0.3	NR	0.2	0.2	0.3	0.3	0.8	0.6	NA	NA
Sugarcane	0.5	0.7	0.7	0.9	0.9	1.02	0.8	0.9	0.2	0.2
Rice	1.8	3.3	2.3	3.1	3.1	3.2	2.7	2.7	1.5	-0.6
Rye	1.6	0.7	0.7	0.4	0.3	0.3	0.3	0.2	-0.9	-0.5
Sunflowers	NR	4.7	1.8	2.0	2.8	2.2	1.7	1.8	NA	-2.9
Dry edible beans	1.4	1.8	1.7	1.5	1.8	1.7	1.5	1.7	0.4	-0.1
Sweet potatoes	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-0.1	0.0
Peanuts	1.4	1.3	1.5	1.7	1.4	1.3	1.2	1.6	-0.1	0.3
Total	55.2	92.8	67.5	75.4	76.3	58.6	62.4	61.0	33.2	-32.5
<b>Feed crops</b>										
Corn, all	68.3	81.3	65.5	78.1	78.7	76.8	86.5	94.8	13.0	13.5
Soybeans	28.6	69.4	57.2	58.2	69.1	72.2	64.1	76.2	40.8	6.8
Sorghum, all	17.0	15.7	11.0	12.0	9.6	7.7	6.8	5.3	-1.3	-10.4
Barley	11.2	9.0	10.0	7.3	6.2	4.1	3.5	3.2	-2.2	-5.8
Oats	21.3	10.3	6.9	4.5	2.8	2.1	1.5	1.0	-11	-9.3
Hay	66.4	59.8	60.1	58.9	61.1	64.5	61.0	56.3	-6.6	-3.5
Total	212.8	245.5	210.7	219.0	227.5	227.4	223.4	236.8	32.7	-8.7
<b>Other crops</b>										
Tobacco	1.2	0.9	0.6	0.8	0.8	0.1	0.4	0.3	-0.3	-0.6
Cotton	14.2	9.7	10.0	11.1	13.4	12.4	10.2	9.4	-4.5	-0.3
Flaxseed	3.2	0.7	0.5	0.2	0.1	0.1	0.3	0.3	-2.5	-0.4
Total	18.6	11.3	11.1	12.1	14.3	12.6	10.9	10.0	-7.3	-1.3
Total principal crops <sup>1</sup>	286.6	349.6	289.3	306.5	318.1	298.6	296.7	307.8	63.0	18.5

NA = calculation not applicable. NR = statistic not reported. <sup>1</sup>Distributions may not add due to rounding. The above crop classifications (food, feed, and other) are based on the predominant use of each crop. Due to data limitations, it is not possible to distinguish between the harvested acreages for multi-use crops (e.g., soybeans).

Sources: USDA, Economic Research Service using data on principal crops harvested from Frey and Hexem (1985); Daugherty (1991 and 1995); and USDA, National Agricultural Statistics Service (1999b, 2005, 2009, and 2014b).

Market forces and changes in farm programs have affected supply and demand for the four most common principal crops (corn, soybeans, wheat, and hay) that account for 90 percent of principal crop harvested acres in the United States (see fig. 8). The increase in planting flexibility, introduced with the Food, Agriculture, Conservation, and Trade Act of 1990 and culminating with the Federal Agriculture Improvement and Reform Act of 1996, enabled producers to increase more profitable soybean plantings without jeopardizing payments associated with their base acreage in wheat, corn, and other program crops. Such shifts could have been costly under previous farm programs.

Additionally, recent studies find that Federal crop insurance has a positive, albeit small, effect on corn plantings (see Claassen et al., 2016; Walters et al., 2012).

Another trend that has affected U.S. crop plantings over the past 30 years is the use of crops as a biofuel input source. Over the past decade, the use of corn for biofuel increased sharply due to the mandate in the Energy Policy Act of 2005 to increase the amount of renewable fuels in the U.S. fuel supply. This law, coupled with an expansion of required amounts of renewable fuels in 2007, boosted production of corn ethanol. Using data from a special survey of corn and soybean farmers, Wallander et al. (2011) found that producers' shifts from soybeans to corn drove the expansion in corn acreage over the 2006-08 period. Other producers, however, shifted acreage from other crops, primarily cotton, to soybeans, offsetting much of the shift from soy to corn. Total acreage of harvested cropland on corn and soybean farms expanded during the period, with about a third of the increase due to shifts from hay and CRP/idle land and increases in double cropping. More recently, Beckman et al. (2013) found that gains in planted corn acreage over the longer 2001-12 period in response to biofuel demand resulted in a net decrease in land used to grow barley, oats, and sorghum.

## Grassland Pasture and Range and Total Grazing Land

In 2012, just over 35 percent of U.S. land area, or 798 million acres, was used for grazing (i.e., **grassland pasture and range, cropland pasture, and forestland grazed**) (see table 7). This estimate includes forested land on which grazing occurs, but it excludes land that is grazed and used for crop production in a single year (e.g., fall and winter grazing of small grains and after-harvest grazing of hay land). The three types of grazing land discussed here differ greatly in terms of acreage, distribution, productivity, and other characteristics (see Daugherty (1989) for an overview of U.S. grazing lands from 1950 to 1982).

### Grassland Pasture and Range

The vast majority of U.S. grazing land (655 million acres, or more than 80 percent of the total) was used as grassland pasture and range in 2012.<sup>22</sup> Four regions accounted for about 589 million acres, or 90 percent, of U.S. grassland pasture and range—50 percent in the Mountain region, 19 percent in the Southern Plains, and 21 percent in the combined Northern Plains and Pacific regions. No other region holds more than 3 percent of the total. In all regions, grassland pasture and range is the dominant type of grazing land. Grassland pasture and range account for more than half of the total land area in the Southern Plains and Mountain regions. Other regions with large shares of their total land base used for grassland pasture and range include the Northern Plains (41 percent) and the Pacific (28 percent) regions.

### Cropland Pasture

At 13 million acres, cropland pasture—the smallest but generally most productive component of grazing acreage—accounted for 1 percent of total U.S. land area and 2 percent of total U.S. grazing acreage in 2012. While cropland pasture is considered part of the cropland base and is included in the estimate of total cropland, it may be marginal from the perspective of crop production and can remain in pasture for extended periods of time. Cropland pasture is concentrated in the Southern Plains region, where 30 percent of all land in this use is located. The regional shares of total cropland pasture are generally much higher in the central United States, where most of the Nation's cropland is located.

### Grazed Forestland

The 130 million acres of grazed forestland in the United States in 2012 included acreage in open forest, land reverting to forest, and other forested areas with grass or other forage growth that are grazed to some extent. Grazed forestland ranged from less than 1 million acres in the Far West to 71 million acres in the Mountain region. In the Mountain and Pacific regions, the majority of grazed forestland is on land managed by USDA's Forest Service (FS), whereas the majority of grazed forests in other regions tend to be privately owned. This pattern reflects the distribution of FS land across the country (Vincent et al., 2014). The value of forestland for grazing varies widely across regions and depends on grazing productivity and demand; the amount of forestland; and other idio-

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<sup>22</sup>Although both "grassland pasture" and "range" are used for grazing, the two terms are primarily distinguished by the type of grass species present. The former term is more commonly used in the Eastern United States, and the latter is used in the Western United States.

syncratic factors, including climate and forest characteristics such as species composition, stand density, and tree canopy cover. Values are relatively high on open stands of pine in the South, for example, where the warm climate permits grazing throughout the year. Upland hardwood stands, on the other hand, which have a more complete canopy, promote lower forage production, although a substantial amount of acreage may be grazed due to availability and limited alternative uses. Ponderosa pine and other open forest types in the West enable seasonal grazing, but forestland thick with growing trees, such as fir trees, generally offers little grazing value.

## Trends in Grazing Acreage

Taken together, total grazing land increased by 21 million acres between 2007 and 2012, the first estimated increase in this land use since the start of the MLU estimates in 1949. Total grazing land declined by about 243 million acres (about 24 percent) from 1949 to 2007 (table 7). The long-term decline in grazing land is consistent with trends in the dairy and beef cattle industries, which have been characterized by a move toward more efficient large-scale industrial operations, while some smaller producers who grazed their herds went out of business (MacDonald and McBride, 2009; MacDonald et al., 2016). Grassland pasture and range has been relatively more stable over time than the other components of total grazing land. Over the most recent 5-year period (2007-12), grassland pasture and range increased 41 million acres (7 percent), but this shift was largely due to methodological changes in the Census of Agriculture (see box on page 15) and FS's Forest Inventory Analysis, which resulted in some land being reclassified from forest-use and cropland pasture to grassland pasture and range. Grazed forestland, the remaining grazing land component, increased by 3 million acres (2 percent) over 2007-12.

Despite a long-term decline, total U.S. grazing land increased between 2007 and 2012. The increase in grassland pasture and range use over this period is plausibly due to some cropland being taken out of production in response to the drought in 2011-12, particularly in the Western United States. As forage yields declined, some livestock farmers may have acquired new pastureland to compensate for the reduction in pasture/range productivity. Growth in commercial dairy exports also expanded after 2003, giving farmers an incentive to boost domestic production, potentially at the extensive margin, to meet this new market opportunity (MacDonald et al., 2016). Another factor that can influence the trajectory of grazing acreage is crop prices. When crop prices are high, as they were for several major crops during 2007-12 (see fig. 5), landowners may convert some pasture and range parcels to cropland. Cropland pasture lands, in particular, are most suited to shift into crop production when commodity prices are high enough to offset conversion costs and the economic returns to grazing (i.e., the opportunity cost of cropland use). Indeed, in the Corn Belt, where highly productive land for corn and soybean production is concentrated, the increase in grassland pasture and range area during the period was more muted (in absolute terms) than that in other regions.

According to the NRI (USDA, NRCS, 2014b), a roughly equal amount of pasture/range-to-cropland and cropland-to-pasture/range transitions occurred between 2007 and 2012. Substantial acreages of land used for grazing also shifted to recreational, wildlife, and environmental uses. Under favorable growing conditions, particularly in the South, pastureland may also revert to forest. NRI data (USDA, NRCS, 2014b) suggest that pasture-forest transitions brought about the bulk of new forestland between 2007 and 2012. In addition, like cropland, grazing land can also be converted to urban uses to serve the needs of expanding cities and exurban areas. Despite the increase in grazing land between 2007 and 2012, these sources of change have, in combination, led to a long-term net decline in grazing acreage of over 200 million acres since 1949 (table 7).

Although the most recent change period (2007-12) indicates a relatively small increase of 3 million acres, grazed forestland decreased 190 million acres (59 percent) from 1949 to 2012 (table 7). A number of factors combined to trigger this long-term decline, including increases in forest-stand density restrictions that reduced grazing possibilities, improvements to both livestock feeding and forest management practices, and the large decline in total farmland and the number of farms since 1950. These factors had the largest effect in the South, where grazing in wooded areas is relatively common.

Table 7  
**Total U.S. grazing land, by type**

Year	Cropland pasture <sup>1</sup>	Grassland pasture and range <sup>2</sup>	Subtotal	Grazed forestland <sup>3</sup>	Total <sup>4</sup>
Million acres					
1949	69	632	702	320	1,022
1954	66	634	700	301	1,001
1959	66	633	699	245	943
1964	57	640	698	225	922
1969	88	604	692	198	890
1974	83	598	681	179	860
1978	76	587	663	172	835
1982	65	597	662	158	820
1987	65	591	656	155	811
1992	67	591	658	145	803
1997	68	580	648	141	788
2002	62	587	648	134	783
2007	36	614	650	127	777
2012	13	655	668	130	798

<sup>1</sup>Cropland pasture estimate based on the Census of Agriculture (e.g., USDA, National Agricultural Statistics Service, 2014a). See box "Cropland Pasture in the Census of Agriculture" for more information on how cropland pasture acreage information is elicited. <sup>2</sup>Grassland and other nonforested pasture and range based on the National Resources Inventory (e.g., USDA, Natural Resources Conservation Service, 2014a), Census of Agriculture (e.g., USDA, National Agricultural Statistics Service, 2014a), and estimates of open or nonforested grazing land on Federal land (e.g., USDA, Forest Service, 2012b; U.S. Department of the Interior, Bureau of Land Management, 2013). <sup>3</sup>Estimates of total grazed forest acreage are based on acreage estimates of active grazing allotments in national forests, plus grazed woodlands on nonfederally owned land from the Census of Agriculture and the National Resources Inventory. Though available for grazing, not all the acreage in active grazing allotments may be currently grazed. <sup>4</sup>Distribution may not add to totals due to rounding.

Sources: USDA, Economic Research Service calculations using data from USDA, National Agricultural Statistics Service (2014b); USDA, National Agricultural Statistics Service (2014a); USDA, Natural Resources Conservation Service (2014a); U.S. Department of the Interior, Bureau of Land Management (2013); Oswalt et al. (2014); USDA, Forest Service (2012a); USDA, Forest Service (2016); U.S. Department of the Interior, Bureau of Land Management (2012); USDA, Forest Service (2012b). Estimates prior to 2012 are based on Nickerson et al. (2011); Lubowski et al. (2006b); Vesterby and Krupa (2001); Daugherty (1991 and 1995); Frey (1973, 1979, and 1982); Frey and Hexem (1985); Frey et al. (1968); Wooten et al. (1962); Wooten and Anderson (1957); and Wooten (1953).

## Forest-Use Land and Total Forested Land

**Forested land** used for all purposes totaled 766 million acres in the United States in 2012, including **forest-use land** and land in other uses, such as **special uses**, that has forest cover (table 8). The forest-use classification is a subset of forested land that includes both grazed and ungrazed forests capable of being used for timber harvests but excludes forestland in parks, wildlife areas, and other special uses, where commercial timber harvests are rare. By removing land that has forest cover but cannot generally be used for timber harvests or grazing, the refined forest-use area is a more realistic approximation of the land that may serve commercial forest uses.

Table 8  
**Total forested land by region, 2012**

Region	Grazed forest	Ungrazed forest-use land	Total forest-use land	Forested land in other uses <sup>1</sup>	Total forestland
Thousand acres					
Northeast	464	65,206	65,670	7,022	72,692
Lake States	1,750	50,168	51,918	2,560	54,478
Corn Belt	5,277	30,160	35,437	815	36,252
Northern Plains	2,869	3,309	6,178	545	6,723
Appalachia	2,745	67,884	70,629	2,435	73,064
Southeast	2,529	73,475	76,004	2,222	78,226
Delta States	3,374	49,310	52,684	325	53,009
Southern Plains	11,457	10,556	22,013	30,561	52,574
Mountain	71,481	27,364	98,845	25,770	124,615
Pacific	27,837	31,351	59,188	25,091	84,279
Far West	30	93,086	93,116	37,209	130,325
United States	129,813	501,869	631,682	134,555	766,237

<sup>1</sup>Forested land not included in "forest-use" was reclassified for the purposes of the Major Land Uses series. Much of this land was determined to fit under the special-uses category, which includes forested parks and wilderness areas. However, in some States (e.g., Texas and Oklahoma), grassland pasture and range appeared to be the best fit. In Alaska, much of the other forested land is contained in the "miscellaneous" use category.

Source: USDA, Economic Research Service calculations using data from Oswald et al. (2014); U.S. Department of the Interior, Bureau of Land Management (2013); USDA, Forest Service (2012a); USDA, Forest Service (2016); U.S. Department of the Interior, Bureau of Land Management (2012); and USDA, Forest Service (2012b).

These 2012 estimates of forest-use land incorporate definitional changes found in the Forest Inventory Analysis (FIA) and the *Forest Resources of the United States, 2012* report by Oswald et al. (2014).<sup>23</sup> Specifically, changes to the "in situ" height requirement (from 13.1 to 16.4 feet) for what constitutes a tree has led to some reclassification of lands that were previously considered "forest" to a new "woodland" class. In addition, some lands that were previously not accounted for in the FIA were also classified as woodland (Oswald et al., 2014). Note that the areas labeled as woodland in Oswald et al. (2014) are not included in the **forest-use** class, nor are they accounted for in the esti-

<sup>23</sup>The *Forest Resources of the United States, 2012* report by Oswald et al. (2014) is the latest in a recurring series of reports by the Forest Service to inventory the composition and changes in forestland nationwide.

mate of **forested land**.<sup>24</sup> These classification changes mainly affect MLU estimates for several arid Mountain States—New Mexico, Arizona, Nevada, and Utah—and Alaska.

## Forest-Use Land

An estimated 632 million acres were in forest use in 2012 (table 8). About 130 million acres of forest-use land (21 percent) was grazed, and the remainder was largely used, or capable of being used, for timber production. Forest-use land is about equally divided between the Eastern (Northeast, Appalachia, Southeast, Lake States, Corn Belt, and Delta regions) and Western (Northern and Southern Plains, Mountain, Pacific, and Far West regions) United States. Forest-use land predominates in the Northeast, Southeast, Appalachia, and Delta States, accounting for 57-61 percent of all land in these regions. A relatively large share of the Lake States and Pacific regions is also devoted to forest uses—43 and 29 percent of all land, respectively. Forest-use acreages in the Mountain region and Alaska are quite large but make up smaller shares of each region's total land area (18 and 25 percent, respectively).

## Total Forested Land

More than two-thirds of total forested land in the United States in 2012 was **timberland**—forests capable of commercial timber production and not removed from timber use by statute or administrative regulation (table 9; Oswald et al., 2014). The greatest shares of timberland were in the Southeast (15 percent), Appalachia (14 percent), Northeast (13 percent), and Mountain (12 percent) regions. The remainder of the Nation's total forested land is a combination of **reserved forestland** and **other forestland**. Much of the reserved forestland is available for recreational use (see "Special Uses") These forested lands provide watershed protection, wildlife habitats, and parks; some serve other purposes, depending on the region. Other forested land includes land that is less productive for commercial harvest but produces other wood and tree products, such as fuelwood. Much of this land is located in high-elevation areas, in Alaska, or in the dry, pinion-juniper lands of the interior West (Oswald et al., 2014).

About 35 percent of all reserved and other forested land (e.g., parks, wilderness areas, and wildlife refuges) in the United States is in the Mountain and Pacific regions, where the two categories jointly account for over 40 percent of all forested land. Much of the remainder (47 percent) of reserved and other forested land is in Alaska, where it accounts for 90 percent of all forested land (table 9). In contrast, the combined area of reserved and other forestland accounts for no more than 8 percent of all forested land in any region east of the Mississippi River.

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<sup>24</sup>This decision was made in an effort to be consistent with the historical definition of forest-use in the Major Land Uses (MLU) series. As mentioned earlier, the "forest-use" category is intended to capture land that is a forest or may serve commercial forest uses. Therefore, while Oswald et al. (2014) included chaparral and other lands with woody vegetation in the "woodland" category, the uses of these lands are more consistent with either the grassland pasture and range or miscellaneous other use classes. Similarly, since its inception, the MLU has generally not included land considered "other forestland" as being in forest use, since, by definition, such land is "incapable of annually producing 20 cubic feet [of timber] per acre [...] under natural conditions because of adverse site conditions [...]" (Oswald et al., 2014, p. 33).

Table 9

**Total forestland and woodland by class and region, 2012**

	Forestland			
	Timberland	Reserved	Other	Total forestland
	Thousand acres			
Northeast	67,962	4,323	407	72,692
Lake States	52,118	1,468	892	54,478
Corn Belt	35,438	527	288	36,252
Northern Plains	6,180	63	482	6,723
Appalachia	71,121	1,689	252	73,064
Southeast	76,093	1,680	452	78,226
Delta States	52,684	230	95	53,009
Southern Plains	22,012	276	30,285	52,574
Mountain	64,844	17,425	42,345	124,615
Pacific	59,189	11,908	13,183	84,279
48 States <sup>1</sup>	507,641	39,589	88,681	635,912
Alaska	12,817	33,735	82,025	128,577
Hawaii	700	196	853	1,748
United States <sup>1</sup>	521,158	73,520	171,559	766,237

<sup>1</sup>Distributions may not add due to rounding.

Source: USDA, Economic Research Service using data from Oswald et al. (2014).

## Trends in Forest-Use and Forested Acreage

Forest-use land area has generally trended downward since 1949. Much of the 16-percent decline from 1949 to 1997 was a result of land being reclassified from forest-use to special-use areas (see “Special Uses”). In recent years, forest-use area increased 10 million acres and 20 million acres across the 1997-2002 and 2002-07 MLU assessments, respectively. However, forest-use land decreased by 40 million acres (6 percent) from 2007 to 2012. This decline is primarily attributed to FS’s reclassification of forestland to woodland in the Southern Plains and Mountain regions.<sup>25</sup>

Because forested land provides numerous ecosystem services, such as carbon sequestration, water filtration, and wildlife habitat, information on trends in total forested land (forest-use land, as well as other multiple-use areas with forest cover) can be an important component of land-use analysis. Total forested land in the United States declined from colonial times until about 1920, increased from 1920 to 1960, and then trended downward between 1960 and 1987 (USDA, FS, 1982). Urbanization and conversion of forested land to agricultural uses in Southern U.S. regions also contributed to the decline. Development-induced changes, however, may have been greater if various Federal and State programs had not provided incentives for private landowners to plant trees (Smith et al., 2009). Total forested area increased by about 34 million acres from 1987 to 2012, mirroring

<sup>25</sup>This trend continues to follow that seen in States such as California, where, between 2002 and 2007, the Forest Service’s definitional change to exclude chaparral, sparse juniper, and scrub oak land in the West largely accounted for a 6.8-million-acre decline in forest-use land (Smith et al., 2009). Forest-use land in California declined another 10 million acres between 2007 and 2012. This was due to reclassifications of relatively unproductive forestland away from the MLU forest-use category. Similar reclassifications led to reduced forest-use land in Nevada, Utah, Arizona, Wyoming, Montana, Colorado, and New Mexico.

the trend in timberland, the largest component of total forested land (Oswalt et al., 2014). Along with changes in forest cover, forests can also change in species and age composition and health due to human-induced changes and natural processes of mortality and regeneration (Smith et al., 2009). For example, since the 1950s, the share of timberland occupied by sawtimber-sized trees increased in the Eastern United States. Over the same period, the relative amount of poletimber, seedlings, and saplings decreased (Oswalt et al., 2014).

Recent increases in timberland area stem partially from a reclassification of some national forestland due to standardization with protocols in use on other types of land ownership. Some of the increases in total timberland since 1987 may also reflect a response to rising real prices for forest products. Based on a national-level analysis of NRI data, Lubowski et al. (2008) find that increases in net returns from timber production, combined with a decline in profits from crops, were the major determinants of forest-area change from 1982 to 1997. While timberland acreage increased nationally, changes were not uniform across the country, reflecting the regional nature of forest product markets.

## Urban and Rural Residential Uses

Total land in urban use in the United States was estimated at 70 million acres in 2012, a 15-percent increase over the previous estimate for 2007 (61 million acres). The 2012 estimate is the highest recorded since the start of the MLU series.<sup>26</sup>

Comparing the MLU urban-area estimate with estimates derived from alternative data sources for urban, or related, land uses illustrates how the MLU urban-area estimate differs from an estimate of total developed land. The MLU urban-area estimate is based on data from the U.S. Census of Population and Housing; it represents densely populated “urbanized areas” with at least 50,000 people and “urban clusters” with 2,500-50,000 people. The estimate excludes portions of extended cities that are essentially rural in character and rural residential lots. As such, it under-represents developed land uses. The American Housing Survey (AHS), a periodic national survey administered by the U.S. Department of Housing and Urban Development (HUD) and the U.S. Census Bureau, can be used to derive estimates of land area in rural regions attributable to residential housing lots (USDOC, CB, 2014a). According to the 2013 AHS, the combined urban and rural residential land area in the United States amounted to 139.1 million acres. Of this total, 32.8 million acres were attributable to urban residential lots, while the remaining 106.3 million acres were in nonfarm, rural residential use. Although the 1-year discrepancy makes the 2013 AHS and 2012 MLU estimates not strictly comparable, the 32.8 million acres in urban residential use amounts to 47 percent of the MLU urban-area estimate of 70 million acres, suggesting that 53 percent of urban land is in nonresidential use (e.g., commercial). Taken in combination, the AHS and MLU estimates suggest that urban land and rural residential areas account for 176 million acres, or 7.8 percent of total U.S. land area.

Another source for developed land-use estimates in the United States (excluding Alaska), of which urban area is a part, is the NRI. Unlike the urban land definition used in the census, which is based on population and land contiguity, the NRI developed land estimates are based on the amount of land that has been removed from rural uses (Nickerson et al., 2013). According to the most recent NRI data, developed land totaled 114 million acres in 2012. This estimate includes 84 million acres in large-scale urban use (10 acres or greater), 7 million acres in small-scale urban use, and 23 million acres of rural transportation land (USDA, NRCS, 2014a).<sup>27</sup> The discrepancy between the MLU (70 million acres) and NRI (84 million or 91 million acres, depending on whether small-scale uses are considered) estimates suggests that there are 14-21 million acres of land in the United States that are in an urban use but do not meet the census criteria used to form the MLU urban-area estimate.<sup>28</sup>

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<sup>26</sup>As noted in the 2002 and 2007 versions of the MLU report (Lubowski et al., 2006b and Nickerson et al., 2011, respectively), the urban area definition was revised in the 2000 Census of Population and Housing to take advantage of advances in geographic information systems (GIS) processing technology, which resulted in fewer outlying low-density developed areas being included in census-recognized urban areas. The definition of urban areas in the 2010 census was largely the same as that used in the 2000 census (USDOC, CB, 2010), providing an opportunity to construct the 2012 MLU urban area from two consistently measured census estimates. Although the 2007-12 change in urban-use area (9 million acres) is much larger than the corresponding 2002-07 change (1 million acres), the overall gain between 2002 and 2012 (10 million acres) is in line with the change reported in the 2000 and 2010 census (9 million acres).

<sup>27</sup>An estimate of the land area used for rural transportation based on U.S. Department of Transportation records is included in the MLU special-uses category.

<sup>28</sup>For additional information on the current urban-area definition used by the U.S. Census Bureau, including the changes that led to the current definition, see USDOC, CB (2010).

Ideally, the MLU would distinguish rural residential land and other forms of rural development (e.g., commercial and industrial rural land) from the other land uses identified in this report. However, making this distinction is problematic for several reasons. The NRI urban land-use estimate of 91 million acres overlaps with the census-based estimate of urban land area, but the difference, 21 million acres, accounts for less than 20 percent of the AHS estimate of rural residential area. Since the AHS estimates are not available for individual States, a more disaggregated comparison cannot be made between the NRI and AHS. Further, in addition to land used for residential purposes, the NRI estimate includes other types of developed and built-up land in its urban use definition, which are captured in the miscellaneous other MLU category (see page 41). Since the NRI estimates are based mainly on interpreting satellite imagery, misclassification of rural residential lands as other rural uses (e.g., grassland or forest) is possible, as sparse development patterns are difficult to identify using such methods (Irwin and Bockstael, 2007). Due to these data constraints, the rural residential land area estimate presented here is not added to the MLU urban land estimate, nor is it explicitly accounted for in a separate MLU category.

## Trends in Urban and Rural Residential Uses

Over seven decades, the urban land area of the United States increased by a factor of 4.7, rising from roughly 15 million acres in 1945 to an estimated 70 million acres in 2012. Over the same period, according to the U.S. Census Bureau, the population of the United States increased from approximately 140 million to 314 million. Although the definition of urban land used by the Census Bureau changed over time, these broad measures suggest that the pace of urban development increased at a rate more than twice that of population growth.

Given the periodic changes in the Census Bureau's definition of urban land, inter-census comparisons of urban land are not always possible, particularly in more recent years. Results based on past urban-area definitions indicate decadal gains in urban land area of 9.1 million acres (1960s), 12.8 million acres (1970s), and 8.6 million acres (1980s). These changes are in line with those derived from the updated urban-area definition, which suggests a gain of 7.4 million acres in the 1990s and 9 million acres in the 2000s.

The difference between population growth rates and urban land-area growth rates can, to some degree, be attributed to the increased prevalence of suburban residential land use, which characterizes the way in which many urban cities expanded over time (Heimlich and Anderson, 2001). Suburban land use typically takes place on larger lots, and, thus, reduces population density relative to development that may occur in more centralized urban areas. Indeed, the AHS-based estimate of land in rural residential use nearly doubled over the last three decades: 56 million acres in 1980, 73 million acres in 1997, 94 million acres in 2002, 103 million acres in 2007, and 106.3 million acres in 2013. The relatively low growth in rural residential land between 2007 and 2013 is likely an artifact of the housing crisis that marked the early portion of the period, which decreased the demand for residential land. As noted earlier, the MLU urban-use estimates do not account for rural residential growth, a form of development that has been noted as a major driver of land development in some areas (see, e.g., Irwin et al., 2009), which could account for some of the discrepancy between population and urban land growth rates.

NRI data provide a means to track the land use of individual plots over time, facilitating an examination of the sources of land-use change (i.e., land use prior to development). The data suggest that the net gain in developed land (43 million acres) between 1982 and 2012 was largely driven by the

conversion of forest and cropland, which account for 41 percent and 27 percent of total conversions to developed uses, respectively (USDA, NRCS, 2015). The remaining development primarily occurred on pasture, range, or other lands. In the most recent NRI transition period (2007-12), land development followed similar patterns, with the majority of conversions on land previously in forest (42 percent) and crops (21 percent).

As new land is developed, additional rural land that has not been converted becomes subject to urban influence, which can affect the investment and land-use decisions of private landowners. One way to define urban influence is to calculate the total area of rural land contained in each of ERS's Urban Influence Codes (UICs); in figure 9, we demonstrate this for land in farms.<sup>29, 30</sup> The UIC classification system shows that farmland is subject to a range of urban influences, with a large share of land located in close proximity to existing metropolitan areas. Between 2002 and 2012, the total area of farmland in UIC category 2 increased by 2 percent, or approximately 20 million acres, indicating that urban influences on farmland strengthened in recent years. Acres in the "most urban" UIC counties, UIC 1, declined slightly by about 1.5 million acres during the period, which potentially represents losses of farmland to urban development. However, urban influence did not necessarily increase in all areas of the United States.

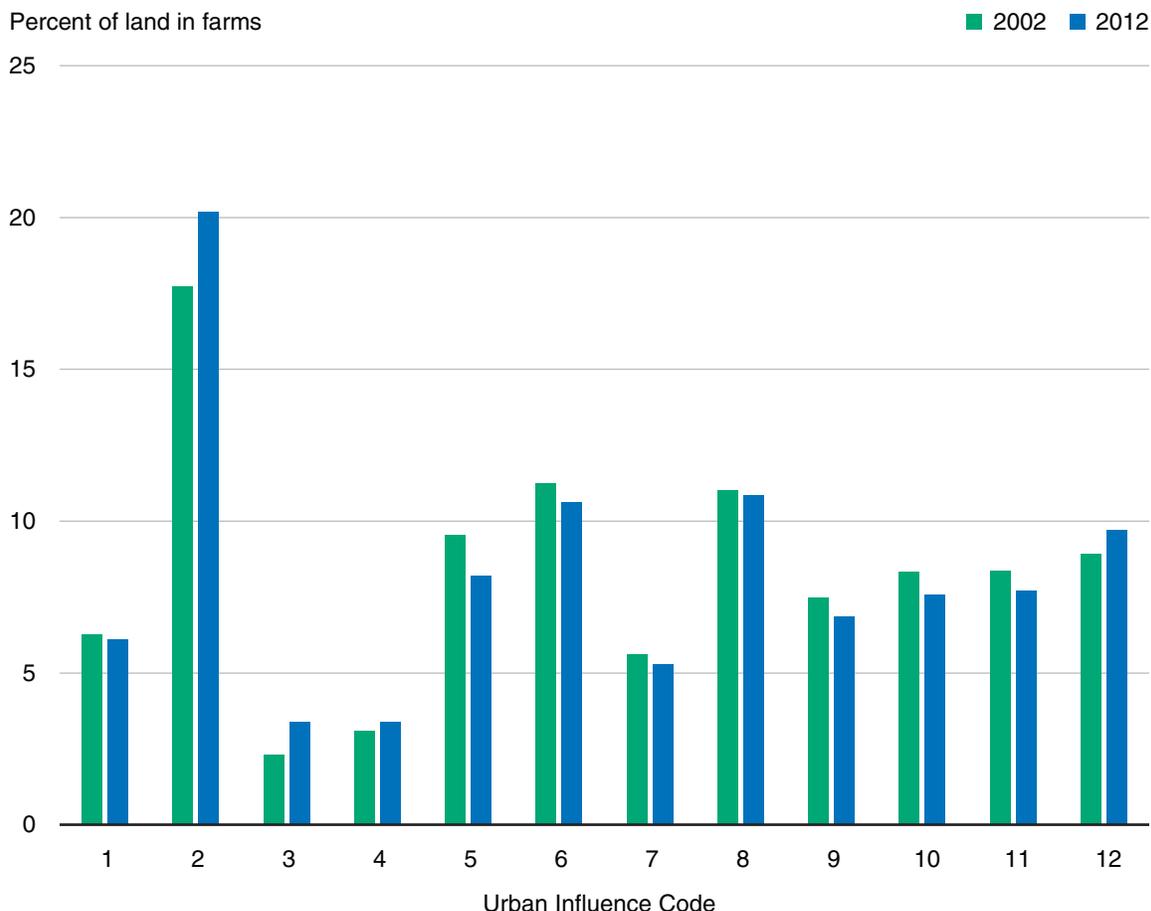
The majority of U.S. counties (2,471) had the same UIC in 2003 and 2013, representing over 80 percent of farmland acres in 2012. In these counties, the total amount of farmland declined by 17.5 million acres between 2002 and 2012. The UICs associated with the largest amounts of farmland loss are 1 (4.1 million acres), 2 (4.0 million acres), and 8 (3.1 million acres), while UICs 5, 9, and 11 are also associated with farmland losses of more than 1 million acres. This shows the extent to which urban factors associated with farmland conversion can vary considerably, from those related to large built-up urban areas to more rural forms of development. An additional 381 U.S. counties, accounting for 100 million farmland acres in 2012, became more urban between 2003 and 2013. Somewhat surprisingly, these areas experienced a net gain in farmland of 13.1 million acres, a possible explanation for which is that increases in market access can have a positive influence on farm communities. Lastly, 172 U.S. counties, accounting for 55 million acres of farmland, became more rural over 2003-13 and experienced a relatively small 2-million-acre decline in farmland. Counties in this group that transitioned to the most rural category (#12) made up more than half (1.1 million acres) of the net farmland loss, further evidence that farmland conversions can and do occur outside of the sphere of influence of large population centers.

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<sup>29</sup>The Urban Influence Codes (UICs), currently updated to 2013, form a classification scheme that distinguishes metropolitan counties by population size of their metro area and nonmetropolitan counties by size of the largest city or town and proximity to metro and micropolitan areas. There are 12 distinct UICs that a county may fall into, which range from 1, denoting a county in a metro area with at least 1 million residents or more, to 12, indicating a county that is not adjacent to a metro/micro area and does not contain a town of at least 2,500 residents.

<sup>30</sup>Ideally, this calculation would be done with the MLU estimate of agricultural land. However, not all of the MLU data are available at the county level; hence, the use of the land-in-farms measure collected in the Census of Agriculture (USDA, NASS, 2014a). To compare the same counties in 2002 and 2012, we omitted counties for which farmland acres are available in one year but not the other, which resulted in 42 counties being dropped. The total area of farmland in the 3,066 counties that were included declined from roughly 915 million to 908 million acres between 2002 and 2012. Since the Census of Agriculture years do not line up with those of the UIC data, the 2002 and 2012 farmland acreages are matched with their respective 2003 and 2013 UICs.

Figure 9  
**Distribution of farmland acres by Urban Influence Code**



Notes: Farmland acreage in counties that did not have at least some census-reported farmland in both 2002 and 2012 is not included in chart. Urban Influence Codes for individual counties are defined as follows: (1) in large metro area of 1+ million residents, (2) in small metro area of less than 1 million residents, (3) micropolitan area adjacent to large metro area, (4) noncore adjacent to large metro area, (5) micropolitan area adjacent to small metro area, (6) noncore adjacent to small metro area and contains a town of at least 2,500 residents, (7) noncore adjacent to small metro area and does not contain a town of at least 2,500 residents, (8) micropolitan area not adjacent to a metro area, (9) noncore adjacent to micro area and contains a town of at least 2,500 residents, (10) noncore adjacent to micro area and does not contain a town of at least 2,500 residents, (11) noncore not adjacent to metro or micro area and contains a town of at least 2,500 residents, and (12) noncore not adjacent to metro or micro area and does not contain a town of at least 2,500 residents. For additional information, see the Urban Influence Codes data series on the ERS website.

Sources: USDA, Economic Research Service 2003 and 2013 Urban Influence Codes and USDA, National Agricultural Statistics Service, 2002 and 2012 Censuses of Agriculture.

Although expansion of development into rural areas is, to some extent, a natural byproduct of economic growth, some research finds that proximity to rural land uses, and the open space and ecosystem services they provide, can attract new land development (Wu and Plantinga, 2003; Towe et al., 2008; Irwin et al., 2009), while there is also some evidence suggesting that open space conservation neither increases nor reduces nearby development (Zipp et al., 2017). Findings from other studies suggest that agricultural parcels benefit from nearby urban areas due to increased market access (Heimlich and Anderson, 2001). Effects of urban influence on forestland, on the other hand, tend to be negative and can result in decreased investment, management, and harvest rates (Kline et al., 2004; Munn et al., 2002; Wear et al., 1999). To balance the tradeoffs between competing land

uses and to promote orderly patterns of urban land conversion, many localities have passed land-use policies aimed at preserving rural lands (Paulsen, 2013). Evidence of the effectiveness of these growth control measures is mixed (Towe et al., 2008; Butsic et al., 2011; Dempsey and Plantinga, 2013; Newburn and Ferris, 2016), but their sheer abundance gives some indication of the importance to local governments of managing urban-rural land-use conflicts and mitigating the detrimental effects of sprawl-like development patterns. Growth-control regulations can take a number of forms and include policies such as minimum lot zoning, urban growth boundaries, greenbelts, and transferable development rights. Overall, the efficacy of a given type of land-use policy, as measured by property values, congestion, housing access, and environmental health (among other indicators), will vary in response to local preferences, ownership arrangements, and land market conditions.

## Special Uses

Land for all **special uses**, including parks, recreational areas, rural highways, roads, railroads, and airport rights-of-way, totaled just under 316 million acres in the United States in 2012 (table 10). These areas, reflecting a variety of land-use objectives, represented about 14 percent of all land nationwide.

Table 10  
**Trends in special uses of U.S. land**

Special-use areas <sup>1</sup>	1959	1964	1969	1974	1978	1982	1987	1992	1997	2002	2007	2012
	Million acres											
<b>Rural transportation</b>	25.0	26.0	26.0	26.3	26.7	26.8	25.7	25.2	25.4	27.3	26.5	26.9
Highways/roads	20.2	21.2	21.0	21.2	21.5	21.5	21.2	21.0	21.0	21.8	21.2	21.1
Railroads	3.4	3.3	3.2	3.1	3.0	3.0	2.3	2.0	1.9	3.1	3.0	3.0
Airports	1.4	1.5	1.8	2.0	2.2	2.3	2.2	2.2	2.5	2.4	2.4	2.8
<b>Rural parks and wilderness</b>	61.4	75.5	81.4	87.5	97.9	210.9	224.9	228.8	237.1	242.2	251.7	253.6
National/State parks	29.7	31.9	35.0	36.8	38.5	89.7	96.0	94.3	98.1	99.2	99.5	101.4
Wilderness areas	14.5	14.6	14.3	14.8	18.1	26.0	32.5	35.7	40.0	41.4	47.5	45.5
Wildlife areas	17.2	29.0	32.1	35.9	41.3	95.2	96.4	98.8	99.0	101.6	104.8	106.8
<b>Defense/ industrial</b>	26.3	31.9	25.6	25.0	24.9	24.0	20.9	20.5	16.4	16.7	22.1	27.0
<b>Farmsteads</b>	10.1	9.2	8.4	8.1	8.4	8.0	7.1	6.2	6.6	10.8	12.2	8.3
<b>Total<sup>2</sup></b>	122.8	142.6	141.4	146.9	157.9	269.7	278.6	280.8	285.5	296.8	313.5	315.9

<sup>1</sup>See definitions in the appendix. The Major Land Uses data series with regional and State-level estimates from 1945 to 2012 is available on the ERS website. <sup>2</sup>Distributions may not add to totals due to rounding.

Sources: USDA, Economic Research Service calculations. Estimates for 2012 based on Oswald et al. (2014); USDA, Natural Resources Conservation Service (2014a); U.S. Department of Defense (2012); U.S. Department of Energy (2012); U.S. Department of Transportation, Federal Highway Administration (2013); U.S. Department of Transportation, Bureau of Transportation Statistics (2015); U.S. Department of Transportation, Federal Aviation Administration (2011); U.S. Geographic Data Technology (2007); U.S. Department of Transportation, Bureau of Transportation Statistics (2007); U.S. Department of Commerce, Census Bureau (2012); U.S. Department of the Interior, Fish and Wildlife Service (2012); U.S. Department of the Interior, National Park Service (2012), and additional information gathered through personal communication with numerous State agencies responsible for managing fish, wildlife, and game areas. Estimates prior to 2012 are based on Nickerson et al. (2011); Lubowski et al. (2006); Vesterby and Krupa (2001); Daugherty (1991 and 1995); Frey (1973, 1979, and 1982); Frey and Hexem (1985); Frey et al. (1968); Wooten et al. (1962); Wooten and Anderson (1957); and Wooten (1953).

The largest share of land in special uses—land used for outdoor recreation and land maintained in its natural/wild/preserved state, collectively referred to as rural parks and wilderness—is estimated at 254 million acres (80 percent of the special uses total). This acreage can be further dissected into national and State parks (32 percent of the special uses total) and wilderness/wildlife uses (48 percent of the special uses total). Of the total acreage used for rural parks and wilderness purposes in 2012, nearly 29 percent was in the Mountain and Pacific regions (combined), and 57 percent was in Alaska. The remaining 15 percent of rural parks and wilderness land was located east of the Rocky Mountains, including large tracts in New York, Pennsylvania, Michigan, Minnesota, North Carolina, Tennessee, Florida, Louisiana, and Texas (each with a million or more acres).

Areas contained in parks and wildlife areas, which, at the Federal level, are typically managed by the Department of the Interior, are often selected because of specific or unique site characteristics, including those related to natural amenities, recreational opportunities, and historical significance.

Based on U.S. Department of Transportation records, land used for rural transportation in 2012 accounted for roughly 27 million acres, or 8.5 percent of the total special-use land. The nearly 27 million acres in national defense and industrial areas are concentrated primarily in less agriculturally productive States of the Mountain region, such as Nevada (about 16 percent of defense and industrial land). Land in farmsteads accounted for the remaining 12 million acres of land in special uses, as of 2012.

## Trends in Special Uses

Since 1959, land used for rural transportation, recreation, wildlife, defense, and other special uses in the United States has increased by a factor of more than 2.5, growing from 123 million acres in 1959 to 316 million acres in 2012. This is largely a result of a fourfold increase in rural parks and wilderness/wildlife areas. Alaska, alone, now has about 146 million acres (46 percent of U.S. total) of special-use acreage due to the establishment of national parks, wilderness areas, and wildlife refuges on land that earlier MLU efforts had inventoried as being in forest or other unclassified land uses. Among all States, Alaska has the largest share of land in special uses (40 percent), followed by California (25 percent) and Hawaii (24 percent). Among regions, the Northern Plains and the Southern Plains have the lowest shares of land in special uses (fig. 10).

Special-use areas nationwide increased 2.4 million acres (0.8 percent) from 2007 to 2012, continuing a steady upward trend since the 1940s. The long-term change, however, should be interpreted with caution, as it reflects an upward adjustment due to new data and methods.

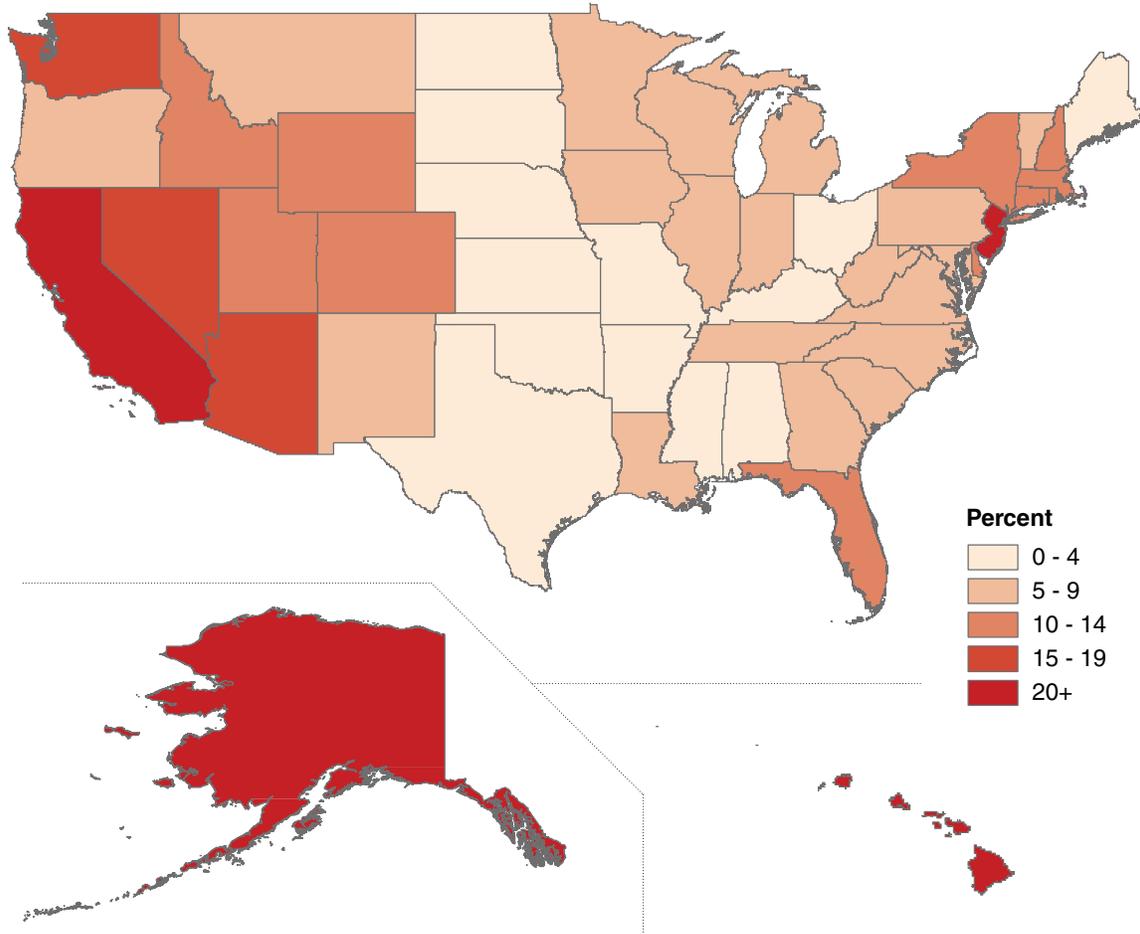
The increase in special-use land over 2007-12 resulted from a nearly 5-million-acre increase in defense/industrial land and a 2-million-acre increase in rural parks and wilderness areas. The increases more than offset a reduction in farmstead areas of about 4 million acres. Land in rural transportation use remained relatively constant between 2007 and 2012, exhibiting a modest gain of approximately 400,000 acres.

The loss in farmstead area is attributable to a change in the way the estimates are computed. Previous versions of the MLU farmstead estimates were computed by multiplying the number of farms from the Census of Agriculture by the average farmstead size found in the NRI data. However, the farmstead category in the NRI was discontinued in recent versions of the survey, necessitating a change in how the MLU farmstead estimates are calculated. In place of the discontinued NRI information on average farmstead acreage, we used the average rural lot size from the Census Bureau's AHS, which was then multiplied by the number of farms provided by the 2012 Census of Agriculture to derive a total farmstead area estimate for each State. If the updated methodology were applied to 2007, the total farmstead area for that year would be 8.6 million acres, slightly larger than the 8.3 million acres estimated for 2012.

National defense (airfields, training land, and miscellaneous military land) and industrial (energy and research areas) acres differ from other special uses mainly in that location is paramount and higher value uses characterize much of the land. This land category totaled 27 million acres in 2012, an increase of 4.9 million acres over the 2007 estimate and the largest defense and industrial acreage since 1964.

Estimated land in rural transportation uses increased by less than a half-million acres from 2007 to 2012. Similar to the approach used for the 2007 estimate, we used spatial data in a geographic information system (GIS) for the 2012 estimate.

Figure 10  
**Percent of U.S. land in special uses, by State, 2012**



Sources: USDA, Economic Research Service calculations. Estimates for 2012 based on Oswald et al. (2014); USDA, Natural Resources Conservation Service (2014a); U.S. Department of Defense (2012); U.S. Department of Energy (2012); U.S. Department of Transportation, Federal Highway Administration (2013); U.S. Department of Transportation, Bureau of Transportation Statistics (2015); U.S. Department of Transportation, Federal Aviation Administration (2011); U.S. Geographic Data Technology (2007); U.S. Department of Transportation, Bureau of Transportation Statistics (2007); U.S. Department of Commerce, Census Bureau (2012); U.S. Department of the Interior, Fish and Wildlife Service (2012); U.S. Department of the Interior, National Park Service (2012), and additional information gathered through personal communication with numerous State agencies responsible for managing fish, wildlife, and game areas.

## Miscellaneous Other Land Uses

The remaining 275 million acres (12 percent) of the Nation's land are included in the **miscellaneous other** land category (see table 2). Miscellaneous land increased by 78 million acres (40 percent) from 2007 to 2012, due largely to the improved measurement of the forest-use category, which no longer includes many areas labeled by FS as unproductive forestland or woodland. This category comprises wetlands, **rural residential land** (see "Urban and Rural Residential" section on page 33), nonharvestable forests not accounted for in the special-use category (see "Forest" section on page 29), desert, tundra, and other barren land generally of low value for agricultural purposes that are not independently classified in the MLU report. The West and Mountain regions account for a relatively large share of this unclassified land in the lower 48 States. Alaska and its ecologically sensitive tundra areas contain 205 million acres of miscellaneous land, nearly 75 percent of the U.S. total.

According to the *2012 NRI Summary Report*, non-Federal acreage of wetlands in the contiguous 48 States totaled almost 111 million acres in 2012. NRCS estimates that over 65 percent of these wetland acres are on forestland; 23 percent are on cropland, pasture, and rangeland; 2 percent are on developed land; and 3 percent are grouped with water areas (USDA, NRCS, 2014b). Approximately 15 million (13 percent) of these wetland acres are included in **miscellaneous other** land in the MLU, as they are contained on what NRCS labels "other rural land." The amount of wetland cover declined by 227,000 acres between 1992 and 1997, increased by 79,000 acres in 1997-2002, increased by 53,000 acres in 2002-07, and then declined again over the most recent 5-year period by nearly 38,000 acres (USDA, NRCS, 2014b).

Using a different sampling technique and including Federal and non-Federal land, the U.S. Fish and Wildlife Service estimated total wetland acreage in the contiguous 48 States at 110 million acres in 2009, which marked a 62,000-acre decline between 2004 and 2009 (Dahl, 2011).<sup>31</sup>

The **miscellaneous other** MLU category remains difficult to itemize given the various sources of land-use and land cover data in the United States and the various definitions, motivations, and mission for each data collection enterprise.

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<sup>31</sup>See USDA, NRCS and Iowa State University (2009) for details on the differences between NRI and U.S. Fish and Wildlife Service wetland estimates.

## Major Land Uses, by Class of Ownership

More than 60 percent of the land in the United States is privately owned (table 11). The Federal Government owns approximately 28 percent of the total land base, mostly in Western States. State and local governments own about 8 percent of all land, and American Indian trust land accounts for the remainder, at just under 3 percent. These shares have changed gradually over time, except in Alaska, where, in 1971, the Alaska Native Claims Settlement Act resulted in the transfer of 44 million acres of Federal land to native (private) ownership interests.

Table 11

### Ownership and use of U.S. land, by major categories, 2012 (with change since 2007)

Ownership	Cropland	Grassland pasture and range	Forestland <sup>1</sup>	Total special, urban, and misc. land	Total land area
Million acres					
Federal	*	158 (+13)	194 (+29)	292 (-51)	644 (-9)
State and other public	*	36 (-4)	67 (-8)	86 (+3)	189 (-9)
American Indian	6 (0)	47 (-2)	7 (-2)	3 (+1)	63 (-3)
Private	386 (-16)	415 (+25)	363 (-59)	190 (+48)	1,365 (+18)
Total <sup>2</sup>	392 (-16)	655 (+31)	632 (-39)	581 (+11)	2,260 (-4)

Note: \* = Less than 500,000 acres. <sup>1</sup>These numbers were based on Oswald et al. (2014) and adjusted to conform to the forest-use definition adopted in this report. <sup>2</sup>Distributions may not add to totals due to rounding. The changes reported in parentheses may reflect improved measurement, reallocation across uses within a given ownership type, actual changes in ownership, or some combination thereof.

Sources: USDA, Economic Research Service using data on Federal, State, and local government and Indian land acreage from Natural Resources Council of Maine (2000), Oswald et al. (2014), Vincent et al. (2014), U.S. General Services Administration (2012), Western States Land Commission Association (2014), Bureau of Indian Affairs (2016), and U.S. Geological Survey (2010). Private land is the remainder of the land in each use category. Land-use totals were calibrated to those used throughout this report.

Federal land, at roughly 644 million acres in 2012, includes the original public domain and land acquired by purchase and other means. This total acreage is approximate, as there is currently no Federal agency solely responsible for keeping track of all land owned by the Government. Land owned by the Federal Government can be split into two components: accessible to the general public and not accessible to the general public. In 2012, the acreage of Government-owned land not in the public domain totaled just under 42 million acres, large shares of which are managed by different branches of the military in Western States, including Nevada, New Mexico, Arizona, and California (GSA, 2012). Acreage of land in the public domain is more difficult to estimate as it covers an expansive area with sometimes overlapping ownership interests. However, a recent report indicates that the vast majority of land in the public domain, roughly 602 million acres, is managed by four Federal agencies: the Bureau of Land Management (BLM), the Forest Service, the Fish and Wildlife Service, and the National Park Service (Vincent et al., 2014).

Total federally owned land declined by 9 million acres between 2007 and 2012, with much of the decline attributable to disposal of BLM land in Alaska and BLM and DoD land in Arizona (Vincent et al., 2014). About 35 percent of all Federal land is in Alaska, 43 percent is in the Mountain region, and 15 percent is in the Pacific region. The remaining 7 percent is distributed among the other 8 farm production regions and Hawaii. About 194 million acres of Federal land is in forest use, while

another 158 million acres is in grassland, pasture, or range use. Federal land also includes forest-cover land in **special uses**, such as that contained in the national park system, and **miscellaneous other** land, such as marshes, open swamps, bare rock areas, desert, and special uses not inventoried.

State and local governments have accumulated landholdings of various sizes through grants from the Federal Government, tax reversions, purchases, gifts, and escheats.<sup>32</sup> The land acquired by State and local governments may also be divested through sales and other exchanges. As with Federal lands, no single agency is responsible for tracking the total amount of land owned by State and local governments. The measure of State-owned land reported here—189 million acres in 2012, down 9 million acres from the previous estimate in 2007—was assembled from a variety of State agencies and regional organizations. These publicly administered areas are distributed throughout the Nation more evenly than Federal land but are still highly concentrated in the Western States. State and local governments hold land in forests, parks, wildlife refuges, highways and roads, institutional uses, and other specific purposes. Most Western States also own and manage relatively large acreages to earn income through leasing and royalty payments, provide financial support to schools, and meet other State-level policy objectives. About 36 million acres in this category are used for grazing.

The Bureau of Indian Affairs (BIA) manages 63 million acres in trust for tribes and individuals. Like Federal and State land, most land managed by BIA is concentrated in the Western States. The largest share of American Indian land, 47 million acres, is in grassland, pasture, or range use, whereas smaller areas of 6 and 7 million acres are used for crop production and forest uses, respectively.

Private land, not including that under American Indian ownership, totaled more than 1.3 billion acres in 2012, an 18-million-acre increase from 2007. Private interests hold about 98 percent of the Nation's **cropland**, 63 percent of **grassland pasture and range**, 57 percent of forest-use land, and 33 percent of special-use, urban, and miscellaneous land. Between 2007 and 2012, privately owned **forest-use** land and **cropland** both experienced a net decline, while privately owned land in **grassland pasture and range** and **special uses, urban, and miscellaneous other** increased. These increases are attributable to the increases in urban and grassland pasture and range land, much of which is likely to be owned by private entities (see "Grassland Pasture and Range" and "Urban and Rural Residential" sections).

Land ownership can have far-reaching implications for how land is used, as owners may differ in terms of the goals and objectives they have for their land. For example, some owners may focus on meeting individual/private needs instead of achieving broader societal benefits. Diverging objectives for owning land may affect the willingness to convert land from one use to another, to adopt different farm and forestry practices, and to participate in Government programs.

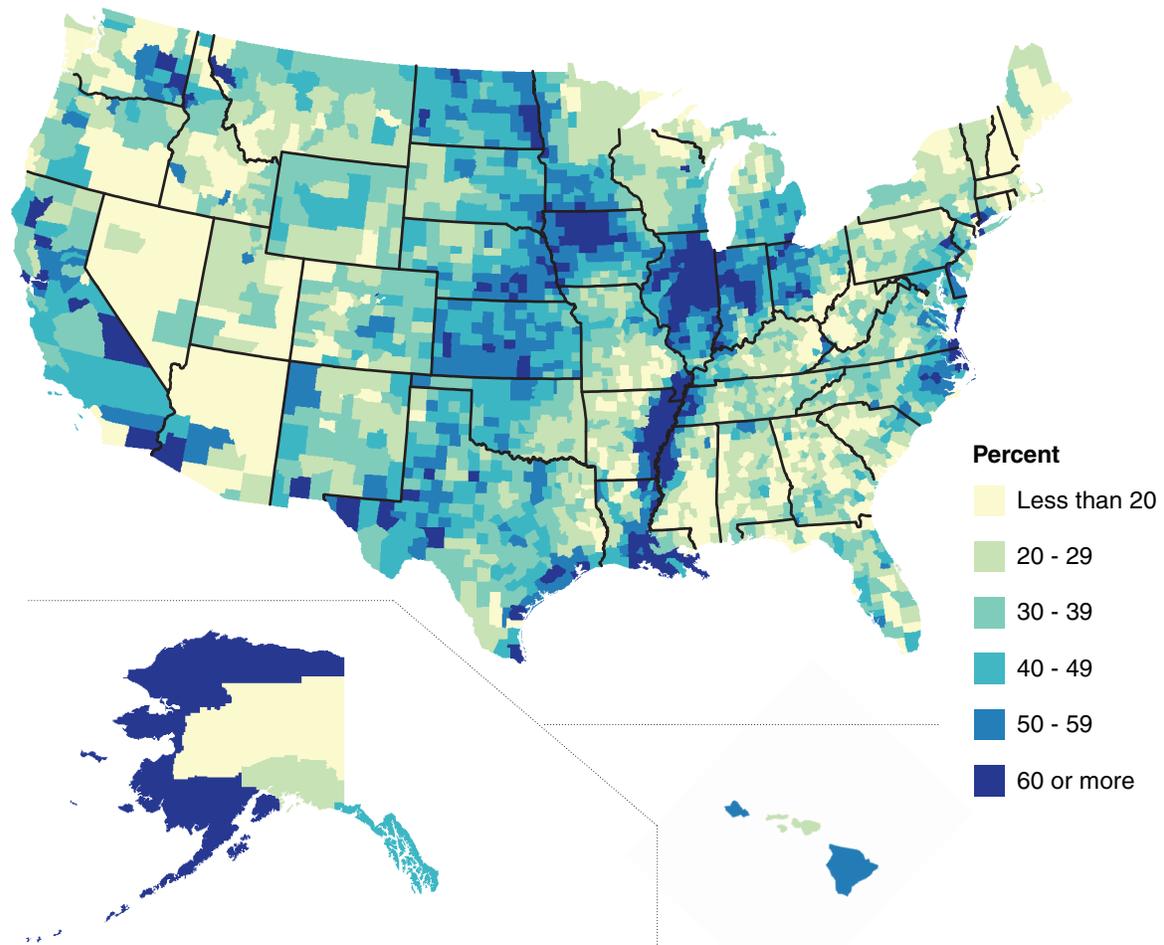
Of the 914 million acres of land in U.S. farms in 2012, which includes cropland, privately owned pasture and rangeland, and privately owned grazed woodland, 62 percent were owner-operated. The remaining land was rented, either from one farm operator to another or from a non-operator—an ownership entity not actively engaged in farming—to a farm operator. Farmland ownership varies across the country, with higher shares of renting and non-operator ownership generally in the

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<sup>32</sup>Escheats relate to a common law doctrine that operates to ensure that property is not left in limbo and ownerless.

Midwest and Plains regions (fig. 11). As of 2014, nearly half (46 percent) of cropland was rented out, which contrasts with just 28 percent of pastureland (Bigelow et al., 2016).<sup>33</sup>

Figure 11  
**Share of U.S. farmland rented, 2012**



Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service (2014a).

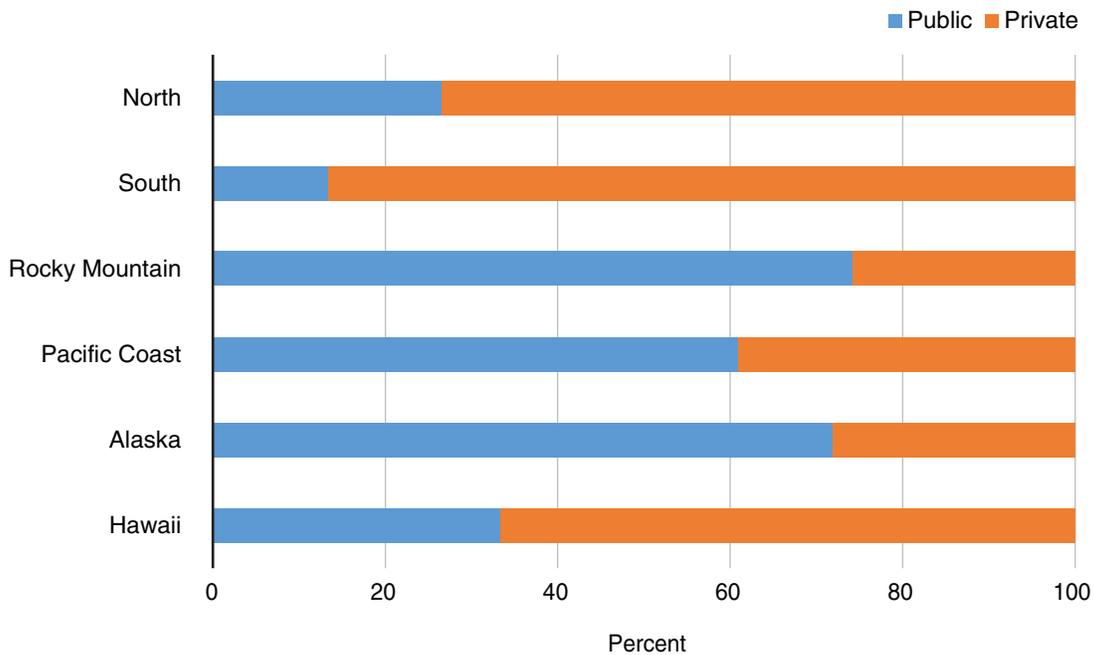
The percentage of U.S. forests under private ownership is much higher than the global share (Siry et al., 2010). Similar to the tenant-owner issue in farmland ownership, it is often thought that privately owned forests are subject to narrower, more profit-driven motives than publicly owned forests. To

<sup>33</sup>To learn more about the patterns and trends in U.S. farmland ownership, USDA's Economic Research Service and National Agricultural Statistics Service recently developed a follow-on to the 2012 Census of Agriculture, the 2014 Tenure, Ownership, and Transition of Agricultural Land (TOTAL) survey. For a descriptive baseline analysis of the TOTAL survey results, see Bigelow et al. (2016).

aid in establishing and maintaining sustainable, multipurpose forest management plans, the Forest Service’s Forest Stewardship Program provides technical assistance and educational materials to owners of nonindustrial private forestland across the United States.

The Forest Service tracks ownership patterns of timberland, which makes up the majority of **forest-use land** capable of being used for commercial timber production. Ownership patterns of timberland vary across the United States. Most federally owned timberland is in the western half of the United States (Alaska, Pacific, and Rocky Mountain regions), while most privately owned land is in the eastern (fig. 12). The private forest category can be broken into corporate and noncorporate ownership interests. According to Oswalt et al. (2014), approximately two-thirds of privately owned land under forest cover (a more expansive definition than the forest-use category) was owned by noncorporate entities in 2012.

Figure 12  
**U.S. forest cover area, by major ownership categories, 2012**



Note: The regions used by USDA’s Forest Service are different than those used throughout this report. Forest Service regions are defined as: **North**—Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, West Virginia, Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin; **South**—Florida, Georgia, North Carolina, South Carolina, Virginia, Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas; **Rocky Mountain**—Kansas, Nebraska, North Dakota, South Dakota, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming; **Pacific Coast**—California, Oregon, Washington.  
 Source: USDA, Economic Research Service using data from Oswalt et al. (2014).

## Foreign Ownership of Land

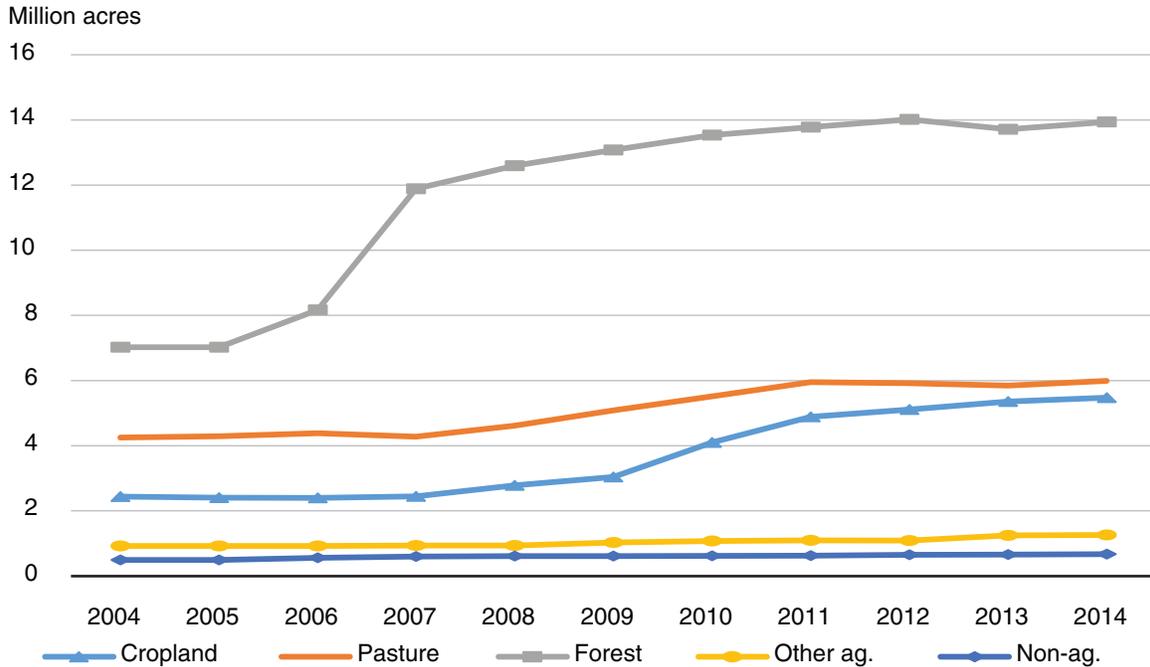
The private ownership category includes U.S. land held by foreign owners. Since 1978, foreign owners have been required to submit information to USDA on farm and forestland holdings in compliance with the Agricultural Foreign Investment Disclosure Act of 1978.

In 2012, foreign owners of U.S. land held an interest in 26.8 million acres, 25 million of which were forest and agricultural land (cropland, pasture, and other agricultural land) (Johnson et al., 2013;

fig. 13). Based on MLU estimates, these foreign holdings represent about 1.6 percent of the Nation's farm and forestland. Between 2007 and 2012, foreign ownership of U.S. land rose by 5 million acres, an increase mostly attributable to a roughly 3-million-acre increase in foreign ownership of cropland. The gain in foreign-owned cropland was triggered by the execution of long-term leases by foreign wind and solar energy companies. Foreign landowners, a plurality of which are Canadian, hold property in all U.S. States. These holdings are primarily forest or timber land, with the largest amounts in Maine and Texas (2.9 million acres each). Foreign landowners also control more than 1 million acres in each of Alabama, California, Colorado, Florida, Louisiana, and Washington.

Figure 13

**Trends in foreign holdings of U.S. agricultural land, by type of use**



Source: USDA, Economic Research Service using data from Johnson et al. (2013).

# Conclusions and Challenges To Resolve

## Conclusions

This update to the MLU series presents land-use estimates spanning from 1945 to 2012 for individual States and the Nation as a whole.<sup>34</sup> In addition to providing the only comprehensive estimates covering all land uses for that length of time, this study provides insights into the factors driving changes in major land-use categories over time. Notable land-use changes from the previous version of the MLU data released in 2007 include a 41-million-acre increase in grassland pasture and range use, a 42-million-acre decline in ungrazed forestland, and a 23-million-acre decline in cropland pasture. While some of the changes reflect actual transitions from forest to grassland pasture and range, most are due to improved measurement of land that can viably be used for timber production. Additionally, the continued decline in cropland pasture is, at least in part, attributable to methodological changes in the Census of Agriculture, yet it is also consistent with recent trends in the organization and structure of U.S. livestock agriculture. This update to the MLU data also illustrates the role of external environmental factors on land use by providing a broad illustration of the effects of drought on various regions of the United States in 2011 and 2012. During the drought, cropland failure was higher than usual, topping the 20-year average of 10 million acres (13 million acres in 2011 and 11 million acres in 2012). Other changes also coincided with the drought, such as an increase in cropland left idle and an increase in emergency CRP land grazing. Although it takes up a relatively small share of the total land base, urban land continued its upward trajectory over the previous 5 years. Ultimately, the factors that influence the appropriate balance between the private and social benefits derived from land-use decisions will vary from place to place, depending on the preferences and goals of landowners, governmental agencies, and other stakeholders.

## Current State of Knowledge and Key Challenges Associated With Comprehensive Land-Use Accounting

The data used to form the MLU estimates are drawn from several disparate, publicly available sources, which presents a challenge because each source defines land-use categories somewhat differently to best meet its own agency's needs, and no single agency measures all land uses; hence, the information gap filled by the MLU project. As a result, a number of ambiguities must be reconciled in generating the comprehensive MLU estimates. Since land-use change is an ongoing, dynamic process, any effort to catalog land use at a given point in time is subject to interpretation, particularly when multiple data sources are used in combination. For example, grassland that is grazed while a previously harvested tract of forestland regenerates is particularly difficult to measure and categorize, as it depends critically on the timing of the land-use inventory.<sup>35</sup> Low-density rural residential use is also difficult and costly to measure, as doing so can require a combination of satellite imagery analysis and "ground-truthing." Yet, it is one of the leading causes of contemporary human-induced land-use change (Irwin and Bockstael, 2007; Irwin et al., 2009).

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<sup>34</sup>State-level estimates for all MLU categories are available in the Major Land Uses data series on the ERS website.

<sup>35</sup>The U.S. Geological Survey's (USGS) Land Cover Trends (LCT) project constitutes one attempt to distinguish mechanically disturbed (e.g., harvested timberland) and nonmechanically disturbed (e.g., land on which a wildfire has recently occurred) lands that are in transition between different land uses. However, the LCT project is explicitly designed to capture changes in land use, not to provide a comprehensive inventory of all land use at a static point in time. For more information on the LCT project, see the USGS Land Cover Trends website.

In general, three methods are commonly used to collect land-use data: questionnaire-based censuses or surveys (e.g., Census of Agriculture), analysis of remotely sensed satellite images (e.g., the National Land Cover Database (NCLD) and Cropland Data Layer), and a combination of satellite data analysis with ground-based inventories (e.g., NRI). The strengths and drawbacks of each of these sources depend on the particular research application to which the data are applied. Moreover, the advantage of using one source is often a disadvantage of using another. For example, remotely sensed data sets allow for repeat measurement of fine-scale, complete patterns of land cover over time, which can be linked to other fine-scale phenomena via geographic information systems. However, how land is used and how it appears to be used from outer space are not always consistent with one another. Survey data sets, by contrast, provide more accurate measurements of land use but do not generally provide the same scope as satellite-based data.

While updates to existing survey and remotely sensed sources of land-use/cover data continue, new sources of information have emerged, such as data on nighttime light use collected by various agencies via satellite to measure economic activity (Donaldson and Storeygard, 2016). A drawback of such data is that nighttime activity does not necessarily correspond to dense urban areas, but it holds promise in identifying changes in, for example, rural residential land use, which is inherently characterized by its low density. ERS researchers have begun to combine administrative data sources, such as the Farm Service Agency's Common Land Unit (CLU) data, with other external sources to provide richer information on the drivers of land-use change. For example, CLU data can be combined with farm program participation records and satellite-based imagery to provide evidence of the relationship between participation in Government programs and land-use outcomes.

As the historical record of satellite-based land-cover data lengthens, efforts to systematically identify inconsistencies between datasets that provide estimates of similar land-use/cover classes become more useful. One way to detect such inconsistencies would be to combine county-level estimates derived from the Forest Inventory Analysis and the NRI and compare them with forest-cover estimates from satellite sources. Similar approaches could be applied to data from the Census of Agriculture to hone in on the distinction between unused shrubland and land used for pasture. Such information would aid research efforts aimed at providing comprehensive land-use assessments. Maintaining updates to existing sources, such as the NRI, NLCD, and Census of Agriculture, is vital for consistency in land-use measurement. Additionally, examining the potential of new and emerging sources, such as nighttime lights data, can help improve our understanding of how land is used.

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## Appendix 1: Definitions and Explanation of the Data

The major land uses presented in this report are the latest in a series of land-use inventories conducted by USDA's Economic Research Service and predecessor agencies. The inventories are based on available data from multiple sources. The estimates were constructed from available data rather than used exactly as developed by source agencies because land-use data, regardless of origin or utility for specific purposes, have limitations for comprehensive inventory purposes.

Data are typically obtained from censuses and surveys that differ greatly in scope, methods, definitions, and other characteristics. Individual sources account for only a few uses and for only a limited part of the total land area. The available data contain conflicts and overlaps that must be reconciled or removed.

### Definitions and Explanations of the Various Land-Use Categories

**American Housing Survey (AHS)**—A periodic survey conducted by the U.S. Census Bureau to obtain housing statistics for the U.S. Department of Housing and Urban Development. This national survey began in 1973 as the Annual Housing Survey. The current series began in 1981 and is conducted every odd-numbered year by field representatives, who collect information through interviews with home occupants, landlords, rental agents, and neighbors (in 2013, the sample was 64,750, and the response rate was 85 percent). The sample is randomly drawn from the 1980 census and updated for coverage improvement and newly constructed housing units. Weights are used to adjust the responses to reflect the probability of selection and noninterview adjustments. Additional information on the AHS can be found in the *Current Housing Report*, and sample design and weighting are detailed in that report's appendix B (DOC/CB, 2014b).

**Cropland**—Total cropland includes five components: cropland harvested, crop failure, cultivated summer fallow, cropland used only for pasture, and idle cropland. The estimate of total cropland in 2012 included total cropland as reported by the 2012 Census of Agriculture (USDA, NASS, 2014a) plus an upward adjustment to conform to data on principal crops harvested in each State as reported by USDA's National Agricultural Statistics Service (NASS) for 2012 (USDA, NASS, 2014b). In 2012, the census's estimate of total principal crops harvested was about 95 percent of the estimate for the same crops from NASS.

The census of agriculture data are derived from a census of all farm operations that produce, or normally would produce and sell, \$1,000 or more of agricultural products annually. NASS undertakes extensive procedures to include all eligible farms in the census. The census is conducted through mailings and, to a lesser extent, telephone or personal enumeration with a goal of achieving at least a 75-percent response rate in all counties. Missing data are calculated from responses to other surveys or imputed from reporting farms of a like type. The response rate for the 2012 Census of Agriculture was 80.1 percent, compared with 85.2 and 88.0 percent for the 2007 and 2002 censuses, respectively. Details on the methodology and reliability of estimates are contained in Appendix A of the 2012 Census of Agriculture (USDA, NASS 2014a). The components of cropland are:

**Cropland used for crops**—Three of the cropland acreage components—cropland harvested, crop failure, and cultivated summer fallow—are collectively termed cropland used for crops, or the land used as an input to crop production. Annual estimates of cropland harvested are based on both

census data and the series on principal crops harvested as maintained by NASS. Annual estimates of crop failure are based on differences in planted and harvested acreage of principal crops from the NASS data series. Annual estimates of cultivated summer fallow historically have been based on fragmentary data from a variety of sources. Since the late 1970s, the estimates have been based on data from the Census of Agriculture and unpublished NASS data.

**Cropland harvested:** Includes row crops and closely sown crops; hay and silage crops; tree fruits, small fruits, berries, and tree nuts; vegetables and melons; and miscellaneous other minor crops. In recent years, farmers have double cropped 2-4 percent of this acreage. This category includes Christmas tree farms.

**Crop failure:** Consists mainly of the acreage on which crops failed because of weather, insects, and diseases but does include some land not harvested due to lack of labor, low market prices, or other factors. Crop failure is calculated using the difference between cropland planted and cropland harvested. However, some cropland planted is not intended to be harvested. Thus, the acreage planted to cover and soil-improvement crops not intended for harvest is excluded from crop failure and is considered idle. In recent years, crops have failed on 2-3 percent of the acreage planted for harvest.

**Cultivated summer fallow:** Refers to cropland in subhumid regions of the West that are cultivated for one or more seasons to control weeds and accumulate moisture before small grains are planted. This practice is optional in some areas, but it is a requirement for crop production in the drier cropland areas of the West. Other types of fallow, such as cropland planted to soil-improvement crops but not harvested and cropland left idle all year, are not included in cultivated summer fallow but are included as idle cropland.

**Cropland pasture**—Generally is considered to be in long-term crop rotation. This category includes acres of crops hogged or grazed but not harvested and some land used for pasture that could have been cropped without additional improvement. Cropland pastured before or after crops were harvested was included as harvested cropland and not cropland pasture. Estimates in this land-use category are derived from the Census of Agriculture (USDA, NASS, 2014a).

**Idle cropland**—Includes land in cover and soil-improvement crops and cropland on which no crops were planted. Some cropland is idle each year for various physical and economic reasons. Acreage diverted from crops to soil-conserving uses (if not eligible for and used as cropland pasture) under Federal farm programs is included in this category. Cropland enrolled in USDA's Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP) is included in idle cropland.

**Grassland pasture and range**—Grassland pasture and range encompass all open land used primarily for pasture and grazing, including shrub and brush land types of pasture; grazing land with sagebrush and scattered mesquite; and all tame and native grasses, legumes, and other forage used for pasture or grazing—regardless of ownership. Because of the diversity in vegetative composition, grassland pasture and range are not always clearly distinguishable from other types of pasture and range. At one extreme, permanent grassland may merge with cropland pasture, or grassland may often be found in transitional areas with forested grazing land. The estimates in this report are composites of data from the National Resources Inventory (NRI), Census of Agriculture, the Bureau of Land Management, the Forest Service, and several other Federal agencies (see definitions for cropland, forested land, special uses, and NRI for details on the data from these sources). The 655 million acres classed as grassland pasture and range in 2012 included 415 million acres in farms

(USDA, NASS, 2014a). Also included are estimates of private grazing land not in farms and public, nonforested grazing land.

**Forested land**—As defined by the Forest Service, the 766 million acres of forested land in 2012 (see table 8) consist of “land at least 120 feet (37 meters) wide and at least 1 acre (0.4 hectare) in size with at least 10 percent cover (or equivalent stocking) by live trees, including land that formerly had such tree cover and that will be naturally or artificially regenerated. Forestland also includes transition zones, such as areas between forest and nonforestlands that have at least 10-percent cover (or equivalent stocking) with live trees and forest areas adjacent to urban and built-up lands.” Fruit orchards or other tree-covered areas in agricultural production settings, or tree-covered areas in urban settings such as city parks, are not considered forestland (Oswalt et al., 2014).

The Forest Service’s inventories of forested land are the primary basis for the MLU estimate of forest-use land. The inventories are based on remote sensing data and supplemented by field sampling to exclude lands with forest cover that are not considered forest use (primarily but not exclusively urban uses) (Oswalt et al., 2014). The inventories are designed so that estimates are accurate within 1 standard deviation at the 67-percent confidence level for each State. States with little forest area will be of lower accuracy, and users of the inventory are cautioned to consider small States, such as those in New England, as a group for analysis (see appendix A in Oswalt et al., 2014). There are a number of components to total forestland, as defined in Oswalt et al. (2014), including:

**Timberland:** Forestland that produces or is capable of producing crops (in excess of 20 cubic feet per acre per year) of industrial wood and not withdrawn from timber use by statute or administrative regulation. Currently inaccessible and inoperable areas are included (Oswalt et al., 2014).

**Reserved forestland:** Forestland withdrawn from timber use through statute, administrative regulation, or designation without regard to productive status (Oswalt et al., 2014). Forested wilderness areas and parks are included in this category. The definition changed slightly in 1997. Prior to 1997, the reserved forestland definition depended on the timberland designation. Reserved timberland was classed as “productive reserved” forest, while nontimberland reserved forests were classified as “unproductive reserved” and included under the “other forest” land category (see below).

**Other forestland:** Forestland other than timberland and productive reserved forestland. It includes available forestland, which is incapable of annually producing 20 cubic feet (1.4 cubic meters) per acre (0.4 hectare) of industrial wood under natural conditions because of adverse site conditions, such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness (Oswalt et al., 2014).

**Forest-use land**—An MLU category defined to account for how forestland is used. The forest-use category includes both grazed and ungrazed forests but excludes forestland in parks, wildlife areas, and similar special-purpose uses from the Forest Service’s inventory of total forestland. While it is impossible to eliminate overlap with other uses, this refined area represents an approximation of the amount of land that serves commercial forest uses, as opposed to land that has forest cover but is used for other purposes. These alternative objectives may be related to recreation and amenity values (e.g., Butler et al., 2016). There are two components of forest-use land:

**Forestland grazed:** Forested pasture and range consisting mainly of forest, brush-grown pasture, arid woodlands, and other areas within forested areas that have grass or other forage growth. The total acreage of forested grazing land includes woodland pasture in farms plus estimates of forested grazing land not in farms. For many States, the estimates include significant areas grazed only lightly or sporadically. The Census of Agriculture, the NRI, and the Forest Service data on active grazing allotments are the principal sources of data used to develop the MLU estimate (USDA, NASS, 2014a; USDA, NRCS, 2014a; USDA, Forest Service, 2012a; USDA, Forest Service, 2016). Historical data from these sources were used to develop the 130-million-acre estimate for 2012.

**Forestland not grazed:** Forest-use land not used for grazing.

**Forestland in special uses**—Forestland in special uses, such as in parks, wildlife areas, and similar special-purpose uses, estimated at 134 million acres for 2012.

**Miscellaneous other land**—Includes miscellaneous other uses, such as industrial and commercial sites in rural areas, cemeteries, golf courses, mining areas, quarry sites, marshes, swamps, sand dunes, bare rocks, deserts, tundra, rural residential, and other unclassified land. In this report, urban land is reported as a separate category.

**National Resources Inventory (NRI)**—The NRI has been conducted by USDA’s Natural Resources Conservation Service (NRCS), in cooperation with Iowa State University, since 1982 to assess the condition and trends in soil, water, and natural resources on the Nation’s non-Federal lands. The NRI covers privately owned land, tribal and trust lands, and lands controlled by State and local governments in the 48 contiguous States and, as of 2012, Hawaii and U.S. Caribbean Territories. The NRI was conducted in 5-year intervals between 1977 and 1997; since 2000, NRI data have been gathered annually on about 40,000 “core” segments and a rotating panel of roughly 31,000 segments. The NRI is a survey conducted using a stratified two-stage, unequal probability area sampling scheme and includes about 800,000 total points. The use of remote-sensing techniques increased during the 1990s and is supplemented by onsite verification and comparison against administrative data (USDA, NRCS, 2014b). See table 3 in the NRI report for margins of error associated with the NRI estimates. NRI defines the following land-cover/use categories as (USDA, NRCS, 2014b):

**Cropland:** Areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and noncultivated.

**Pastureland:** Land managed primarily for the production of introduced forage plants for livestock grazing. Pastureland cover may consist of a single species in a pure stand, a grass mixture, or a grass-legume mixture. Management usually consists of cultural treatments: fertilization, weed control, reseeding or renovation, and control of grazing.

**Rangeland:** Includes land on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands, some deserts,

and tundra are considered to be rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon juniper, are also included as rangeland.

**Forestland:** Includes land that is at least 10-percent stocked by single-stemmed woody species of any size that will be at least 4 meters (13 feet) tall at maturity. Also included is land bearing evidence of natural regeneration of tree cover (cutover forest or abandoned farmland) and not currently developed for nonforest use. Ten-percent stocked, when viewed from a vertical direction, equates to an areal canopy cover of leaves and branches of 25 percent or greater. The minimum area for classification as forestland is 1 acre, and the area must be at least 100 feet wide.

**Developed land:** Consists of urban and built-up areas and land devoted to rural transportation.

**Urban and built-up areas:** Consists of residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; other land used for such purposes; small parks (less than 10 acres) within urban and built-up areas; and highways, railroads, and other transportation facilities if they are surrounded by urban areas. Also included are tracts of less than 10 acres that do not meet the above definition but are completely surrounded by urban and built-up land. Two size categories are recognized in the NRI: 0.25 to 10.0 acres and 10 acres or more.

**Large urban and built-up areas:** Include developed tracts of 10 acres or more.

**Small built-up areas:** Include developed tracts of between 0.25 and 10 acres.

**Rural transportation land:** Includes highways, roads, railroads, and rights-of-way outside of urban and built-up areas.

**Water areas**—Include water bodies and streams that are permanent open water.

**Residential area**—The sum of acres in lots used for housing units. This data series was introduced in 1997 to the MLU report. Due to the limits of available data, it is not possible to distinguish rural residential housing lots and some other rural developed uses from land classified as miscellaneous use. The majority of rural developed land may be included with “miscellaneous other” land, but some overlap could also exist with forest use, grassland pasture and range, and other categories. Data for this series come from the AHS, which is conducted every other year. See USDOC, CB (2014) for the most recent estimates.

**Special-use areas**—Includes highways, roads, and railroad rights-of-way and airports; Federal and State parks, wilderness areas, and wildlife refuges; national defense and industrial areas; and farmsteads and farm roads. Estimates are based on reports and administrative records of the Census Bureau and Federal and State land management and conservation agencies.

**Urban area**—Urban areas in the MLU series follow the Census Bureau urban-area definition. The Census Bureau compiles urban area every 10 years, coincident with the Census of Population. Census urban areas include densely populated areas with at least 50,000 people (“urbanized areas”) and densely populated areas with 2,500 to 50,000 people (“urban clusters”). Densely populated areas include census blocks with a population density of at least 1,000 people per square mile, surrounding blocks with a density of at least 500 people per square mile, and “less densely settled blocks that form enclaves or indentations or are used to disconnect discontinuous areas with

qualifying densities” (USDOC, CB, 2010). In the 2000 census, urban clusters replaced previous designations that were based on the boundaries of census-designated places. The census’s urban-area definition includes residential areas and concentrations of nonresidential urban areas, such as commercial, industrial, and institutional land; office areas; urban streets and roads; major airports; urban parks and recreational areas, and other land within urban defined areas. The definition allows for exceptions and special cases. Portions of extended cities that are essentially rural in character are excluded.

## Appendix 2: Primary Data Sources Used To Derive Major Land-Use Estimates

Land use	Primary data sources
Cropland: Cropland used for crops, idled cropland, and cropland pasture	Census of Agriculture, conducted every 5 years (USDA, National Agricultural Statistics Service, 2014a); other USDA, National Agricultural Statistics Service (2012 and 2014b) reports; USDA, Farm Service Agency (2014); and USDA, Natural Resources Conservation Service (2015).
Grassland pasture and range	National Resources Inventory (USDA, Natural Resources Conservation Service, 2014a), Census of Agriculture (USDA, National Agricultural Statistics Service, 2014a), and estimates of open or nonforested grazing land on Federal land (U.S. Department of the Interior, Bureau of Land Management, 2013; USDA, Forest Service, 2012a; USDA, Forest Service, 2016).
Forest-use land	Forest Inventory (Oswalt et al., 2014). Estimates of total grazed forest acreage are based on acreage estimates of active grazing allotments in national forests (USDA, Forest Service, 2012b), plus grazed woodlands on nonfederally owned land from the Census of Agriculture (USDA, National Agricultural Statistics Service, 2014a) and the National Resources Inventory (USDA, Natural Resources Conservation Service, 2014a).
Special-use areas	<p>National parks and wilderness areas include areas in national and State park systems (U.S. Department of Commerce, Census Bureau, 2013; U.S. Department of the Interior, National Park Service, 2012; U.S. Department of the Interior, Bureau of Land Management, 2013; Oswalt et al., 2014).</p> <p>Wildlife areas include areas administered by the U.S. Fish and Wildlife Service (U.S. Department of the Interior, Fish and Wildlife Service, 2012) and State wildlife agencies (from numerous State fish and wildlife agency websites).</p> <p>Defense and industrial uses based on areas administered by the U.S. Department of Defense, 2012; and U.S. Department of Energy, 2012.</p> <p>Rural highway and road estimates use average right-of-way widths and mileage data (U.S. Department of Transportation, Federal Highway Administration, 2013). Railroad area is from U.S. Department of Transportation, Federal Railroad Administration (2015). Airport area is from U.S. Department of Transportation, Bureau of Transportation Statistics (2007); U.S. Department of Transportation, Federal Aviation Administration (2011); and Geographic Data Technology (2007).</p> <p>Farmsteads and farm roads are estimated based on the State-by-State number of farms and acreage of unclassified land in farms from the Census of Agriculture. Farmstead area was computed using the average based on National Resources Inventory data (U.S. Department of Commerce, Census Bureau, 2014a) multiplied by the number of farms in 2012 (USDA, National Agricultural Statistics Service, 2014a).</p>
Urban areas	Decennial Census of Population (U.S. Department of Commerce, Census Bureau, 2014c). Inter-census estimates are extrapolated.
Miscellaneous other land	Miscellaneous land and low-density residential land from the National Resources Inventory (USDA, Natural Resources Conservation Service, 2014b).