

FARMS UNDER THREAT

The State of America's Farmland



American Farmland Trust
SAVING THE LAND THAT SUSTAINS US



COVER IMAGE:

Farmland and urban sprawl collide in Lompoc, California.

AERIAL ARCHIVES/ALAMY
STOCK PHOTO

ABOVE:

A new housing development encroaches on farmland. Anywhere, USA.

About the Quotes in this Report

Farms Under Threat: The State of America's Farmland honors two former chiefs of the USDA's Soil Conservation Service (now NRCS): Hugh Hammond Bennett, who led the soil conservation movement in the United States and was the first head of the agency; and Norm Berg, who worked with Bennett and rose through the ranks to serve as chief between 1979 to 1982. After he retired, Berg served as a senior policy advisor to American Farmland Trust and the Soil and Water Conservation Society. To learn more about these influential voices, see www.nrcs.usda.gov (Bennett) and www.farmlandinfo.org/norm-berg-collection (Berg).



FARMS UNDER THREAT

THE STATE OF AMERICA'S FARMLAND

MAY 9, 2018

*“Take care of the land and
the land will take care of you....”*

—Soil conservation pioneer
Hugh Hammond Bennett, 1947

Acknowledgments

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Lead authors: A. Ann Sorensen, Julia Freedgood, Jennifer Dempsey and David M. Theobald

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About American Farmland Trust and Conservation Science Partners

American Farmland Trust (AFT) is a nonprofit conservation organization founded in 1980 to protect farmland, promote sound farming practices, and keep farmers on the land. For more information, visit www.farmland.org/FarmsUnderThreat or our technical information center at www.farmlandinfo.org.

Conservation Science Partners (CSP) is a nonprofit scientific collective established to meet the analytical and research needs of diverse stakeholders in conservation projects. More information is available online at www.csp-inc.org.

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A crop of onion grown for seed in Payette County, Idaho.



A selection of lettuce varieties at Lane Farms in Santa Barbara, California.

Executive Summary

WITH KEY FINDINGS AND RECOMMENDATIONS

The United States is blessed with a remarkably productive agricultural landscape. Cropland, pastureland, rangeland, and woodland support a regionally diverse food and farming system capable of ensuring domestic food security. Agricultural land contributes to state and local economies, supplies lucrative export markets, and bolsters the nation's balance of trade. These exceptional natural resources sustain valuable wildlife habitat, provide flood control and fire suppression, scenic views, and resources for hunting and fishing. This land also acts as an enormous carbon sink, drawing down carbon from the atmosphere, which helps combat climate change. By 2050, the demands on agriculture to provide sufficient food, fiber, and energy are expected to be 50 to 70 percent higher than they are now. Given a limited land area in the United States and the need to feed and house an increasing number of people, it is more important than ever to protect the agricultural land and natural resources needed for long-term sustainability.

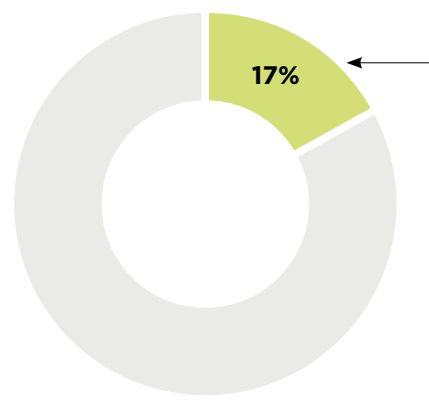
This call for action is documented and reinforced by the findings of *Farms Under Threat: The State of America's Farmland* by American Farmland Trust (AFT). The report's research shows that between 1992 and 2012, almost 31 million acres of agricultural land were irreversibly lost to development. That is nearly double the amount of conversion previously documented and is equivalent to losing most of Iowa or New York. As alarming, this loss included almost 11 million acres of the best land for intensive food and crop production. This is land where the soils, micro-climates, growing seasons, and water availability combine to allow intensive production with the fewest environmental impacts. These precious and irreplaceable resources comprise less than 17 percent of the total land area in the continental United States. Their conversion was equivalent to losing most of California's Central Valley, an agricultural powerhouse.

Over 20 years ago, AFT released the groundbreaking report, *Farming on the Edge*. This compelling study and extensive mapping gained global media attention by showing how sprawling development consumed America's highest quality farmland in critical regions across the country. Now, new threats to the nation's agricultural lands create a pressing need to update the old analyses and assess threats to America's agricultural land in the 21st century. Improvements in the availability of national data and models now enable AFT to more accurately track the scale and spatial location of the threat of development to the nation's agricultural



Beets in Inyo County, California.

U.S. AGRICULTURE RELIES ON HIGH-QUALITY FARMLAND



Only 17 percent of the land in the continental U.S. is agricultural land with the productivity, versatility, and resiliency (PVR) to produce a wide variety of crops with minimal environmental limitations.

AFT's goal is to document the threats and offer policy solutions to ensure the long-term protection and conservation of agricultural land in the United States to sustain an expanding population and maximize biodiversity.

land.¹ They also make it possible to assign values to measure the land's productivity, versatility, and resilience. These advances make it possible for AFT not only to examine past conversion patterns but also to forecast future development patterns likely to occur without better land use planning and policy intervention.

These analyses underpin *Farms Under Threat*, AFT's multi-year initiative to complete the most comprehensive assessment of the loss of U.S. farmland and rangeland ever undertaken, both past and future. AFT's goal is to document the threats and offer policy solutions to ensure the long-term protection and conservation of agricultural land in the United States to sustain an expanding population and protect biodiversity. This first report, *Farms Under Threat: The State of America's Farmland*, examines the nation's irreversible loss of agricultural land to development between 1992 and 2012. A subsequent report will analyze state-level data on past farmland conversion and the effectiveness of state-level farmland protection policies. In a third report, *Farms Under Threat* will assess a range of future threats, forecast potential impacts to 2040 and recommend effective policies that help conserve agricultural land.

AFT is working with Conservation Science Partners (CSP), a non-profit conservation organization, to ensure these assessments are grounded in reliable data and strong science. This partnership is supported by the USDA's Natural Resources Conservation Service (NRCS). A national Advisory Committee provided additional guidance, and NRCS shared data and reviewed findings. *Farms Under Threat* significantly advances our understanding of the patterns of past farmland conversion and provides information about the location, quantity, type, and quality of the agricultural land lost to development in the continental United States between 1992 and 2012. These maps and data can serve to improve agricultural land conservation and permanent protection across the nation.

***Farms Under Threat: The State of America's Farmland* significantly improves the national inventory of agricultural land in multiple ways:**

- 1) It maps and analyzes the extent of low-density residential development on agricultural land; 2) It identifies agricultural land based on its productivity, versatility, and resiliency to support intensive food and crop production (PVR values); 3) It includes a new class of agricultural land that estimates woodland associated with farm enterprises; 4) It maps grazing on federal land; and 5) It shows the spatial patterns of agricultural land

¹ *Farms Under Threat* defines *agricultural land* as cropland, pastureland, rangeland, and woodland associated with farms in the continental United States (48 states), excluding federally owned grazing land. This non-federal agricultural land is called farmland and rangeland by the public. The analysis uses the USDA National Resources Inventory (NRI) definitions for cropland, pastureland, rangeland, and forestland.



DESIGN PICS INC./ALAMY

An Iowa soybean field.

uses and conversion to development in a consistent way over time so that people can see the patterns of change.

Assigning PVR values to agricultural land helps quantify the quality of the agricultural land converted by development. Land with lower PVR values has progressively greater limitations that restrict how it can be used and whether it can be cultivated. The land best suited for intensive food and crop production has much higher PVR values and is geographically limited to areas where the nation's soils, micro-climates, growing seasons, and water access combine to allow production with the fewest environmental impacts.

KEY FINDINGS²

BOB NICHOLS/USDA NRCS

New homes replace farmland in Dane County, Wisconsin.

- **The U.S. converted almost 31 million acres of agricultural land between 1992 and 2012.** By including woodlands associated with farms and low density residential development, this analysis found nearly twice the conversion previously reported. The loss is equivalent to developing most of Iowa or the entire state of New York.
- **Overall, development disproportionately occurred on agricultural lands.** More than 70 percent of urban development and 62 percent of all development took place on agricultural land. Expanding urban areas accounted for 59 percent of the loss, including the commercial, industrial, transportation, and high-density residential development which reflect the expanding footprint of U.S. cities and towns. Low-density residential development accounted for 41 percent of the loss and included residential areas with houses built on one- to 20-acre parcels and exurban homes on even larger lots that effectively removed these properties from agricultural uses.
- **Urban development favored cropland while low-density residential development posed an equal threat to cropland and pastureland.** Urban development most frequently converted cropland (41 percent) and lower percentages of pastureland (25.9 percent), rangeland (23.8 percent), and woodland (9.3 percent). In contrast, low-density residential development posed an equal threat to cropland and pastureland (34.5 percent each) and favored woodland (19.9 percent) over rangeland (11.1 percent). For forestland, low-density residential development presented a greater threat than urban development.
- **The impact of these development patterns puts high quality agricultural land at risk.** The analysis assigned values to reflect the productivity, versatility, and resiliency (PVR value) of agricultural land for cultivation. As the PVR value increased, fewer acres of land qualified. The analysis found that the median PVR value of agricultural land lost to development was 1.3 times higher than the median PVR value of land that stayed in production. These cumulative and irreversible losses of most productive, versatile, and resilient lands have serious implications for agricultural productivity and domestic food security.

² AFT is solely responsible for the conclusions and recommendations in this report. Although information from NRCS data comprises a major component of this analysis, the conclusions and recommendations are AFT's alone.

- **By 2012, the best land to support intensive food and crop production had dropped to less than 17 percent of the total land area in the continental United States.** Only 324.1 million acres of agricultural land had PVR values with the optimal soil characteristics and growing conditions to support intensive food and crop production with minimal environmental limitations. This is slightly more than one third of agricultural land.
- **In less than one generation,³ the United States irrevocably developed nearly 11 million acres of its best land for intensive food and crop production.** While a 3.2 percent loss does not sound devastating, it is roughly equivalent to losing one of the most productive growing regions in the United States, California's Central Valley.

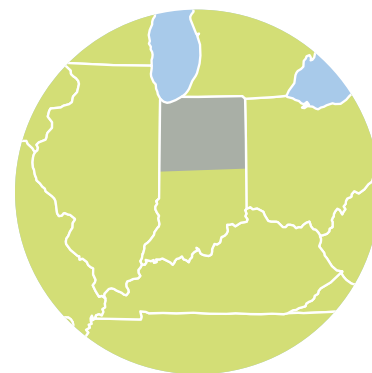
Beyond food security and economic prosperity, well-managed agricultural land provides open space, recreational resources for activities like hunting and fishing, and critical ecological services such as wildlife habitat, carbon sequestration, groundwater recharge, and flood control. This incredible diversity provides the United States with invaluable options to help the nation optimize the use of agricultural resources to sustain future generations.

It is time for the United States to recognize the strategic value of our agricultural land and step up our efforts to protect it. It is critical to balance the growing demands for energy, housing, transportation, and water to ensure our best agricultural land remains available for food and other crop production. Through thoughtful and carefully implemented land use and agricultural policies, the nation can protect farmland and strategically direct development away from critical agricultural resources while nourishing the land with conservation practices and helping the farmers and ranchers who manage this landscape to thrive.

FARMLAND LOST TO DEVELOPMENT, 1992–2012



All farmland lost:
almost 31 million acres
(nearly equivalent to the land
mass of New York State)



**Some of our best farmland was
irreversibly lost:** almost 11 million
acres (equivalent to 47% of the
land mass of Indiana)

³ A generation is considered to be about 25.5 years in length.

KEY RECOMMENDATIONS

DESIGN PICS INC./ALAMY STOCK PHOTO



Ripe cranberries in Valley Junction, Wisconsin.

Based on these national findings, AFT believes a bold and comprehensive national strategy is needed to save the land that sustains us, including:

- A dramatic increase in federal investments in agricultural land protection through the USDA Agricultural Conservation Easement Program—Agricultural Land Easements (ACEP-ALE);
- Supporting and fully funding the USDA agencies and their programs that provide unbiased information to help monitor changes to U.S. agricultural resources, including the NRCS' National Resources Inventory (NRI), the National Agricultural Statistics Service's (NASS) Tenure, Ownership and Transfer of Agricultural Land (TOTAL) survey, and the Economic Research Service's (ERS) Major Land Uses reports; and,
- Enacting a 21st century federal agricultural land protection platform to more effectively address the interconnected threats to farmland from development, climate change, agricultural viability, and farm succession.

Introduction

The precious arable land that sustains life on Earth is a finite and irreplaceable resource that is under heavy stress. Less than six percent of the Earth's surface is suitable for agriculture and growing food. When climate, soils, and topography are factored into the equation, just over half of this land can be farmed without any physical constraints (FAO 2011). Over 10 percent of the world's arable acres are in the United States.⁴

The United States is blessed with a varied and extensive agricultural landscape comprised of cropland, pastureland, rangeland and woodland associated with farms, making agriculture a significant contributor to rural and urban economies. However, agricultural land, both domestically and globally, faces unprecedented challenges as the world's population continues to expand. By 2050, the demands on agriculture to provide the necessary food, fiber, and energy are expected to be 50 to 70 percent higher than they are now. To meet these demands, all countries must sustainably improve their agricultural productivity, protect their natural resources, and deal with changing weather patterns and the intensification of natural hazards (FAO 2011; FAO 2017).

Because the United States is home to such a significant amount of the world's arable land, the protection of this resource is a national and global concern.

Since our founding in 1980, AFT has been concerned about the loss of agricultural land. Over 20 years ago, AFT released the groundbreaking report *Farming on the Edge* to call attention to the sprawling development that consumes America's highest quality farmland in every state in the nation (Sorensen et al. 1997). *Farming on the Edge* was a wake-up call about the impacts of farmland loss and the need to act to protect our agricultural land base from poorly planned development. The report led to policy action at the federal, state, and local levels. While development slowed significantly during the recession from 2007 to 2012, it has rebounded with the strengthened economy. Recognizing the need to update AFT's old analyses and assess the threats to America's agricultural land in the 21st century, AFT launched its *Farms Under*



BLEND IMAGES/ALAMY STOCK PHOTO

By 2050, the demands on agriculture to provide the necessary food, fiber, and energy are expected to be 50 to 70 percent higher than they are now.

⁴ Arable land is land capable of being farmed productively (i.e. being plowed or cultivated and used to grow crops).



California pastureland.

Threat initiative, the most comprehensive and ambitious assessment ever undertaken of the status and threats to U.S. farmland and ranchland.

***Farms Under Threat* is a multi-year initiative to complete the most comprehensive assessment ever undertaken of the status and threats to U.S. farmland and ranchland.** Its analyses underpin AFT's goal to document the threats to the nation's agricultural resources and offer policy solutions. The goal is to ensure the long-term protection and conservation of America's diverse agricultural landscape to support farmers and ranchers, sustain an expanding population, and maximize biodiversity.

This report, *Farms Under Threat: The State of America's Farmland*, is the first in a series of analyses of past and future threats to America's agricultural land. AFT defines agricultural land as the non-federal cropland, pastureland, rangeland, and woodland associated with farms that is managed to support agricultural production. For the first time, data and models are available to spatially portray the extent, diversity, and quality of America's agricultural land and the threat of development. These tools make it possible to examine past conversion rates and map the scale and location of that development. Future *Farms Under Threat* assessments will analyze farmland conversion at the state level and the effectiveness of state policies to address it; study demographic shifts and the impending transition of agricultural land ownership; and use housing density and climate projections to forecast what could happen to the nation's agricultural land by 2040 if no actions are taken.

AFT is working with Conservation Science Partners (CSP) to ensure these assessments are grounded in reliable data and strong science. This partnership is supported by the USDA's Natural Resources Conservation Service (NRCS). Additional guidance was provided by a national Advisory Committee, and NRCS shared data and reviewed findings and drafts of maps and reports.

What Is at Risk

U.S. agricultural land supports state and local economies, significant export markets, and the nation's balance of trade. Locally, this agricultural land contributes to fiscal balance: as with other commercial land uses, the property taxes generated by agricultural land typically exceeds the expense of providing it with public services.⁵ Collectively, this land supports a regionally diverse food and farming system and contributes to a secure food supply. Fifteen percent of U.S. counties are classified as farming-dependent (in terms of jobs), and nearly 60 percent of the market value of U.S. farm production comes from metropolitan counties and adjacent areas.⁶ These counties supply 91 percent of domestically sourced fruits, tree nuts, and berries; 77 percent of vegetables and melons; 68 percent of dairy; and 55 percent of eggs and poultry. Farms in metropolitan counties often supply local and regional markets, making up 81 percent of food sold directly to consumers; 76 percent of community-supported-agriculture (CSA) farms; and 74 percent of farms selling directly to retail outlets.⁷ Fruits and vegetables often require unique soils and microclimates, access to water and labor, an existing infrastructure that has built up over time (e.g. farm equipment, storage, processing, and packing facilities, etc.), and markets to support production and sales (Plattner et al. 2014). The difficulty in moving production of these high-value crops elsewhere has likely kept producers from expanding production, even though domestic demand for fruit and vegetables now exceeds supply by 203 percent and 164 percent, respectively (White and Hall 2017).

Agriculture, food and related industries contribute \$992 billion (5.5 percent) to the U.S. GDP (USDA ERS 2015). Agriculture and its related industries provide 11 percent of U.S. employment. Many economic sectors rely on agricultural inputs, including forestry, fishing and related activities; food, beverages, and tobacco products; textiles, apparel, and leather products; food and beverage stores; and food service, eating, and drinking establishments. U.S. agricultural exports support

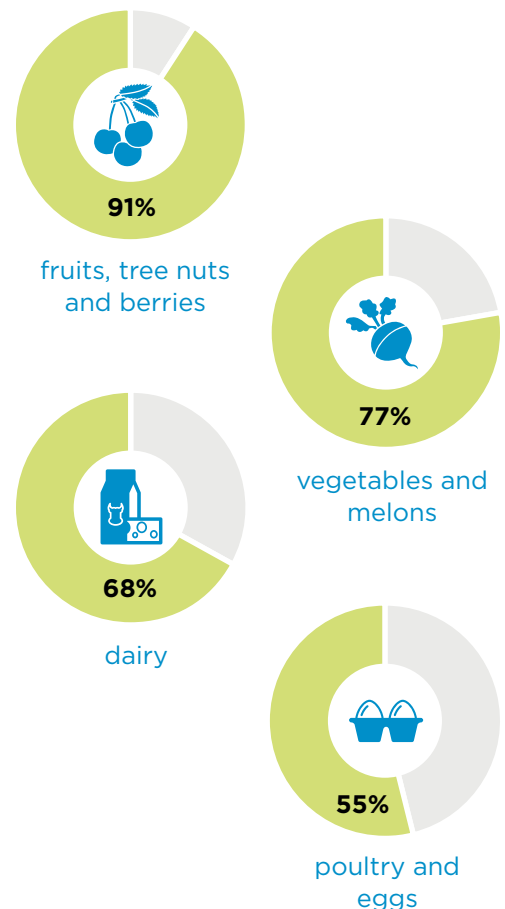
⁵ The median cost to provide public services for each dollar of revenue raised is \$0.30 for business, \$0.37 for agriculture, and \$1.16 for residential (www.farmlandinfo.org/cost-community-services-studies).

⁶ Analysis by AFT's Farmland Information Center (FIC) combines information from the 2012 Census of Agriculture with 2013 USDA Economic Research Service (ERS) Urban Influence Codes (UIC). ERS classifies counties into 12 groups. The FIC uses UICs 1-5 to identify the "most urban" counties. These 1,652 counties comprise 54 percent of U.S. counties.

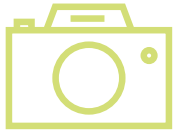
⁷ See AFT's "Food in the Path of Development" fact sheet: www.farmlandinfo.org/food-path-development-talking-points.

FOOD IN THE PATH OF DEVELOPMENT

Metropolitan counties and adjacent areas supply the majority of domestically produced:



AGRICULTURAL LAND PROVIDES BENEFITS BEYOND FOOD



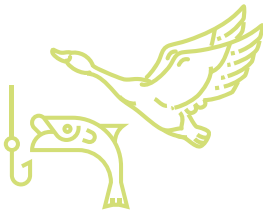
open space and scenic views



biodiversity and wildlife habitat



fire suppression, floodplain management, and carbon sequestration



recreation

output, employment, income, and purchasing power in both the farm and nonfarm sectors, and each dollar of agricultural exports stimulates another \$1.27 in business activity.

Agricultural land also plays a significant role in the nation's landscape and psyche. Along with food, fiber, and energy, Americans highly value the contributions that agricultural land makes to the environment and quality of life. Well-managed agricultural land provides open space and scenic views; biodiversity and wildlife habitat; and critical ecological services like fire suppression, floodplain management, and carbon sequestration (Heimlich and Krupa 1994; Northeast Regional Center for Rural Development 2003; Hellerstein et al. 2002; Farm Foundation 2004; Swinton et al. 2007; Duke 2008; Freedgood and Fydenkez 2017). Agricultural land also supports rural lifestyles and recreational opportunities like hunting, fishing, and horseback riding. Many of the nation's agricultural regions are deeply important to U.S. heritage, such as the glacially borne wild blueberry barrens of Down East Maine; the wild rice region of the upper Great Lakes; New Mexico's Hatch Valley, known as the "chili pepper capital of the world"; and Michigan's Grand Traverse cherry region, which produces most of the nation's tart cherries (Hilchy 2008).

As an added benefit, agricultural land can help stabilize and reduce future greenhouse gas emissions. Keeping land in agriculture and limiting low-density residential development can curb one of the largest sources of carbon emissions: transportation. Emerging studies show that the average greenhouse gas (GHG) emissions from urban land uses are orders of magnitude higher than those from cropland (approximately 66–70 times higher per unit area) (Culman et al. 2014; Shaffer and Thompson 2015; Arjomand and Haight 2017). In addition, GHG emissions from lower density, suburban-style developments account for roughly half of the GHG emissions in the United States (Jones and Kammen 2013). Although a full accounting of emissions benefits from protecting farmland will take more time, intact agricultural landscapes provide communities with future opportunities to further reduce emissions and sequester carbon in agricultural soils and vegetation (Culman et al. 2014). Farmers and ranchers manage more than one billion acres of U.S. land, and agricultural practices that sequester carbon and improve soil health—increasing soil productivity, resiliency, and versatility—are the next frontier of agricultural innovation.

"We have been too wasteful too long in this country—indeed, over most of the world. We had so much good land in the beginning we thought the supply was limitless and inexhaustible." —**Hugh Hammond Bennett, 1943**

Tracking the Status of Agricultural Land

Since the 1930s, the USDA has closely monitored the conditions and threats to the nation's natural resources. The Dust Bowl of the 1930s in the Great Plains dramatically called attention to the dangers of severe drought and poor land management, leading to the establishment of the USDA Soil Conservation Service (SCS) in 1935, now NRCS (USDA 1992). Since its founding, SCS/NRCS has periodically inventoried the nation's land and natural resources and, in 1975, released the *Potential Cropland Study* to examine the loss of the nation's best agricultural land to urban development (Schnepf and Flanagan 2016).

The advent of NRCS' National Resources Inventory (NRI) in 1977 made it possible to track the conditions and trends of soil, water, and related resources. NRCS conducts this statistical survey of natural resource conditions and trends on nonfederal land in cooperation with Iowa State University's Center for Survey Statistics and Methodology. Among other attributes, the NRI tracks changes in land cover/use, which provides critical data on how much farmland is converted and other trends affecting the nation's strategic land and natural resources (Schnepf and Flanagan 2016). The precision of NRI statistical estimates vary with the number of samples involved in a particular inventory activity. Based on statistical area sampling, as opposed to full areal coverage, it is most applicable for monitoring state and national levels of gross land conversion (Lark et al. 2017). The NRI currently releases state-level estimates to the public and is exploring ways to achieve statistical reliability for county-level sub-state estimates (Schnepf and Flanagan 2016). These periodic inventories remain the primary source of information about changes in land use in the United States. However, leveraging the NRI by mapping the patterns of land cover/use and trends over time provides powerful information to inform planning and decision-making at state, county, and municipal levels. The planners queried by AFT at the start of *Farms Under Threat* agreed that having access to spatial maps was important for planning purposes.

The 1977 NRI data also became the primary data source for the National Agricultural Lands Study (NALS) undertaken by USDA in 1979 (USDA and the President's Environmental Council 1981). When the NALS opted to use the 1977 NRI data on urban and built-up uses of land, it not only focused more national attention on the inventory work by SCS, but it also generated considerable controversy in academic circles over how much



A Colorado ranch during the Dust Bowl.

USDA NRCS ARCHIVES

Federal Farmland Protection: The Farmland Protection Policy Act (FPPA)

Congress enacted the FPPA as a subtitle of the 1981 Farm Bill to minimize the impact that federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. The FPPA stipulates that federal programs be compatible with state, local,

and private efforts to protect farmland. (For the purposes of the law, federal programs include construction projects—such as highways, airports, dams, and federal buildings—sponsored or financed in whole or part by the federal government, and the management of federal land.)

Federal agencies are required to develop and review their policies and procedures to implement the FPPA every two years. NRCS is charged with oversight of the FPPA (www.farmlandinfo.org/sites/default/files/FPPA_8-06_1.pdf).

agricultural land was actually being converted to nonagricultural uses. This controversy led USDA to establish new procedures for identifying and recording urban and built-up areas that were incorporated into the 1982 NRI and subsequent sampling (Schnepf and Flanagan 2016). The findings in the NALS, along with a Congressional report that concluded federal infrastructure grants and mortgage subsidies had led to wasteful farmland conversion (U.S. Congress 1980), prompted the passage of the Farmland Protection Policy Act (FPPA) as a subtitle in the 1981 Farm Bill.

In addition to the NRI, USDA monitors other trends that impact the nation's agricultural resources. The USDA Economic Research Service's (ERS) major land use estimates and related cropland series provide a comprehensive accounting of all major uses of public and private land in the United States (www.ers.usda.gov/data-products/major-land-uses). Every five years, the USDA National Agricultural Statistics Service's (NASS) Census of Agriculture does a complete count of U.S. farms and ranches, providing information about land use and ownership, ownership characteristics, production practices, income, and expenditures (www.agcensus.usda.gov). In 2014, ERS and NASS completed the Tenure, Ownership and Transfer of Agricultural Land (TOTAL) survey, the first survey since 1999 to focus solely on the ownership and transfer of agricultural land (Bigelow et al. 2016). TOTAL provided invaluable information about agricultural land ownership and otherwise unavailable data on agricultural landlords. All of this critical information helps USDA evaluate the status of the nation's soil, water, and related resources on non-federal land every 10 years as required by the 1977 Soil and Water Resources Conservation Act (RCA). RCA appraisals assess the capacity of the nation's resources to meet present and future demands and play a key role in shaping conservation strategies, but they are scheduled to

terminate on December 31, 2018 (www.nrcs.usda.gov/wps/portal/nrcs/rca/national/technical/nra/rca/ida).

Both NRI and RCA appraisals indicate the United States is developing its more productive agricultural land at a disproportionate rate. AFT identified the same trend when it documented the relationship between highly productive farmland, land development trends, and farmland loss over 20 years ago (Sorensen et al. 1997). The need to improve the nation's understanding of the scale and spatial location of this threat provided the impetus for AFT's *Farms Under Threat* initiative.

Mapping the quality of agricultural land and tracking its loss is a critical step to better understanding the impacts of conversion that has already occurred. However, this is not easy to do because the various databases and maps available at the national level differ in purpose, scope, and how various land categories and uses are defined (Nickerson et al. 2015). The collected data also differs in scale, including their extent and spatial resolution, as well as in duration, accuracy, update frequency, and timing. As a result, estimates from different federal agencies do not agree on how much agricultural land the United States has—let alone how much the nation is losing.

To meet the need for more accuracy, AFT and CSP applied advanced geospatial and remote sensing analysis to fill in the data gaps and create the most comprehensive and most accurate national analysis ever undertaken of agricultural land and conversion patterns from urban and low-density residential development. ***Farms Under Threat: The State of America's Farmland* adds value to the national inventory of agricultural land in multiple ways:** 1) It includes a new class of agricultural land that estimates woodlands associated with farm enterprise; 2) It maps grazing on federal land; 3) It identifies agricultural land based on its productivity, versatility and resiliency to support intensive food and crop production (PVR values); 4) It maps



The Sneffels Range in Ridgeway, Colorado.

PAT & CHUCK BLACKLEY/ALAMY STOCK PHOTO

“Each day, each year—individually and on a national scale—the conversions of cropland to non-agricultural uses may not have been large in proportion to the total national landscape. However, collectively and cumulatively, these land use shifts are seriously reducing the world’s supply of important farmlands. Moreover, while these continued losses are ‘significant’ or ‘rather serious’ on a global scale, they may already be critical for individual, local, or regional areas.” —Norm Berg, 1979

and analyzes the extent of low-density residential development on agricultural land; 5) It shows the spatial patterns of agricultural land uses and conversion to development in a consistent way over time so that people can see the patterns of change.

“Productive land is neither limitless nor inexhaustible.” —**Hugh Hammond Bennett, 1959**

Federal Farmland Protection: Agricultural Conservation Easement Program (ACEP)

USDA’s NRCS is a key partner for state and local governments, private land trusts, and recognized tribes working to protect farmland and ranchland from development. The agency’s Agricultural Conservation Easement Program (ACEP), authorized in the farm bill, protects agricultural land and conserves wetlands. The Agricultural Land Easements (ALE) enrollment option provides matching funds to buy conservation easements on farmland and ranchland.

An agricultural conservation easement is a deed restriction that landowners voluntarily place on their property to restrict

development and keep the land available for farming. The funds from selling agricultural conservation easements allow farmers to free up capital without having to sell their land outright and are most often used to improve or expand the farm operation (Esseks and Schilling 2013). Since 1996, NRCS has invested about \$1.5 billion in agricultural conservation easements through ACEP-ALE and its forerunners, leveraging state, local, and private funds to contribute to the long-term protection of more than 1.2 million acres of agricultural land nationwide. The program has

protected agricultural land for agriculture, improved agricultural viability, encouraged on-farm conservation, and helped farmers gain access to land (Esseks and Schilling 2013). Although the demands for the federal, state, and local programs remains very high, the limitations in funding at all levels constrains each partner’s ability to protect this critical land. For more information about the impact of the federal farmland protection program, see www.farmlandinfo.org/impacts-federal-farm-and-ranch-lands-protection-program-assessment-based-interviews-participating-1.

Methods

CSP analyzed the location, quantity, type, and quality of the agricultural land converted to development in the continental United States to a 30-meter resolution with mapping units of about five to 10 acres. To achieve this level of precision and inform future forecasting, CSP focused on the 20-year time period⁸ between 1992 and 2012 when there were sufficient databases with the national coverage necessary to complete the more detailed spatial mapping. The most recent releases of databases with the coverage needed for a national assessment are 2011 and 2012.

To show the extent of land in agricultural uses, the analysis identifies and maps woodland, a new class of agricultural land, and also maps grazing on federal land. To provide greater clarity on the extent of agricultural land conversion, it improves on previous efforts to spatially map low-density residential development, which extends beyond the suburbs into rural parts of counties. The conversion of working land to very large lot developments not only diminishes the agricultural land base, it also threatens the vitality of rural economies. Finally, to more fully understand the quality of the agricultural land being converted, it identifies and spatially maps agricultural land based on values that denote their productivity, versatility, and resiliency (PVR) for cultivation. This complex approach significantly advances the understanding of farmland conversion.

Developing the base map.

CSP started the assessment with the 2011 U.S. Geological Survey (USGS) National Land Cover Dataset (NLCD)—a 30-meter-resolution national database that provides spatial reference and descriptive data of land surface characteristics. It adds in critical data from the NRI and Soil Survey Geographic Database SSURGO datasets (soil suitability and capability classes), the NASS Cropland Data Layer (CDL) and Census of Agriculture data (median farm size), the USGS NLCD accuracy assessments, National Elevation Dataset (at 10 m) and Protected Areas Dataset (PAD-US), and housing data from the U.S. Census Bureau at census block level. It directly incorporates NRI data to generate a



Dickie Brothers Orchard in Roseland, Virginia.

PAT & CHUCK BLACKLEY/ALAMY STOCK PHOTO

⁸ CSP initially applied this approach to map conversion over a 30-year period based on 1982 data from the NRI. However, because many of the datasets used to model land cover/use represented conditions in the early 1990s, the results were too inconsistent and had too much variability.



Farmland in the Mohawk Valley, New York.

suitability model that produces maps of land cover/use at 1992 and 2012 and then applies additional geospatial analyses to quantify change.

Farms Under Threat adds a new class of agricultural land: woodland associated with farms. This is a subset of forestland that CSP mapped by approximating the area of woodland reported by operators in the 2012 Census of Agriculture. To show the total extent of land in agricultural uses, it includes federal land that is grazed based on grazing permits issued by the U.S. Forest Service and the U.S. Bureau of Land Management in 2014 and 2015, respectively. It also identifies low-density residential development as another land cover/use class.⁹ Depending on location, once this intensity of residential development occurs on agricultural land, the analysis assumes it is no longer primarily used for agricultural purposes.

The assessment focuses on the continental United States (the contiguous 48 states) because of data availability and spatial data processing efficiencies. A number of datasets used in the analyses were either not available or had limited (less than 25 percent) spatial coverage in Alaska and/or Hawaii. For Alaska, the NRCS NRI and SSURGO soils databases were very limited; for both Alaska and Hawaii, data are not available for the CDL or grazing allotments, and the earliest availability of the NLCD is 2001 (not 1992).

Mapping and assessing irreversible losses due to both urbanization and low-density residential development.

Previous work by the technical mapping team, access to unique national data, and a geospatial model enabled CSP to map urbanization and the low-density residential development that extends beyond the suburbs. CSP started with the NLCD urban land cover/use class. The satellite imagery used to create the NLCD dataset detects the high-density urbanized or built-up areas but misses urban development hidden under forested canopies, as well as low-density residential areas. This shortcoming became apparent when CSP compared the detailed land use observations from the NRI to the NLCD 2011. Roughly 30 percent of the area represented by the NRI as urbanized did not fall on urban/built-up classes in the NLCD.

The next step was to figure out how to spatially map low-density residential development, especially large-lot development occurring in exurban areas. AFT interviewed farmland protection practitioners, county planners, and other key stakeholders at the start of the *Farms*

⁹ *Farms Under Threat* uses the NLCD definition for urbanization: areas occupied by urban development or “built-up” areas of commercial, industrial, transportation, and high-density residential (NLCD categories 21–24). Low-density residential includes residential areas with more than one housing unit per one to two acres up to homes on 10–20 acres as well as exurban homes on even larger lots that effectively remove these properties’ agricultural uses.

Under Threat initiative. In some parts of the country, these stakeholders identified exurban development as the principal threat, and they urged AFT to investigate the lower-density residential development missed by the NRI.

The NRI urban classification captures residential land areas with more than one housing unit per one to two acres up to homes on 10–20 acres. This resulted in another gap between what the NLCD captures and the NRI samples. To bridge the gap between NLCD and NRI, CSP sought to map both the NRI residential land areas and the nonagricultural development on larger lots.

To do this, CSP created an additional land cover/use category of low-density residential. The low-density residential model filled in the NRI urban projections up to one house per 10–20 acres. It also captured exurban homes on even larger lots that effectively removed even more land from agricultural uses. To identify these larger lot residences, AFT asked NASS to generate the quartiles of farm size from the 2012 Census of Agriculture for each county. The size of a viable farm or ranch varies considerably from region to region and from county to county. To distinguish between a viable agricultural operation and a rural estate (also called a “farmette” or “ranchette”), CSP identified the low-end tail (approximately the 10th percentile) of the entire distribution of farm sizes in each county by using 50 percent of the lowest (25 percent) quartile. Based on feedback from scientists involved with the NRI, CDL,



BLEND IMAGES/ALAMY STOCK PHOTO

A crop farmer in Oyster, Virginia.

Limitations of the Data from *Farms Under Threat: State of America's Farmland*

The *Farms Under Threat: State of America's Farmland* datasets are produced at a resolution of 30 meters (about 1/4 acre), though the minimum mapping unit is five to 10 acres, which is useful to inform and support sub-county decisions regarding mapped patterns at extents of roughly 1,000 acres or greater. Calculating summaries of the data at scales finer than this generally is not recommended. To characterize broader-scale patterns and trends, the minimum analytical (decision)

unit should be aggregated to the sub-county level (approximately 10,000 acres or greater), the equivalent of a Hydrologic Unit Code 12 or HUC12 level. CSP and AFT recognize that there may be some utility for using these data at relatively fine-scales, but caution that the interpretation of the results be used appropriately and considered in a probabilistic perspective, particularly when using the data for site-scale planning exercises. Calculating landscape change is particularly

challenging, and so we suggest that appropriate scales for calculating change or trends with data from *Farms Under Threat: State of America's Farmland* should be done at county, state, and national scales. Fine-scale analysis should proceed under advisement of the data developers (CSP) on a case-by-case basis. As with any map, there is some level of uncertainty associated with the data, and the statistical uncertainty associated with our findings has been fully documented.



Fields of squash in Virginia.

and NLCD, this best represents the point below which land previously identified as agricultural land is likely too small or fragmented to support an agricultural operation. These farm-size thresholds (calculated as roughly the 10th percentile of farm size in the county) vary widely from county to county and state to state and ranged in size from two acres (e.g. in parts of the Northeast) to 186 acres (e.g. in parts of Great Plains, etc.). This land was then re-classified as most likely low-density residential. Then CSP harmonized this data with the housing density data from the U.S. Census and used housing density to help distinguish large lot, low-density residential from agricultural uses.

Assigning values to agricultural land based on their productivity, versatility, and resilience for long-term cultivation.

Farmers and ranchers make decisions about how to use their land based on soil type, water resources, climate, adjoining land uses, proximity to markets and transportation, access to farm equipment, and other factors (Olson and Lyson 1999). However, the long-term sustainability of keeping the land in cultivation or in other agricultural uses depends on the productivity,¹⁰ versatility¹¹ and resiliency¹² (PVR values) of the land base. The research team looked for factors that offered reliable national coverage and could act as proxies to rank agricultural land nationally based on these key factors and chose *soil suitability*, *land cover/land use*, and *food production* to assess the land's potential to support long-term cultivation.

¹⁰ **Productivity** is output per unit of input (often measured as crop yield per acre). The highest productivity occurs in coastal areas where climate, soil, location, and irrigated conditions favor the production of perishable crops (fruits and vegetables) or where integrated livestock operations draw from an extended cropping area. Unfortunately, productivity can often mask environmental or health components of soil quality (Widbe and Gollehon 2006). The PVR analysis considers soils, their limitations, climate, type of production, and whether the land can produce commonly cultivated crops and pasture plants without deterioration over a long period of time.

¹¹ **Versatility** is the ability of land to support production and management of a wide range of crops. It is mainly assessed in terms of soil and land physical characteristics (Bloomer 2011).

¹² **Resiliency** (the land's ability to maintain its potential to provide ecosystem services) depends on the same factors that determine potential productivity (topography, relatively static soil properties and climate (UNEP 2016)).

“Each acre not retained for use in agriculture, and each acre exceeding the tolerance value in erosion loss, removes flexibility for future decisions and reduces the nation’s options for directing our own destiny.” —Norm Berg, 1981

National Factors Used in the Productivity, Versatility and Resiliency (PVR) Analysis

Soil suitability uses important farmland designations, which interpret soil survey information to indicate relative suitability and productivity of soils. Important farmland designations are an attribute in the NRCS SSURGO database. This factor gets at the capacity of soils to support agricultural production (productivity) and provides clues to the land’s versatility and resiliency to withstand weather extremes. We consulted with state soil scientists and included the following important farmland designations: prime farmland, prime farmland with limitations, unique farmland, farmland of statewide importance, and farmland of statewide importance with limitations. We reclassified locally important soils in all states except Michigan and Ohio as not prime, because states inconsistently define their locally important soils and most states identify fewer than 1,000 acres as locally important. Working with the NRCS state soil scientist,

AFT reclassified Michigan locally important soils in counties adjacent to Lake Michigan as unique (since these areas support fruit trees or vineyards) and reclassified the locally important soils in remaining counties as statewide important. For Ohio, we reclassified locally important soils as statewide important.

Broad land cover/use shows where different major types of agriculture are conducted. Land cover is the vegetation or other kind of material that covers the land surface. Land use is the purpose of human activity on the land; it is usually, but not always, related to land cover. Continuous production indicates there are relatively fewer limitations and environmental consequences. It indicates resiliency over time. We mapped land cover/use by combining data from the NRI, the USGS National Land Cover Dataset for 2011, and the SSURGO database.

Food production was included in recognition of the fact that a primary goal of agriculture is to feed people. This factor is especially important as a proxy for characteristics that support production of specialty crops that may require unique soils and microclimates. Using data from the USDA NASS Cropland Data Layer, we grouped 132 Individual cropland types into five main groups: 1. fruit and nut trees; 2. fruits and vegetables grown as row crops; 3. staple food crops (e.g. wheat, rice, barley, oats, dry beans, potatoes); 4. feed grains, forages, and crops grown for livestock feed and processed foods (corn and soybean; hay and alfalfa; oilseeds and sugar beets and sugarcane); and 5. non-food crops (i.e. crops used for energy production excluding corn, fiber, tobacco, and nursery/greenhouse).



Pumpkin plants in Starlight, Indiana.

Farms Under Threat then used a structured, replicable process to elicit feedback from 33 national experts to decide the importance of each factor in determining the land's potential. The experts assigned the strongest weight to soil suitability (given the value of 1.0), followed by food production (= 0.522), and land cover/land use (= 0.398). For soil suitability, the experts ranked the soil types in the following order: prime, unique, prime with limitations,¹³ state important, and state important with limitations. For land cover/use, types, the ranked order was cropland, pastureland, rangeland, and woodland. For food production, the ranked order was fruit and vegetables, fruit and nut trees, staple food crops, feed grains, and forages and non-food crops. Because fruits, nuts, and vegetables occupy only a small percentage of total cropland acres and often depend on unique microclimates that limit their range, their ultimate weighting within the analysis was higher to reflect their disproportionate value.

Factoring in critical limitations to production and versatility.

To strengthen the soil suitability analysis, the analysis included a secondary factor based on production limitations documented within NRCS Land Capability Classes (LCC) (USDA SCS 1961). USDA developed this classification to group soils primarily on the basis of their capability to produce commonly cultivated crops and pasture plants without deteriorating over a long period. The LCC considers management hazards (e.g. erosion and runoff, excess water, root zone limitations, and climatic limitations). It also helps identify production versatility, identifying whether soils can be used for cultivated crops, pasture, range, woodland, and/or wildlife food and cover. The LCC identifies eight categories with increasing limitations. Land in Classes I through IV is suited to cultivation, although Classes II through IV have increasing limitations that reduce the choice of plants and require the use of progressively more conservation practices. Classes V through VIII are not suited to cultivation, and their use is limited largely to pastureland, rangeland, woodland, or wildlife food and cover. To improve the food production factor, the analysis also incorporated information about growing season length that limits production in parts of the country but allows almost year-around production in some of the southern states and in some coastal regions. After completing these refinements, CSP assigned each agricultural land mapping unit (5–10 acres) a combined PVR value based on the PVR factors and weighting (see Figure 4).

¹³ *Farms Under Threat* uses the NRI definitions for the various soil types. In this case, limitations denote the conditions that must be addressed before the soil qualifies as prime (e.g. prime if irrigated, prime if drained, prime if drained and either protected from flooding or not frequently flooded, etc.) or statewide important.

Identifying the best land for intensive food and crop production.

After assigning combined PVR values, CSP then applied a scenario model to identify the best land for intensive food and crop production (includes the production of fruits, vegetables, staple foods, grains, and animal feed). The scenario model included soils that are prime, unique, or prime with limitations; cropland and pasture; and the relevant cropland types. The land with values at or above the resulting PVR threshold value has the highest potential for food and crop production with the fewest limitations and environmental impacts. This subset of agricultural land is the best land for intensive food and crop production in terms of its ability to support cultivation.

Checking the PVR continuum against other classification schemes.

To help put the PVR value continuum into context with other classification schemes, CSP examined the PVR values generated for the NRI points. For the NRI points designated as prime, the mean PVR value was 0.45. For Land Capability Class designations, the mean PVR value for LCC Class I points was 0.53, Class II was 0.49, Class III was 0.40, Classes IV and V were 0.29, Class 6 was 0.20 and Classes VII and VIII were 0.15. *Farms Under Threat: State of America's Farmland* identifies land with a PVR value above 0.43 as best suited for intensive food and crop production. In other words, the threshold the scenario model uses to identify the best land for intensive food and crop production picked up all the prime farmland identified by the NRI points, all the agricultural land in LCC Classes I and II, and some of the agricultural land in LCC Class III.



Cherry Bomb peppers growing in northern Illinois.

JESS MERRILL/ALAMY



LARRY LINDELL/ISTOCKPHOTO

The sun sets over an Iowa cornfield.

Findings¹⁴

- **Between non-federal and federal lands, America’s farmers and ranchers make use of a diverse agricultural landscape that covers 55 percent of the land area in the continental United States.**

Farms Under Threat land cover/use categories include cropland, pastureland, rangeland, and woodland (Table 1)¹⁵ in the context of other major land uses (e.g. urban, low-density residential, forest, water, federal, federal land used for grazing, other rural land, etc.) (Figure 1). The broad extent to which land in the continental United States is used by farmers and ranchers becomes apparent when non-federal agricultural land and federal land used for grazing are mapped together (Figure 2). Farmers and ranchers use over one billion acres in the continental United States (Table 2), roughly 55 percent of the land area, providing a wide range of benefits and amenities that are valued by the public.

A Note About Land Cover/Use Categories Used in *Farms Under Threat*

Farms Under Threat defines agricultural land as cropland, pastureland, rangeland and woodland associated with farms in the continental United States (48 states), excluding federally owned grazing land. This non-federal agricultural land is commonly referred to as farmland and ranchland by the public.

Farms Under Threat uses the NRI definitions for rangeland, forestland, cropland and

pastureland. “Woodlands” is a new class of forested cover that is part of a functioning farm. “Federal (grazed)” is a new class compiled from USFS and BLM allotment data. “Urban” is mapped from the USGS NLCD urban/built-up categories. “Low density residential” is a new class calculated from Census block level housing statistics. “Other” includes locations not classed in other cover/use classes (e.g. along rural roads or scattered in

areas with little vegetation cover such as barren or steeper slopes). “Water” includes freshwater and some near-shore ocean. Compared to NRI, FUT slightly under estimates the total land area of the contiguous United States (CONUS). All percentages reported are based on the total CONUS land area reported by NRI and will not sum to 100 percent due to rounding and other factors described in more detail in the FUT technical report.

14 AFT is solely responsible for the conclusions and recommendations in this report. Although information from NRCS data comprises a major component of this analysis, the conclusions and recommendations are AFT’s alone.

15 Direct comparison of *Farms Under Threat* with the NRI and other agricultural datasets is difficult because of different classifications, sources, time periods, and spatial resolution. The accuracy of the revised cover types in our resulting map, compared to the ~800,000 NRI validation data points, is roughly 83 percent overall.



Figure 1: The extent and distribution of agricultural land in 2012.

Agricultural land in the continental United States, shown here in shades of yellow and green, encompass roughly 912 million acres of non-federal land, including cropland, pastureland, rangeland and woodland associated with farms. This agricultural land provides a rich and varied landscape that is part of a larger mosaic of land cover/uses, including forestland, federal land, federal land grazed by livestock, and other rural land, as well as urban and low-density residential development.

Table 1: Farms Under Threat Land Cover/Uses in 2012.*

Land Cover/Use		Thousands of Acres	Percent of Total Land Area
Agricultural Land	Cropland	313,845	16.2%
	Pastureland	108,410	5.6%
	Rangeland	409,275	21.1%
	Woodland	80,136	4.1%
	Total Agricultural Land	911,666	
Federal grazed		158,418	8.2%
Federal		217,934	11.2%
Forestland		328,572	17.0%
Other		87,889	4.5%
Urban		71,464	3.7%
Low Density Residential		69,536	3.6%
Water		43,469	2.2%
No data (unknown)		48,765	2.5%
Total		1,937,713	100%

* See box on page 17 for an explanation of land use categories.

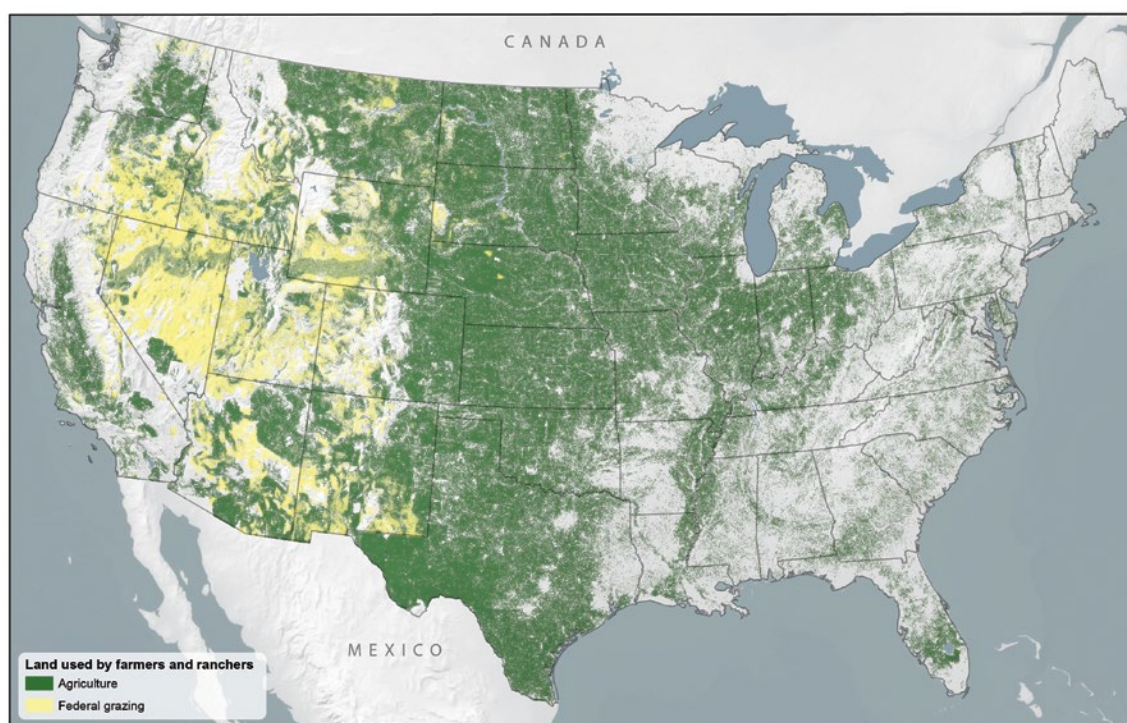


Figure 2: The widespread landscape used by farmers and ranchers in 2012.

Farmers and ranchers use over one billion acres, or 55 percent of the land in the continental United States, which includes agricultural land and federal land used to graze livestock. This map depicts only these land uses to show the broad extent of land used for agricultural production.

Table 2. *Farms Under Threat* agricultural land and federal land used for livestock grazing in 2012.*

Land Cover/Use		Thousands of Acres	Percent of Total Agricultural Land	Percent of Land in Agricultural Use
Agricultural Land	Cropland	313,845	34.4%	29.3%
	Pastureland	108,410	11.9%	10.1%
	Rangeland	409,275	44.9%	38.2%
	Woodland	80,136	8.8%	7.5%
	Total Agricultural Land	911,666	100%	
Federal Land Used for Grazing		158,418		14.9%
Total Land in Agricultural Use		1,070,084		100%

* See box on page 17 for an explanation of land use categories.

- **Agricultural land varies in its potential to be used for food and crop production.**

The PVR land potential model calculates the productivity, versatility and resiliency value at each location on the map (Figure 3). As PVR values decrease, the land has progressively greater limitations and usually requires greater inputs to cultivate. Farmers may also need to adapt crops and practices and increase their level of management to use this land for cultivation. As PVR values increase, fewer and fewer acres of land qualify. Land that has high enough PVR values has the right soil characteristics and growing conditions to support intensive food and crop production with the fewest environmental limitations (Figure 5).

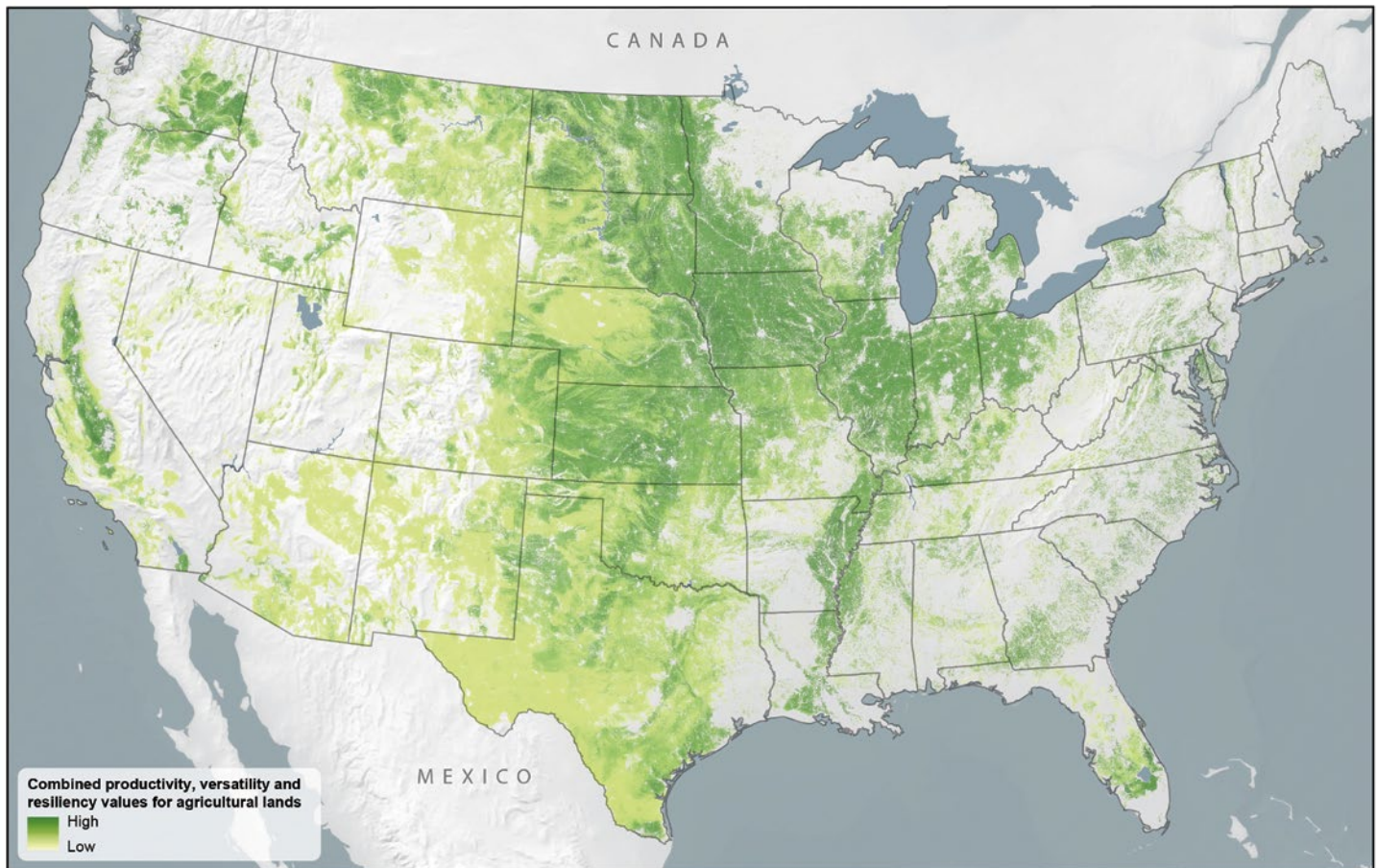


Figure 3: Combined productivity, versatility, and resiliency values for agricultural land.

The productivity, versatility, and resiliency of agricultural land for long-term cultivation largely depend on the quality of the soils, the farming infrastructure that exists, and climatic conditions, such as the length of the growing season. PVR values are calculated using data of the PVR factors and expert-based weights. Lower PVR values are shown by lighter tones, indicating land that has progressively greater limitations, may be more prone to off-farm environmental impacts, and that offers less potential for food and crop production and narrower choices for agricultural production in general.

- **Development converted almost 31 million acres of agricultural land in the United States between 1992 and 2012, nearly double the amount previously documented by national datasets.**

Agricultural land use in the United States continually changes—and these changes mask the irreversible losses that are taking place. *Farms Under Threat* was able to spatially map the patterns of conversion since 1992 that the NLCD was unable to distinguish through remote sensing (Figure 4). Overall, more than 62 percent of the development that occurred was on agricultural land.

Urban development converted roughly 18 million acres of agricultural land (59 percent of conversion), reinforcing the findings by the NRI. *Farms Under Threat* also captures and, for the first time, spatially allocates the emerging threat of low-density residential development associated with exurban development. Low-density residential development converted nearly 13 million acres of additional agricultural land (41 percent of conversion). Taken together, the loss of agricultural land to development is far more widespread than previously documented—nearly double previous estimates.

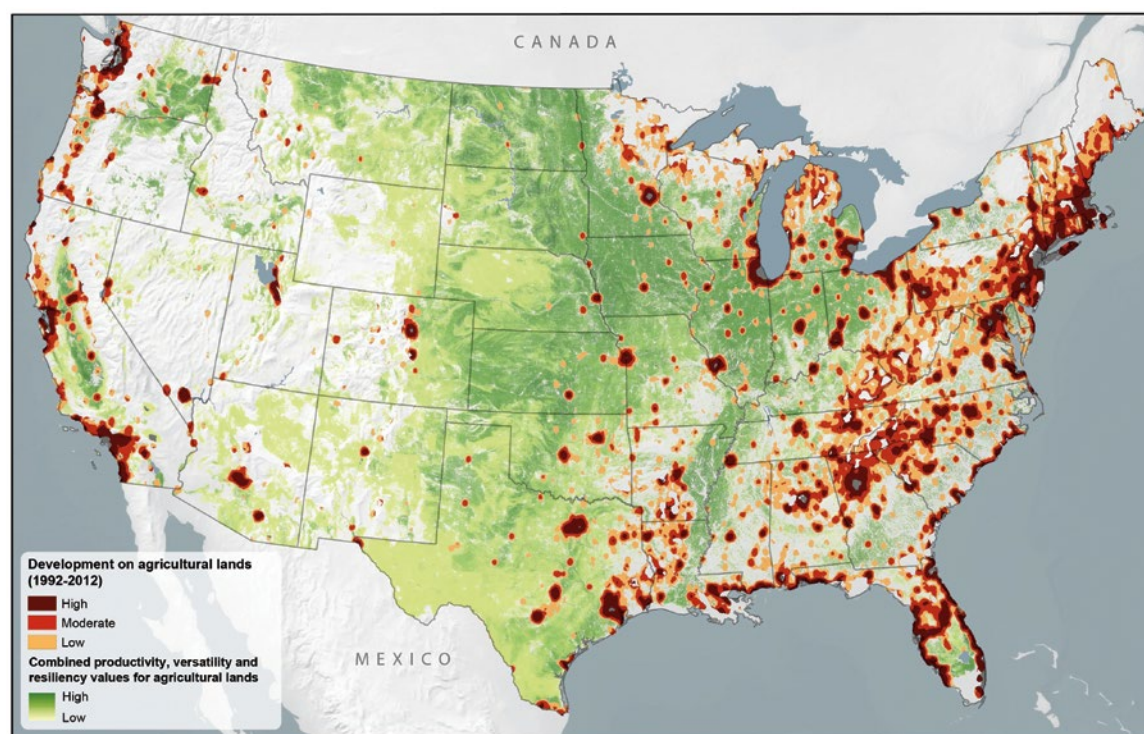


Figure 4: Conversion of agricultural land to urban and low-density residential development between 1992 and 2012.

The development of agricultural land is shown in relationship to the low-to-high continuum of productive, versatile, and resilient values for agricultural land. The conversion of agricultural land to urban and low-density residential uses between 1992 and 2012 is shown as high (dark brown-red, > 25% conversion within a 10-kilometer (6.2 miles) radius), moderate (light brown-red, 10-25% conversion) and low (tan, 5-10% conversion). Urban areas are shown in gray.

Table 3. Conversion by land cover/use in thousands of acres between 1992 and 2012.

Land cover/use		Urban Development			Low Density Residential			Total Developed		
	% of ag land	Acres lost	% by land type	% of ag land type converted	Acres lost	% by land type	% of ag land type converted	Acres lost	% by land type	% of ag land type converted
Cropland	34.3%	7,408	28.9%	41%	4,385	18.5%	34.5%	11,793	23.9%	38.4%
Pastureland	11.9%	4,662	18.2%	25.9%	4,379	18.5%	34.5%	9,041	18.3%	29.4%
Rangeland	44.9%	4,285	16.7%	23.8%	1,408	5.9%	11.1%	5,693	11.5%	18.5%
Woodland	8.8%	1,674	6.5%	9.3%	2,527	10.6%	19.9%	4,201	8.5%	13.7%
Total on ag land		18,029	70.4%		12,698	53.5%		30,727	62.3%	
Forestland		5,107	19.9%		9,739	41%		14,846	30.1%	
Other		2,463	9.6%		1,297	5.5%		3,761	7.6%	
Total		25,600			23,735			49,335		

- **Over 70 percent of urban development and about 54 percent of low-density residential development occurred on agricultural land.**

As shown in Table 3, in the context of all land uses, urban development occurred more frequently on cropland (28.9 percent) than on any other land use type, while low-density residential development was more likely occur on forestland (41 percent).

When urban development occurred on agricultural land, it most frequently converted cropland (41 percent) while converting much lower percentages of pastureland (25.9 percent), rangeland (23.8 percent) and woodland (9.3 percent). In contrast, low-density residential development posed an equal threat to cropland and pastureland (34.5 percent each) and favored woodland (19.9 percent) over rangeland (11.1 percent).

After mapping the patterns of development on agricultural land, the analysis determined whether the United States was disproportionately losing agricultural land with higher PVR values. This was done by comparing the PVR values of the agricultural land that was converted by urban and low-density residential development between 1992 and 2012 with the PVR values of the agricultural land that was not developed.

- **Development patterns put higher quality agricultural lands at greater risk.**

The analysis found that land with higher PVR values was more at risk of being developed. Figure 5 shows the cumulative distribution curve of the PVR values of agricultural land in 1992 (335 million acres) that remained in agriculture in 2012 contrasted with similar cumulative distribution curves of the PVR values of land converted by low-density residential (13 million acres) and urban development (18 million acres). These distribution curves show that urban development and, to a lesser

extent, low-density residential development occurred on land with higher PVR values.

The median PVR value of agricultural land lost to development (0.39) was 1.3 times higher than the median PVR value of land that stayed in production (0.31). The contrasting distribution curves also show the nation's best land for intensive food and crop production (land with PVR values of 0.431 or higher) is disproportionately converted by urban and low-density residential development up to a PVR value of about 0.51.

It is interesting to note that above a PVR value of 0.51, the distribution curves converge, indicating that conversion is now proportional to the amount of agricultural land with these higher PVR values (less than 25 percent of agricultural land in 1992). Although the losses are no longer disproportional, the land with the highest PVR values continues to be converted. All of these cumulative losses could have serious implications for agricultural productivity and domestic food security in future decades.

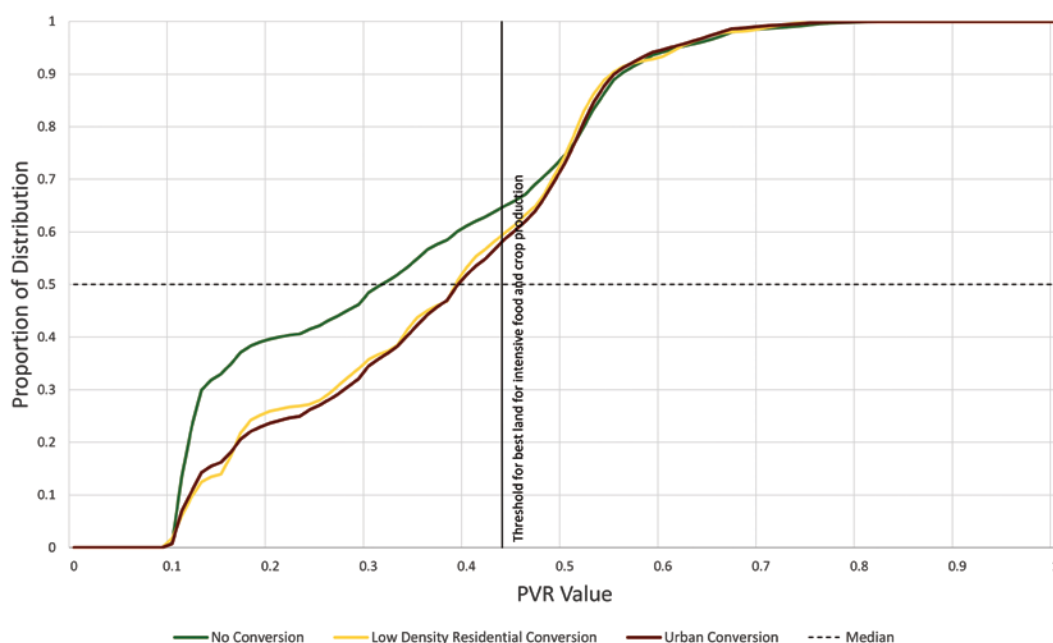


Figure 5: Distribution of PVR values for converted agricultural land and land remaining in agriculture.

Cumulative distribution curves are shown for the PVR values of agricultural land in 1992 that remained in agriculture (no conversion) in 2012 (335 million acres) and for the agricultural land lost through urban conversion (18 million acres) and low-density residential conversion (13 million acres). Development disproportionately occurred on land with PVR values between 0.1 and 0.51. The distribution curves then converge above a PVR value of 0.51, indicating that conversion is now proportional to the amount of agricultural land with higher values (> 0.51). The dotted horizontal line shows the median PVR value of the agricultural land that remained in production was 0.31, whereas agricultural land lost to development had a higher median PVR value of 0.39. A solid vertical line shows the PVR threshold value (0.43) used to identify the best land for intensive food and crop production and represents slightly more than one third of agricultural land.

- **By 2012, the best land to support intensive food and crop production comprised less than 17 percent of the total land area.**

Only 324.1 million acres of agricultural land had PVR values > 0.43 that indicated that the right soil characteristics and growing conditions were present and the land could be farmed with the fewest environmental limitations (Figure 6). This is slightly more than one third of agricultural land.

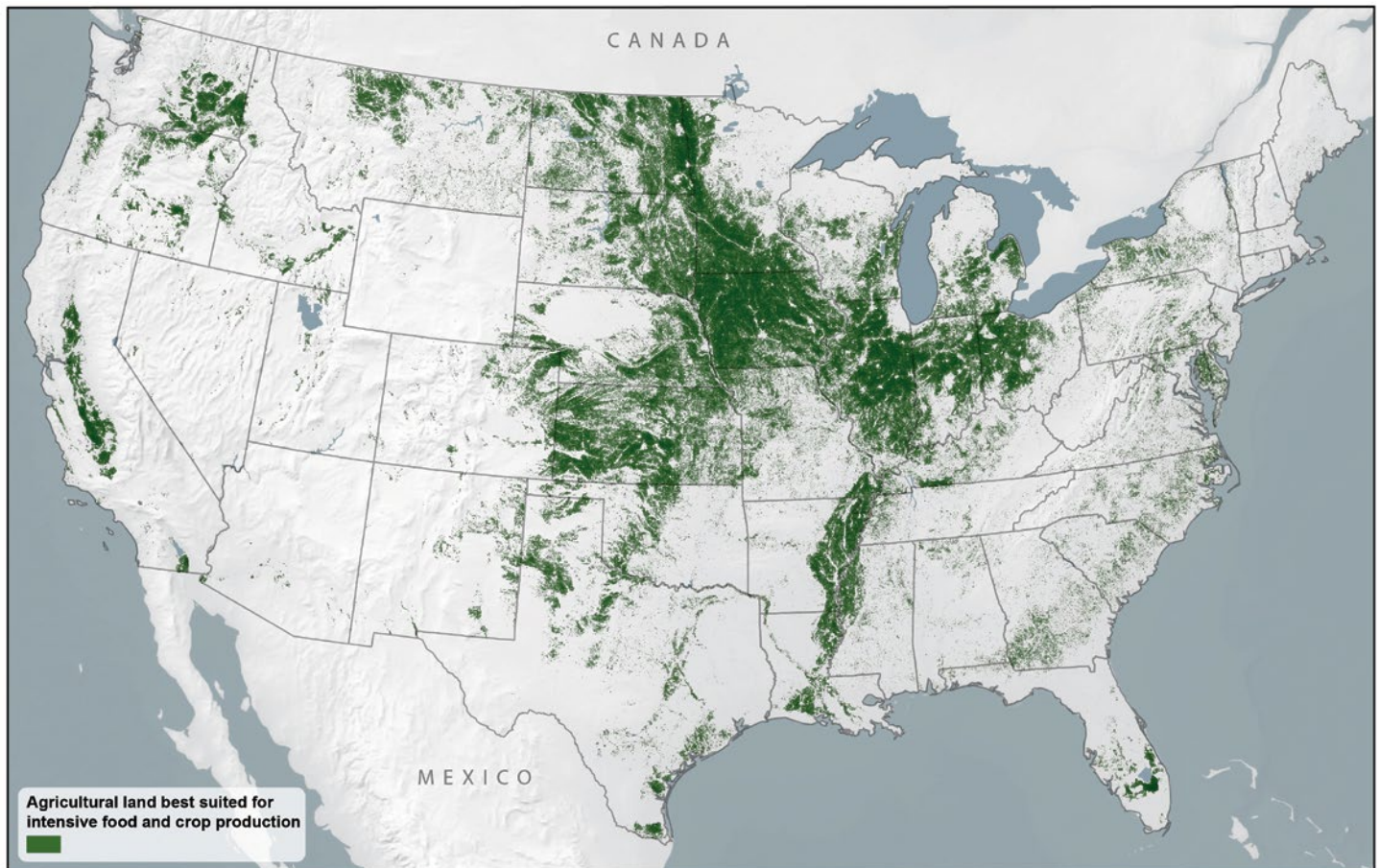


Figure 6: Best agricultural land for intensive food and crop production in 2012.

Agricultural land with PVR values between 0.43 and 1.0 is the land most suited for the intensive production of fruit and nut trees, vegetables, staple foods, grains, and animal feed with the fewest environmental limitations. This land represented about 36 percent of U.S. agricultural land, or only 16.7 percent of the total land area in the continental United States in 2012.



CAVAN SOCIAL/ALAMY STOCK PHOTO

Harvesting lettuce in New York state.

- **In less than one generation, the United States irreversibly lost nearly 11 million acres of the best land for food and crop production.**

From 1992 to 2012, the United States converted 10.928 million acres of land where soils, climate, growing seasons, and access to water combine to allow intensive food and crop production with the fewest environmental impacts. *To put this into perspective, this is equivalent to losing 95 percent of California's Central Valley or 47 percent of the state of Indiana.* This is the land that can help ensure food security for future generations, but only if the nation protects it from any further conversion, soil erosion, and declines in soil health. At this rate of loss (slightly over 3 percent), the nation would lose over 15 percent of its best agricultural land by the end of the century just to development—without factoring in any other threats. But housing a growing population while losing land to a changing climate will likely accelerate this rate of loss and farmers and ranchers will have to produce more food, fiber and energy on the agricultural lands that remain.



Harvesting wheat in the Palouse region of Washington state.

Discussion

U.S. agricultural land supports a regionally diverse food and farming system and provides a secure food supply—for now. This land also plays a significant role in the U.S. landscape and economy. However, it faces unprecedented challenges as the world's population continues to expand and the climate continues to change. By 2050, the demands on agriculture to provide sufficient food, fiber, and energy are expected to be 50 to 70 percent higher than they are now. Given a fixed land mass in the United States and the need to feed an increasing number of people, it is extremely important to consider land quality, land availability, and the maximization of nutrient production per unit of total land in the future (White and Hall 2017).

U.S. agricultural land also provides a wide range of benefits and amenities that are valued by the public. Along with producing food and crops, agricultural land is highly valued for providing wildlife habitat and environmental benefits such as flood water storage, etc. Well-managed agricultural land delivers a wide range of amenities that motivate communities and land trusts to pay \$88 to \$124,000 per acre on average to preserve this land (Brinkley 2012). These amenities include ecosystem services that improve the quality of water, air and soil, support wildlife and biodiversity, contribute to viewsheds and quality of life, provide recreational opportunities, shape land use, help the local economy, provide fresh healthy food, support community health and cohesion, and sequester carbon. The more marginal agricultural land where food production is rarely an option provide wildlife with the food, water, shelter, and space they need (AFT 2017). This includes wetlands, woodland, rangeland and pastureland with low-intensity management. The permanent habitat interspersed throughout the agricultural landscape (in areas like field margins, hedgerows, buffer strips, riparian corridors, and wood lots) allow wildlife to travel between larger areas of suitable habitat. Although quantifying the wide range of benefits offered by agricultural land is still in its infancy (Wainger and Ervin 2017), the market value of farmland services extends far beyond the local community and should be viewed in a regional context (Brinkley 2012). Because agricultural land varies so widely in its potential, maintaining this diversity with the philosophy that *every acre counts* provides the nation with options to optimize the nation's limited land and agricultural resources to sustain future generations.



CSA farmer in Iowa.

PRESTON KERES/USDA

Decades of urban and low-density residential development have converted almost twice as much agricultural land as previously thought. Urbanization and associated land-use dynamics beyond the urban fringe encroach on both agricultural land and on natural land that supports wildlife habitat (Theobald 2001). *Farms Under Threat* shows the past spatial patterns of agricultural land conversion by exurban development for the first time.¹⁶ This low-density residential development was responsible for 41 percent of the conversion of agricultural land by development between 1992 and 2012. The pattern of low-density residential development expanding well beyond the suburbs represents an additional, insidious threat to the nation's agricultural land. These scattered single-family houses on large lots remove proportionately more land from agricultural production and are not accounted for in most national assessments. This pattern of development emerged in the 1970s, and by 1997, nearly 80 percent of the acreage used for housing in the previous three years was land outside of urban areas, with 57 percent on lots of 10 acres or more (Heimlich and Anderson 2001). While urban development has become more efficient and compact since then, it appears that better land use planning (i.e. "smart growth") has not yet reached the nation's exurban and rural areas.

Since 1997, large-lot properties have continued to increase in number and are often too small for traditional farming, ranching, and forestry uses. They no longer contribute to rural economies and lead to a loss of open space, a decline in wildlife habitat, water quality problems, and a higher demand for public services (Wilkins et al. 2003). The added roads, parking lots, and highly compacted lawns also increase the risk

Smart Growth: Balancing Economy, Community, and Environment

The antidote to development that needlessly paves over agricultural land is not to halt development but to develop more thoughtfully. Smart growth is a system of urban planning that seeks to balance the economic benefits of growth with distinctive, attractive communities and the protection

of natural resources. Principles of smart growth that relate to farmland protection include taking advantage of compact building design and strengthening and directing development toward existing communities. Compact development, and the transportation opportunities that

this encourages, can also provide greenhouse gas reduction benefits. To learn more about smart growth principles, visit www.smartgrowth.org.

Source: www.farmlandinfo.org/sites/default/files/EPA_what_is_smart_growth_1.pdf
www.epa.gov/smartgrowth/smart-growth-and-climate-change

¹⁶ In this case, suburbs form the ring around the urban core, and exurbs (with larger-lot homes) extend beyond the suburbs into rural areas.

of flooding and degrade water quality compared to concentrating the same number of houses into compact neighborhoods and village centers (Flinker 2010). The scattered development is subsidized by those living in adjoining municipalities, and for many living in these far-flung houses and subdivisions, the emergency response times for police, ambulance, and fire fighters exceed national standards (Esseks et al. 1999). The development footprint grew from 10.1 percent to 13.3 percent from 1980 to 2000, outpacing the population growth by 25 percent. By 2020, urban and suburban development is forecast to expand by 2.2 percent and exurban development by 14.3 percent (Theobald 2001; 2005). Based on the past conversion patterns shown by this present analysis, much of this forecasted expansion will be on land with higher PVR values.

As agricultural land with higher PVR values is lost, cultivation shifts to land with lower PVR values, which problematically can put more pressure on water, soils, and biodiversity. Market demands (e.g. corn to produce ethanol as a biofuel), rising prices, and water availability can accelerate this process, bringing even more of the remaining land into cultivation. Land with lower PVR values is much more limited in the crops it can support, and cultivation may lead to more significant environmental impacts. More inputs (like pesticides and fertilizers) and/or acres are required to maintain the same production levels, putting even more pressure on water, soil, and biodiversity (Verzandvoort et al. 2009). For example, from 2001 to 2011, the Midwest lost cropland to urban expansion in the eastern part of the region and gained cropland at the expense of rangeland in the western part (Wright and Wimberly 2013; Emili and Greene 2014). Keeping this new, more marginal cropland in cultivation is dependent on the use of irrigation and the High Plains aquifer. Long term, this trend could be detrimental to the economy, the environment, and food security.

Unfortunately, development is just one of the many threats to the nation's agricultural land base. Because development leads to the irreversible loss of agricultural land, it commands AFT's immediate attention in this analysis. However, several other interrelated factors pose additional—and significant—risks that can take agricultural land out of production and may result in its permanent loss. *The cumulative effects of these multiple threats to U.S. agricultural land significantly increase the need to recognize the strategic values of this land and step up efforts to protect it.*

For example, the changing climate already has caused shifts in food and fiber production and is intensifying competition for land with available water. Since the late 1970s, climatologists have documented weather-related changes that make it riskier to produce crops. These include rising temperatures that can reduce crop yields, increases in the length of the frost-free period (and corresponding growing season) that affect what can be grown where, increases in precipitation and



Farmland along the Connecticut River in South Deerfield, Massachusetts.

NORMAN EGGERT/ALAMY STOCK PHOTO



LANCE CHEUNG/USDA

Hurricane Harvey severely damaged the Bayside-Richardson Cotton Gin facility in Woodsboro, Texas, in 2017.

heavy downpours, and more frequent extreme weather events: droughts, floods, fires, and heat waves (Walsh et al. 2014). Researchers also have documented decreases in accumulated winter-chill units needed to grow fruit in some of the nation's fruit growing regions (Baldocchi and Wong 2007). A sampling of some of the crop damage in 2017 attributed to a changing climate includes the loss of nearly 80 to 90 percent of the peach crops in Georgia and South Carolina due to an overly warm winter and hard freeze in the early spring. Other effects included damaged peaches, blueberries, strawberries, and apples in parts of the Southeast; extensive damage to wheat, hay, livestock, and other crops in the Northern Plains due to extreme drought; and significant damage to Florida's citrus, sugarcane, and vegetable crops due to Hurricane Irma. The U.S. Office of Management and Budget and Council of Economic Advisors (2016) expects increased extreme heat and drought, more intense precipitation and soil erosion, growing stress from disease and pests, shifting soil moisture and water availability for irrigation, and higher concentrations of ozone, which will continue to reduce crop yields and increase uncertainty for producers.

The production of energy for domestic use and export introduces a new threat that competes for agricultural land. Energy production includes nuclear, natural gas, coal, renewables (wind, geothermal, solar, hydropower, biomass), oil and biofuels (corn, sugarcane, soybean, and cellulose). Researchers predict that, by 2040, the domestic production from all energy sources will rise by 27 percent and impact more than 197 million additional acres of land, an area greater than the state of Texas (Trainor et al. 2016). Most of this production will happen on agricultural land.¹⁷ This pace of development is more than double the historic rate of urban, commercial, and residential development, which has been the greatest driver of land conversion in the United States since 1970. To further reduce GHG emissions, states have also set ambitious goals for increasing the generation of renewable energy, which include dramatic increases in solar and wind energy. These efforts create opportunities for farmers and landowners to reduce their energy expenses and earn new income, but also pose threats to farmland and local food systems. For example, flat and open farm fields, often the most productive agricultural land, are also highly desirable for solar siting due to their ease of access and lower costs to clear vegetation and construct facilities.



U.S. solar panels.

ISTOCKPHOTO

The agricultural land base is also vulnerable to demographic and land ownership changes. Forty percent of U.S. agricultural land is owned by people over the age of 65. According to the 2012 Census of Agriculture, there are twice as many principal operators who are 75 and older as those under 35. Based on the 2014 TOTAL survey (Bigelow et al. 2016) and data from the 2012 Census of Agriculture, AFT calculates that about 370 million acres could change hands nationwide over the next 20 years. At the same time, beginning farmers and ranchers face major barriers like high start-up costs and difficulty accessing capital and affordable land. As a result, the numbers of beginning farmers and ranchers have declined steadily since 1982. Between 2007 and 2012, the number of beginning farmers declined by 20 percent (Freedgood and Dempsey 2014). In coming years, how millions of acres of agricultural land transfer and to whom—along with the agricultural infrastructure and assets associated with them—will fundamentally impact the structure of agriculture and rural America for generations to come.

And, if agricultural activities damage, erode, compact, or salinize the soil, the long term or permanent damage can also take land out of production. The 2011 RCA appraisal reported that about 27 percent of cropland acres were losing soil carbon (USDA 2011). Saline soils occupied about 5.4 million acres of cropland, and another 76.2 million acres were at risk, mostly in the southwestern United States. And roughly 20 percent of non-federal rangeland acres (82 million acres)

¹⁷ Between 2000 and 2012, about seven million acres were lost to oil and gas drilling in 11 central U.S. states and three Canadian provinces. About half the acreage was rangeland, 40 percent was cropland, 10 percent was forestland and a very small amount was wetland (Allred et al. 2015).

The best land for intensive food and crop production is critical for food security and the long-term sustainability of the nation. Securing this land may also help stabilize and reduce future GHG emissions.

needed additional practices or management to restore rangeland health. Even the most productive, versatile, and resilient acres require the use of sound management practices to maintain or improve soil quality and minimize environmental impacts. However, much higher levels of management are necessary to prevent deterioration when soils are cultivated on less productive acres (USDA SCS 1961). Some of the most environmentally sensitive land (like wetlands and grasslands of environmental significance) should not be cultivated at all. About 27 percent of cropland is highly erodible (USDA 2011) but can be carefully cultivated if restrictions and regulations are followed.

Over the last two decades, improved management practices have made it possible for producers to reduce soil erosion on cropland by 44 percent (USDA 2015), but nutrient losses and greenhouse emissions for agriculture still must drop dramatically to restore and maintain clean water and stabilize the climate by 2050 (Hunter et al. 2017). This may require a significant increase in the use of conservation practices on about 20 percent of U.S. cropland and additional conservation practices on about 46 percent to prevent the continuing losses of soil and nutrients.¹⁸ Compounding this challenge, more frequent extreme weather events will likely increase both soil erosion and runoff, particularly on less productive acres (SWCS 2003; Segura et al. 2014).

Balancing the growing demands for housing, food, energy, and water to ensure our best agricultural land remains available for food and crop production is critical. Since land with higher PVR values is most at risk from development, planners, policy makers, and concerned citizens should prioritize its protection before too late. *Farms Under Threat* shows that conversion has already resulted in a disproportionate loss of land with PVR values between 0.1 and 0.51. For the higher range of PVR values between 0.51 and 1.0, the losses are proportional to the shrinking amount of agricultural land existing at those higher PVR values but continue to occur. The high productivity and economic returns from land with the highest PVR values, along with effective farmland protection policies, may be slowing the disproportional losses at this point, and AFT will examine this in future analyses. *But any loss of land with these high PVR values is of great concern, even more so if we factor in the cumulative effects of the multiple threats to U.S. agricultural land mentioned above.* The best land for intensive food and crop production is critical for food security and the long-term sustainability of the nation. Securing this land may also help stabilize and reduce future GHG emissions. The detailed mapping undertaken by *Farms Under Threat*, combined with AFT's upcoming predictive analyses of the impacts of development and a

18 The USDA NRCS Conservation Effects Assessment Project (CEAP) quantifies the environmental effects of conservation practices: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/ceap/>



INGA SPENCE/ALAMY STOCK PHOTO

Spinach pre-harvest in the Coachella Valley of California.

changing climate, can provide the solid foundation that the nation needs to protect and conserve these irreplaceable natural resources.

Now is the time for the United States to recognize the strategic value of its agricultural land and step up efforts to protect it. It is worth repeating that beyond food security and economic prosperity, well-managed agricultural land provides open space, resources for hunting and fishing, and critical ecological services such as wildlife habitat, carbon sequestration, groundwater recharge, and flood control. This incredible diversity provides the nation with options going forward that may help optimize the use of agricultural resources to sustain future generations. The nation has already lost a significant amount of its best land for intensive food and crop production and faces the risk of losing even more in the future. However, through thoughtful and carefully implemented agricultural, conservation, and land use policies, the nation can strategically protect this land from further development, nourish it with conservation practices, and help the farmers and ranchers who manage this bountiful landscape thrive.

Recommended Actions¹⁹

“From every conceivable angle—economic, social, cultural, public health, national defense—conservation of natural resources is an objective on which all should agree.” —**Hugh Hammond Bennet**, 1959

“As a nation, we will conserve our productive land and use it prudently only if there is sustained public demand for such a course of action..” —**Hugh Hammond Bennet**, 1959

The strategic value of U.S. agricultural land is now more important than ever, and any further loss of the best land for intensive food and crop production is short-sighted at best. When the issue of farmland and ranchland loss came to the fore in the 1980s, several federal programs were implemented that we must continue to support and improve. But, given the increasing number of threats to farmland and ranchland and the even higher than previously known land loss of the last decades, we also need a bold, comprehensive, 21st century federal commitment to saving the land that sustains us.

Additionally, concerted policy efforts at the state and local level will be necessary in order to fully address the scope of farmland loss. Future *Farms Under Threat* reports will detail these proposals.

Take Immediate Steps to Strengthen Existing Federal Farmland Protection Policies

→ **Double funding for the federal Agricultural Conservation Easement Program (ACEP) in the 2018 Farm Bill.** Congress has an immediate opportunity to strengthen existing federal farmland protection efforts. Priorities for improving ACEP in the 2018 Farm Bill include:

¹⁹ AFT is solely responsible for the conclusions and recommendations in this report. Although data and information from NRCS comprises a major component of this analysis, the conclusions and recommendations come from AFT alone.

- *Increase Agricultural Conservation Easement Program funding to at least \$500 million annually.* Without additional funding, less than seven percent of farmers and ranchers seeking to put agricultural conservation easements on their properties would be able to protect their land.
- *Provide entities that have the demonstrated experience and financial stability to achieve certification with greater certainty in using their own deed terms.* Improving the current ACEP certification process will allow for faster protection of farmland and ranchland when applicants craft deed terms to fit the broad variety of farmland and ranchland in need of protection. Every acre counts.

→ **Support and fully fund the critical programs that help monitor threats to U.S. land resources.** Just as important as funding for on-the-ground farmland protection is the funding for agencies and projects that help monitor farmland loss and threats to farmland—and help measure successes in reversing these trends.

- *Maintain and strengthen the NRCS National Resources Inventory by restoring staff capacity and continuing to support private-public partnerships.* The NRI is the only national *land use* data collected by federal agencies and is key to the strategic protection of agricultural land resources.
- *Continue critical funding for the USDA National Agricultural Statistics Service and Economic Research Service to deliver objective, timely, and accurate national research and analysis, including sufficient funding for a new 50-state Tenure, Ownership and Transfer of Agricultural Land (TOTAL) survey.* This unbiased information provides critical information for the nation's policymakers and industry leaders to make decisions that can ensure future food security and revitalize rural economies.
- *Reauthorize and fully fund the 1977 Soil and Water Resources Conservation Act (RCA) and broaden its focus to fully assess the interrelated factors affecting the long-term sustainability of the nation's agricultural land as a natural resource.*

Enact a Bold and Comprehensive 21st Century Agricultural Land Policy Platform

As evidenced by these initial findings, current federal policies are inadequate to safeguard America's farmland and ranchland for future food security, economic opportunity, and community well-being. In particular, since land with higher PVR values is most at risk from development, we must prioritize their protection before it is too late.



A young farmer harvests fresh vegetables in New York state.



A New England farm family.

A new level of federal commitment is needed to save the land that sustains America. A comprehensive 21st century agricultural land policy platform might include:

- Develop a national designation for agricultural lands with high PVR values and afford them special protections;
- Strengthen the federal Farmland Protection Policy Act by *requiring* federal agencies to avoid farmland conversion;
- Require a mitigation fee to protect an equivalent amount of farmland when projects that receive federal funding or incentives result in farmland conversion. Use mitigation fees for federal farmland protection projects;
- Dramatically increase ACEP-ALE funding in future farm bills to fully meet demand and to leverage state, local and private investments in farmland protection;
- Develop climate change solutions that take advantage of the greenhouse gas reduction potential of farmland protection, improved management practices, and smart growth;
- Enact federal tax code changes that incentivize keeping agricultural land in production and encourage its transfer from one generation of farmers and ranchers to the next;
- Create tools that link farm business development and resource protection, and tools that enable agricultural landowners to plan for and address succession and retirement needs and transfer their land to the next generation of farmers and ranchers; and
- Fund new investments in planning to help rural communities address low density residential development and plan more proactively for agricultural economic development and conservation.

A diverse coalition of farm, conservation, rural development, and planning organizations will be needed to shape and move such a federal agricultural land agenda, as well as to advocate for changes at the state and local level. AFT welcomes organizations that want to join in such an effort. As we face a growing global population and many new threats to our agricultural land base, it is ever more urgent that we all work together to protect farms and ranches.

Future *Farms Under Threat* Releases and Analyses

State-level agricultural land cover/use data and conversion data: A forthcoming *Farms Under Threat: State of the States* report will use mapping and analyses to assess conversion of agricultural land at state level. It will examine both the quality and quantity of agricultural land lost to development within each state and compared with national findings. AFT will also release a *State Policy Scorecard* to demonstrate how states have used farmland protection policies to forestall agricultural land conversion. By showing solutions as well as threats, the *State of the States* report and *State Policy Scorecard* will share effective policy solutions to galvanize action and encourage states to increase and improve their efforts to protect farmland.

County data and projections to 2040: Going forward, AFT will release county-level data and publish findings that include future scenarios using housing density and climate projections to forecast potential impacts to our agricultural land by 2040 if we fail to take action. The *Farms Under Threat* data and models make it possible to spatially locate the agricultural land that may be most at risk from development and a changing climate.

Future analyses: As noted previously, development is not the only threat our agricultural land faces over the next few decades. With additional time and funding, AFT will map potential conversion due to the expansion of energy and transportation infrastructures, identify areas where we need to improve our soils and minimize the environmental impacts of crop and livestock production, and analyze and map the demographic shifts that put agricultural land at risk when it transitions from older generation landowners.

In future analyses, AFT will consider how to strike a sustainable balance among land use and land management, a viable agricultural economy, and the maintenance of biodiversity to preserve the many public benefits provided by the agricultural landscape. To keep track of the future findings from *Farms Under Threat*, see the “More Information” box on the inside of the back cover.



Blueberries ready for picking.

KC SHIELDS/ALAMY STOCK PHOTO

References



An Oregon vineyard.

- Allred, B. W., W. K. Smith, D. Twidwell, J. H. Haggerty, S. W. Running, D. E. Naugle and S. D. Fuhlendorf. 2015. "Ecosystem services lost to oil and gas in North America." *Science* 348, Issue 6233. pp. 401–402. www.sciencemag.org/content/348/6233/401/suppl/DC1
- American Farmland Trust. 2017. *America's Farms and Ranchlands: Charting a Way for Biodiversity, Wildlife and Agricultural Production to Co-Exist in the Future*. A Farms Under Threat draft white paper. June 2017. American Farmland Trust, Washington, D.C.
- Arjomand, S. and D. Haight. 2017. *Greener Fields: Combating Climate Change by Keeping Land in Farming in New York*. American Farmland Trust. May 2017. 16 pp.
- Baldocchi, D. and S. Wong. 2007. "Accumulated winter chill is decreasing in fruit growing regions of California." *Climate Change* (2008) 87 (Suppl 1):S153–S166. DOI 10.1007/s10584-00709357-8.
- Bigelow, D., A. Borchers and T. Hubbs. 2016. *U.S. Farmland Ownership, Tenure and Transfer*. USDA ERS Economic Information Bulletin No. 161. August 2016. 53 pp.
- Brinkley, C. 2012. "Evaluating the benefits of peri-urban agriculture." *J. Plan Lit.* 2012 August 27(3):2590267. Doi:10.1177/0885412211435172.
- Blomer, D. 2011. *Versatile Soils—Production Land*. Report for Hawke's Bay Regional Council. New Zealand. June 14, 2011. 37 pp.
- Culman, S. W., V. R. Haden, T. Maxwell, H. Waterhouse and W. Horwath. 2014. *Greenhouse Gas Mitigation Opportunities for California Agriculture*. Review of California Cropland Emissions and Mitigation Potential. NI GGMCOA R 3. Durham, NC: Duke University. February 2014. 55 pp.
- Duke, J.M. 2008. "Using research on farmland amenity values to improve preservation policy." Northeast Regional Center for Rural Development. Transatlantic Land Use Conference Policy Brief No. 3. September 2008. 8 pp.
- Emili, L.A. and R. P. Greene. 2014. "New cropland on former rangeland and lost cropland from urban development: The "replacement land" debate." *Land* 2014, 3(3):658–674.
- Esseks, J.D., H. E. Schmidt and K. L. Sullivan. 1999. *Living on the Edge: Fiscal costs and public safety risks of low-density residential development on farmland*. American Farmland Trust Center for Agriculture in the Environment. CAE/WP 98-1. January 1, 1999. 76 pp.
- Esseks, J. D. and B. J. Schilling. 2013. *Impacts of the Federal Farm and Ranch Lands Protection Program: An Assessment Based on Interviews with Participating Landowners*. American Farmland Trust Farmland Information Center, Northampton, MA. June 30, 2013. 126 pp.
- Farm Foundation. 2004. *Farmland Preservation: Issue Report*. Issue One, April 2004. 4 pp.
- Flinker, P. 2010. *The Need to Reduce Impervious Cover to Prevent Flooding and Protect Water Quality*. Ed. S. Miller, Rhode Island Department of Environmental Management. May 2010. 20 pp.
- Food and Agriculture Organization of the United Nations. 2011. "The state of the world's land and water resources for food and agriculture (SOLAW)—Managing systems at risk." Food and Agriculture Organization of the United Nations, Rome and Earthscan, London. 308 pp.

- Food and Agriculture Organization of the United Nations. 2017. *The Future of Food and Agriculture: Trends and Challenges*. Rome. February 2016. 180 pp.
- Freedgood, J. and J. Dempsey. 2014. *Cultivating the Next Generation: Resources and Policies to Help Beginning Farmers Succeed in Agriculture*. Northampton, MA: American Farmland Trust. 44 pp. Available online at www.farmlandinfo.org/cultivating-next-generation-resources-and-policies-help-beginning-farmers-succeed-agriculture
- Freedgood, J. and J. Fydenke. 2017. *Growing Local: A Community Guide to Planning for Agriculture and Food Systems*. Northampton, MA: American Farmland Trust. 56 pp. Available online at www.farmlandinfo.org/growing-local-community-guide-planning-agriculture-and-food-systems
- Heimlich, R.E. and W. D. Anderson. 2001. *Development at the Urban Fringe and Beyond: Impacts on Agriculture and Rural Land*. Economic Research Service. U.S. Department of Agriculture. Agricultural Economic Report No. 803. June 2001. 88 pp.
- Heimlich, R. E. and K.S. Krupa. 1994. "Changes in land quality accompanying urbanization in U.S. fast growth counties." *J. Soil and Water Cons.* 49(4): 367–374.
- Hellerstein, D., C. Nickerson, J. Cooper, P. Feather, D. Gadsby, D. Mullarkey, A. Tegene and C. Barnard. 2002. *Farmland Protection: The Role of Public Preferences for Rural Amenities*. Agricultural Economics Report No. 815. October 2002. 74 pp.
- Hilchy, D. 2008. *Gout de Terroir: Exploring the Boundaries of Specialty Agricultural Landscapes*. pp. 56–70. In: Goetcheus, C. and E. MacDonald, Eds. 2008. *Exploring the Boundaries of Historic Landscape Preservation*. Clemson University Digital Press. 208 pp.
- Hunter, M. C., R. G. Smith, M. E. Schipanski, L. W. Atwood, and D. A. Mortensen. 2017. "Agriculture in 2050: recalibrating targets for sustainable intensification." *Bioscience*, February 2017.
- Jones, C. and D. M. Kammen. 2013. "Spatial distribution of U.S. household carbon footprint reels suburbanization undermines greenhouse gas benefits of urban population density." *Environ. Sci. Technol.* 204, 48(2), pp. 895–902.
- Lark, T. J., R. M. Mueller, D. M. Johnson and H. K. Gibbs. 2017. "Measuring land-use and land cover change using the U.S. department of agriculture's cropland data layer: cautions and recommendations." *Int. J. of Appl. Earth Observation and Geoinfo.* Vol 62: 224–235. October 2017. <https://doi.org/10.1016/j.jag.2017.06.007>
- Nickerson, C., M. Harper, C.J. Henrie, R. Mayberry, S. Shimmin, B. Smith and J.H. Smith. 2015. *Land Use and Land Cover Estimates for the United States*. Report prepared for the Interagency Council on Agricultural and Rural Statistics, subcommittee of the Interagency Council on Statistical Policy.
- Northeast Regional Center for Rural Development. 2003. *What the Public Values about Farm and Ranchland: Workshop Proceedings*. NERCRD Regional Rural Development Paper No. 23. The Pennsylvania State University, University Park, PA. 33 pp.
- Olson, Richard K. and Thomas A. Lyson (eds.) 1999. *Under the Blade. The Conversion of Agricultural Landscapes*. Westview Press. Boulder, Colorado. 459 pp.
- Plattner, K., A. Perez and S. Thornsby. 2014. *Evolving U.S. Fruit Markets and Seasonal Grower Price Patterns*. USDA Economic Research Service. FTS-357-01. September 2014. 27 pp.
- Schnepf, M. and P. Flanagan. 2016. A History of Natural Resource Inventories conducted by the USDA's Soil Conservation Service and Natural Resources Conservation Service. July 2016. 32 pp.
- Segura, C., G. Sun, S. McNulty and Y. Zhang. 2014. "Potential impacts of climate change on soil erosion vulnerability across the conterminous United States." *J. Soil and Water Conservation* 69(2):171–181. March–April 2014.
- Shaffer, S. and E. Thompson. 2015. *A New Comparison of Greenhouse Gas Emissions from California Agricultural and Urban Land Uses*. American Farmland Trust. May 2015. 13 pp.



Pumpkins in Connecticut.

LEE HACKER/ALAMY STOCK PHOTO



A snowy owl on a barn roof in Polson, Montana.


- Soil and Water Conservation Society. 2003. *Conservation Implications of Climate Change: Soil Erosion and Runoff from Cropland*. Ankeny, IA: Soil and Water Conservation Society. 26 pp.
- Sorensen, A. A., R. P. Greene and K. Russ. 1997. *Farming on the Edge*. American Farmland Trust Center for Agriculture in the Environment. Northern Illinois University. DeKalb, Illinois. March 1997. 67 pp.
- Swinton, S. M., F. Lupi, G. P. Robertson and S. K. Hamilton. 2007. "Ecosystem services and agriculture: cultivating agricultural ecosystems for diverse benefits." *Ecological Economics* 64(2007):245–252.
- Theobald, D.M. 2001. "Land-use dynamics beyond the American urban fringe." *Geographical Review* 91(3): 544–564.
- Theobald, D.M. 2005. "Landscape patterns of exurban growth in the USA from 1980 to 2020." *Ecology and Society* 10(1):32. 34 pp. www.ecologyandsociety.org/vol10/iss1/art32
- Trainor, A. M., R. I. McDonald and J. Fargione. 2016. "Energy sprawl is the largest driver of land use change in United States." *PLOS ONE* 11(9): e0162269. <https://doi.org/10.1371/journal.pone.0162269>
- Herrick, J. E., O. Arnalds, B. Bestelmeyer, S. Bringezu, G. Han, M. V. Johnson, D. Kimiti, Yihe Lu, L. Montanarella, W. Pengue, G. Toth, J. Tukahirwa, M. Velayutham and L. Zhang. United Nations Environment Program. 2016. *Unlocking the Sustainable Potential of Land Resources: Evaluation Systems, Strategies and Tools. A Report of the Working Group on Land and Soils of the International Resource Panel*. DTI/2002/PA. ISBN: 978-92-807-3578-9. 96 pp.
- U.S. Congress. 1980. House Committee on Banking, Finance and Urban Affairs. Subcommittee on Cities. *Compact Cities: Energy Saving Strategies for the Eighties: Report Together with Dissenting Views*. U.S. Government Printing Office. 1980. 86 pp.
- U.S. Department of Agriculture. 1992. *Readings in the History of the Soil Conservation Service*. USDA SCS Economics and Social Sciences Division. Historical Notes Number 1. U.S. Government Printing Office: 1992 625–708/60587. 176 pp.
- U.S. Department of Agriculture. 2011. RCA Appraisal: Soil and Water Resources Conservation Act. July 2011. 112 pp.
- U. S. Department of Agriculture. 2015. *Summary Report: 2012 National Resources Inventory*. Natural Resources Conservation Service, Washington, DC and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. August 2015. 210 pp.
- U. S. Department of Agriculture Economic Research Service. 2015. *Effects of Trade on the U.S. Economy—2015. Agriculture Trade Multipliers 2015, Summary of Findings*. Available at www.ers.usda.gov/data-products/agricultural-trade-multipliers/effects-of-trade-on-the-us-economy-2015
- U. S. Department of Agriculture and President's Council on Environmental Quality. 1981. *National Agricultural Lands Study*. Washington, DC; National Agricultural Lands Study. 108 pp.
- U. S. Department of Agriculture Soil Conservation Service. 1961. *Land-Capability Classification*. Agriculture Handbook No. 210. 25 pp.
- U. S. Office of Management and Budget and Council of Economic Advisors. 2016. *The Fiscal Risks Facing the Federal Government. A Preliminary Assessment*. Prepared for US. Office of the President. November 2016. 34 pp.
- Verzandvoort, S., R. Rietra and M. Hack. 2009. *Pressures on Prime Agricultural Land in Europe*. Alterra, Wageningen, UR. November 2009. 18 pp.
- Walsh, J.S., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, S. Donley, R. Feely, P. Hennon, V. Kharin, T. Knutson, F. Landerer, T. Lenton, J. Kennedy and R. Somerville. 2014. "Chapt. 2: Our Changing Climate." *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, T.C. Richmond and G. W. Yohe, Eds. U.S. Global Change Research Program, 19–77. Doi:10.7930/JOKW5CXT.

- Wainger, L. and D. Ervin. 2017. *Synthesis Chapter—the Valuation of Ecosystem Services from Farms and Forests: Informing a systemic approach to quantifying benefits of conservation programs*. The Council on Food, Agricultural and Resource Economics (C-FARE). Report No 0114-301. Washington, D.C. March 2017. 36 pp.
- White, R. R. and M. B. Hall. 2017. “Nutritional and greenhouse gas impacts of removing animals from U.S. agriculture.” *PNAS Early Edition*. 8 pp. www.pnas.org/cgi/doi/10.1073/pnas.1707322114
- Widbe, K. and N. Gollehon. 2006. *Agricultural Resources and Environmental Indicators*. USDA Economic Research Service. Economic Information Bulletin (EIB-16_ July 2006). 239 pp. AREI/Land. 13: Land and Soil Quality, pp. 25–33.
- Wilkins, N., A. Hays, D. Kubenka, D. Steinbach, W. Grant, E. Gonzalez, M. Kyelland and J. Shackelford. 2003. *Texas Rural Lands: Trends and Conservation Implications for the 21st Century*. Texas A&M Cooperative Extension and American Farmland Trust. March 2003. 28 pp.
- Wright, C. K. and M. C. Wimberly. 2013. “Recent land use change in the Western Corn Belt threatens grasslands and wetlands.” *PNAS* 110(10): 4134–4139. March 2013 www.ncbi.nlm.nih.gov/pmc/articles/PMC3593829



TOMAS KASPAR/ALAMY STOCK PHOTO

A blooming pear orchard in the Hood River Valley, Oregon.



Crop fields stretch to the horizon in Illinois.

For More Information

To keep track of *Farms Under Threat* and make use of reports, data, and white papers to build a constituency to protect this land for future generations, visit our website at www.farmland.org/FarmsUnderThreat. For technical questions concerning our analyses, contact AFT's Farmland Information Center at www.farmlandinfo.org or (800) 370-4879.





A new housing development on farmland in Loudoun County, Virginia.


American Farmland Trust
SAVING THE LAND THAT SUSTAINS US
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