Farms Under Threat 2040

CHOOSING AN ABUNDANT FUTURE

American Farmland Trust
SAVING THE LAND THAT SUSTAINS US

Acknowledgments

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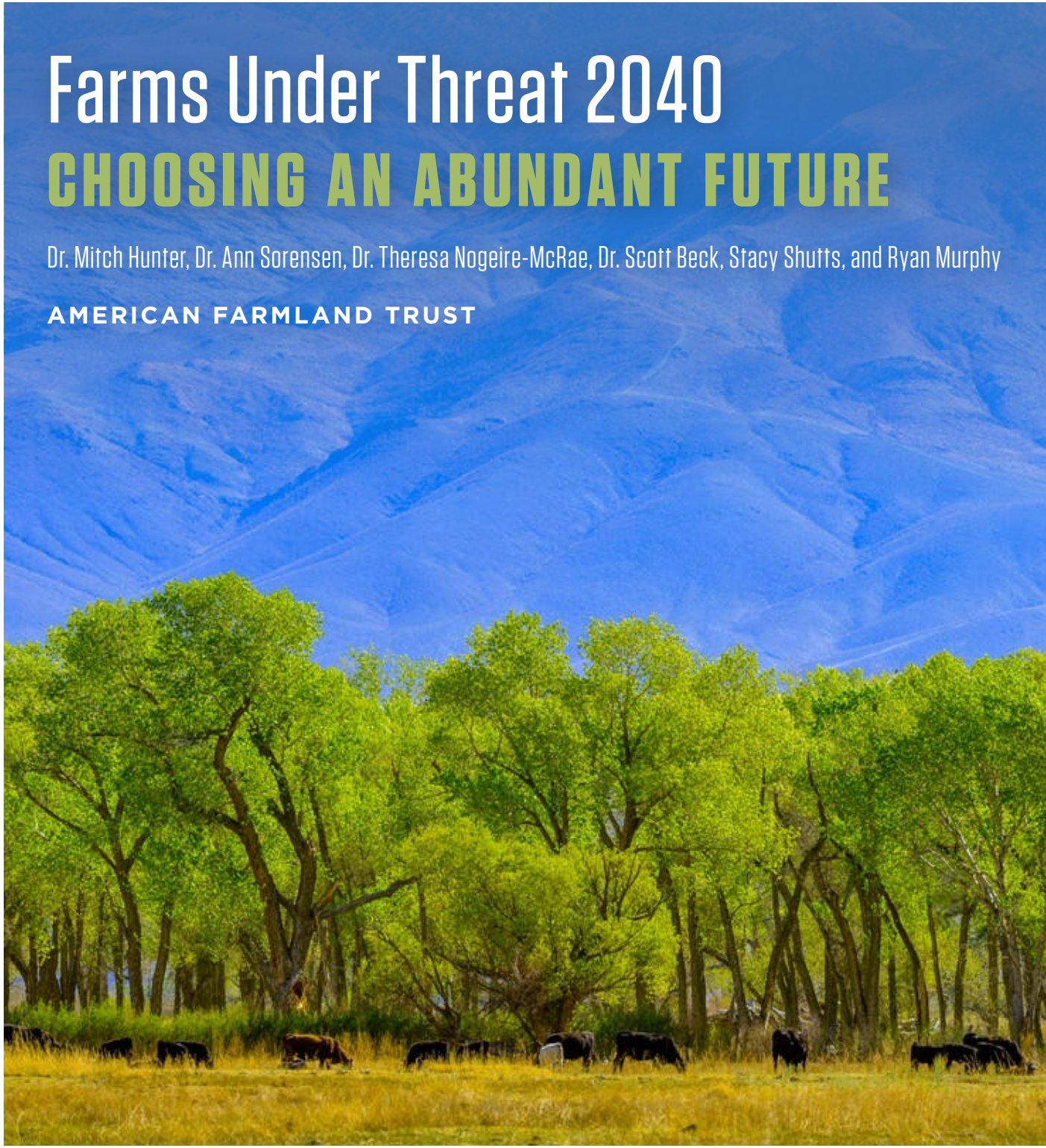
AMERICAN FARMLAND TRUST



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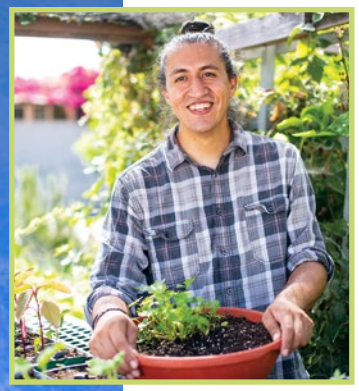

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Executive Summary

AMERICAN FARMS AND RANCHES are a critical life-support system for our nation and the planet. In recent years, the global food system has been severely disrupted by the coronavirus pandemic, the war in Ukraine, and widespread drought—pushing millions more people into severe hunger. The mounting effects of climate change and the rising global population will make it ever harder to ensure a stable food supply in coming decades. It is urgent to safeguard the land that grows our food.

The three future scenarios modeled in this report. For more details see **Visions of the Future: The Scenarios** (page 18).

But farmland and ranchland do so much more than just feed us. With good stewardship, these lands can also sequester carbon in the soil, protect water quality, and provide habitat for diverse wildlife and native species.

Every acre counts. Yet, Americans are still paving over agricultural land at a rapid pace. From 2001–2016, our nation lost or compromised 2,000 acres of farmland and ranchland every day.

This report shows that, if this trend continues, another 18.4 million acres will be converted between 2016 and 2040—an area nearly the size of South Carolina. Of this total, 6.2 million acres will be converted to urban and highly developed land uses such as commercial buildings, industrial sites, and moderate-to-high-density residential development. The remainder, 12.2 million acres, will be converted to low-density residential areas, which range from large-lot subdivisions to rural areas with a proliferation of scattered houses.

While new development is necessary as the population grows, much of this conversion will be inefficient, using more land than necessary to comfortably house and support the population. This poorly planned development undermines global food security, local food systems, and the environment that we all depend on. It pushes up greenhouse gas emissions by lengthening commutes and reinforcing car dependence. Because the conversion is concentrated near cities and towns, it will have an outsized impact on smaller farms. It also places an undue burden on local government coffers, costing more for public services than it provides in taxes.

And rural sprawl could accelerate further in coming decades, driven by factors such as sky-high housing prices in metro areas and new opportunities for remote work. If this happens, 24.4 million acres of farmland and ranchland could be paved over, fragmented, or compromised by 2040.

But if policymakers and land-use planners across the country embrace more compact development, it would slash conversion and keep up to 13.5 million acres of irreplaceable farmland and ranchland from being turned into big-box stores, sprawling

subdivisions, and large-lot rural residences. That is an area larger than the states of Vermont and Maryland put together. These same policies could help retain nearly 7 million acres of our country's "Nationally Significant" farmland and ranchland, the most important land for long-term food security and environmental health.

Poorly planned development is far from the only threat to the future of farming. American agriculture now faces concurrent threats from climate change and energy production. On the current climate trajectory, average crop yields will decline and extreme events like droughts, floods, and heatwaves will wipe out the harvest with increasing frequency, undermining food security and farmer livelihoods. Just as sprawling subdivisions and large-lot rural housing eat up farmland, climate change is accelerating sea-level rise, inundating coastal farms. This report shows that, on our current climate trajectory, a total of nearly 450,000 acres of farmland will experience coastal flooding by 2040. Salinization of soil and groundwater will affect many more acres.

Meanwhile, the rising demand for energy means that tens of millions of additional acres of rural land will be used for energy production and transmission in the coming decades. To slow down climate change, policymakers must drive a transition to renewable energy that not only limits impacts on highly productive agricultural land, but also helps farmers improve viability and resilience.

Socioeconomic trends are exacerbating the threats to agricultural lands. Over 40% of the nation's farmland is owned by people over 65, so up to 370 million acres of farmland could change hands in the next 20 years, increasing the possibility that the land will be sold for development. And while many young people are interested in getting started in farming, the challenge of finding affordable land is keeping too many of them from starting successful farm businesses—especially folks from races, ethnicities, and genders that have historically been and remain marginalized in agriculture.

Proactive policymaking is needed to address climate change and energy while ensuring that a new, more diverse generation of farmers can take up the mantle as older farmers retire.

WITHOUT SMART GROWTH AND GOOD LAND-USE PLANNING, AMERICANS WILL **PAVE OVER**, **FRAGMENT**, OR **COMPROMISE**

18.4 million acres

of farmland and ranchland.

THAT IS THE EQUIVALENT OF LOSING OR JEOPARDIZING:

115,000
FARMS

$11 billion
IN FARM OUTPUT

263,000
JOBS

BASED ON COUNTY AVERAGES.[1]

But it all starts with the land. This report focuses on the land itself, because we must secure our farmland and ranchland, or all other efforts to help farmers and ranchers thrive will be for naught.

We, as a society, have an important choice to make. Are we going to sit back and watch this critical resource disappear, eroding our food security, rural communities, and environment? Or will we join together now in a nationwide effort to secure an abundant future?

This report, and the accompanying web mapping tool, are designed to help Americans explore these alternatives. Using advanced geospatial analysis, AFT and our partners mapped three

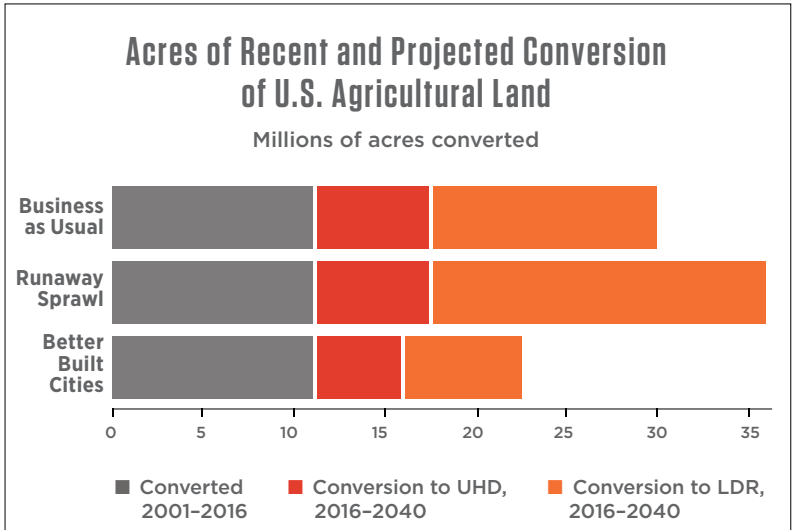
development scenarios from 2016 to 2040 (for more details see **Visions of the Future: The Scenarios**, page 18). The differences among them represent broad policy pathways that the country might take, rather than the results of specific, individual policies.

The results from the three scenarios show that Americans' development choices will have a profound effect on the future of agriculture:

If development follows recent trends, the U.S. will convert 18.4 million additional acres of agricultural land to more-developed uses between 2016 and 2040. Six states will convert over 10% of their agricultural land in this scenario, and more than 20 counties will convert over 40% percent of their remaining farmland. Perhaps most concerning, nearly half of the conversion will occur on the nation's most productive, versatile, and resilient farmland and ranchland, or Nationally Significant land. This means that Nationally Significant land is over 50% more likely to be converted by 2040 than other agricultural land.

If even more Americans choose to live on large lots in rural areas, over 1 million acres of agricultural land will be lost or compromised every year, amounting to 24.4 million acres between 2016 and 2040. In this scenario, over 12 million acres of Nationally Significant land will be converted—a devastating blow to the nation's best land. Compared to *Business as Usual*, both Texas and North Carolina will convert more than a half million additional acres, while five states on the Eastern Seaboard will convert an additional 4–5% of their farmland. Connecticut and New Jersey, for example, will see over 20% of their remaining farmland converted by 2040—in many cases, diversified farms that provide fresh produce, dairy, and meat to their local markets.

However, if policymakers and land-use planners focus on reducing sprawl by promoting compact development, agricultural land conversion could be cut by 7.5 million acres compared to *Business as Usual*—saving an area larger than the state of Maryland. At the same time, conversion of Nationally Significant land would decrease by 42%, taking the pressure off 3.7 million acres of our best land for growing healthy food. And a *Better Built Cities* future



Acres of recent and projected conversion of agricultural land to urban and highly developed (UHD) and low-density residential (LDR) land uses for the contiguous U.S. Recent conversion from 2001 to 2016 includes conversion to both UHD and LDR as documented in *Farms Under Threat: The State of the States*. Projected conversion is for 2016–2040.

would spare *over half* the farmland that would be converted in our *Runaway Sprawl* scenario—13.5 million acres. That is enough land to support over 82,000 urban-edge farms, produce $7.9 billion in annual agricultural output, and provide 184,000 on-farm jobs. The vast majority of this land is located near cities and towns, providing the indispensable foundation for resilient, local food systems.

Which Future Will We Choose?

Without proactive policymaking and land-use planning, the relentless march of *Business as Usual* development across the American landscape will continue or accelerate into *Runaway Sprawl*.

The consequences will be local, global, and even atmospheric. Consumers will have fewer local farms to turn to the next time a pandemic or supply chain disruption leaves grocery store shelves bare. The global food supply will be further pinched, compounding crop losses due to climate change and putting millions more people at risk of severe hunger across the globe. And low-density sprawl will drive up greenhouse gas emissions, while undermining opportunities to sequester soil carbon on farms and ranches.

However, if policymakers and land-use planners band together with farmers, ranchers, and concerned citizens to choose *Better Built Cities*, it will save millions of acres of farmland and ranchland. This means following smart-growth principles and prioritizing agricultural land in land-use policies. It will also require supporting the farmers, ranchers, and farmworkers who bring in the bounty and keep pantries full, including by helping the next generation access land.

If Americans choose abundance—if we embrace smart growth and minimize sprawl, secure our most productive land in perpetuity, implement a smart transition to renewable energy, and usher in a new generation of farmers and ranchers—we will feel the benefits beyond our dinner tables.

Every American can help. Developers can choose to revitalize urban spaces and build compact communities. Citizens can promote local land-use decisions that protect farmland and ranchland. Individuals can support local land trusts, buy locally produced food, and choose to live in compact neighborhoods. If you own farmland or ranchland, you can protect it with an easement so that your land becomes a legacy that feeds future generations.

But ultimately, achieving the goals of *Better Built Cities* will require rapid, widespread, and sustained efforts to improve policy and land-use planning at all levels of government. This will be a major undertaking, but Americans have come together in the past to forge a new approach to development and safeguard agricultural land. Innovative policies and approaches at the local, state, and federal levels have helped combat sprawl; supported farm viability and land access; and enabled the permanent protection of 6.9 million acres of agricultural land and counting.

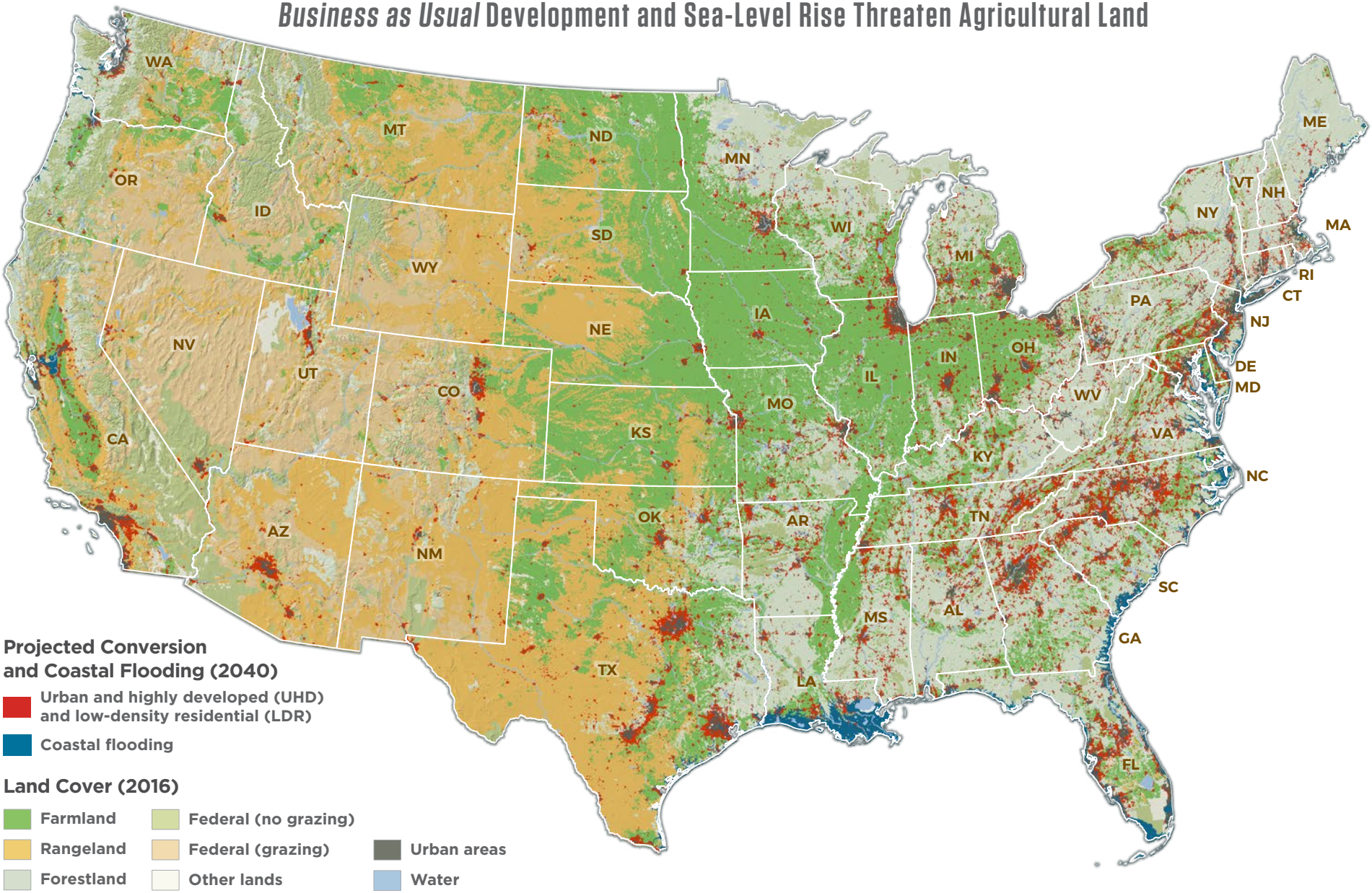
America must now build on these successes to counter the concurrent threats facing our irreplaceable agricultural resources. We offer the following policy recommendations to help our nation secure an abundant future:

1. Embrace smart-growth principles to improve land-use planning,
2. Permanently protect agricultural land to secure a supply of land in perpetuity,
3. Advance smart solar to boost both renewable energy and farm viability, and
4. Support farmland access to create opportunities for a new generation of farmers, particularly historically marginalized producers.

What Will Your Town Look Like in 2040?

AFT created an interactive web mapping tool (farmland.org/development2040) to help Americans understand the implications of their development choices. We invite you to explore these alternative futures and consider a few key questions: What do you want the landscape of your town, state, and country to look like in 2040? Do you want to see an abundance of healthy farmland and ranchland, or more big-box stores, warehouses and sprawling, large-lot housing? Which development choices would best reflect your values?

Business as Usual Development and Sea-Level Rise Threaten Agricultural Land



Projected conversion of non-federal farmland and rangeland to urban and highly developed (UHD) and low-density residential (LDR) land uses from 2016 to 2040 in the *Business as Usual* scenario, with the projected extent of coastal flooding due to sea-level rise in 2040. Farmland is composed of cropland, pastureland, and woodland associated with farms. Projections are illustrative of a possible future, not predictive. To explore this map in detail, visit farmland.org/development2040.

WHAT LOCAL GOVERNMENTS CAN DO

Smart Growth: Create comprehensive plans, embrace zoning approaches that encourage compact growth, and proactively plan for agriculture.

Farmland Protection: Identify agricultural resources and protect the agricultural land identified as a community priority.

Smart Solar: Incorporate smart solar siting into local land-use decisions; develop solar land-use laws and permitting through inclusive processes; ensure solar strengthens farm viability; and ensure best practices for soil health are followed when siting solar on farmland.

Farmland Access: Make municipal and county-owned lands available for agriculture and help match farm seekers with agricultural landowners.

WHAT STATES CAN DO

Smart Growth: Adopt smart-growth principles within state agencies, support local alignment with state smart-growth goals, and plan for agriculture across state agencies.

Farmland Protection: Identify priority agricultural resources, require mitigation for conversion, accelerate farmland protection efforts, incentivize keeping land in agricultural use, and enact the Uniform Partition of Heirs' Property Act to address heirs' property issues.

Smart Solar: Incentivize solar development on the built environment, previously disturbed, and marginal agricultural land; require mitigation for solar that displaces farming from productive agricultural land; and provide guidance and resources to communities for smart solar, including best practices for construction and decommissioning. Fund research on dual-use solar (agrivoltaics) and, pending proof of concept, define and incentivize it.

Farmland Access: Invest in land access and farm transfer assistance to landowners and farm seekers, including FarmLink programs. Establish transition incentives, address farmland affordability through state farmland protection programs, and make state-owned land available for leasing to producers.

WHAT THE FEDERAL GOVERNMENT CAN DO

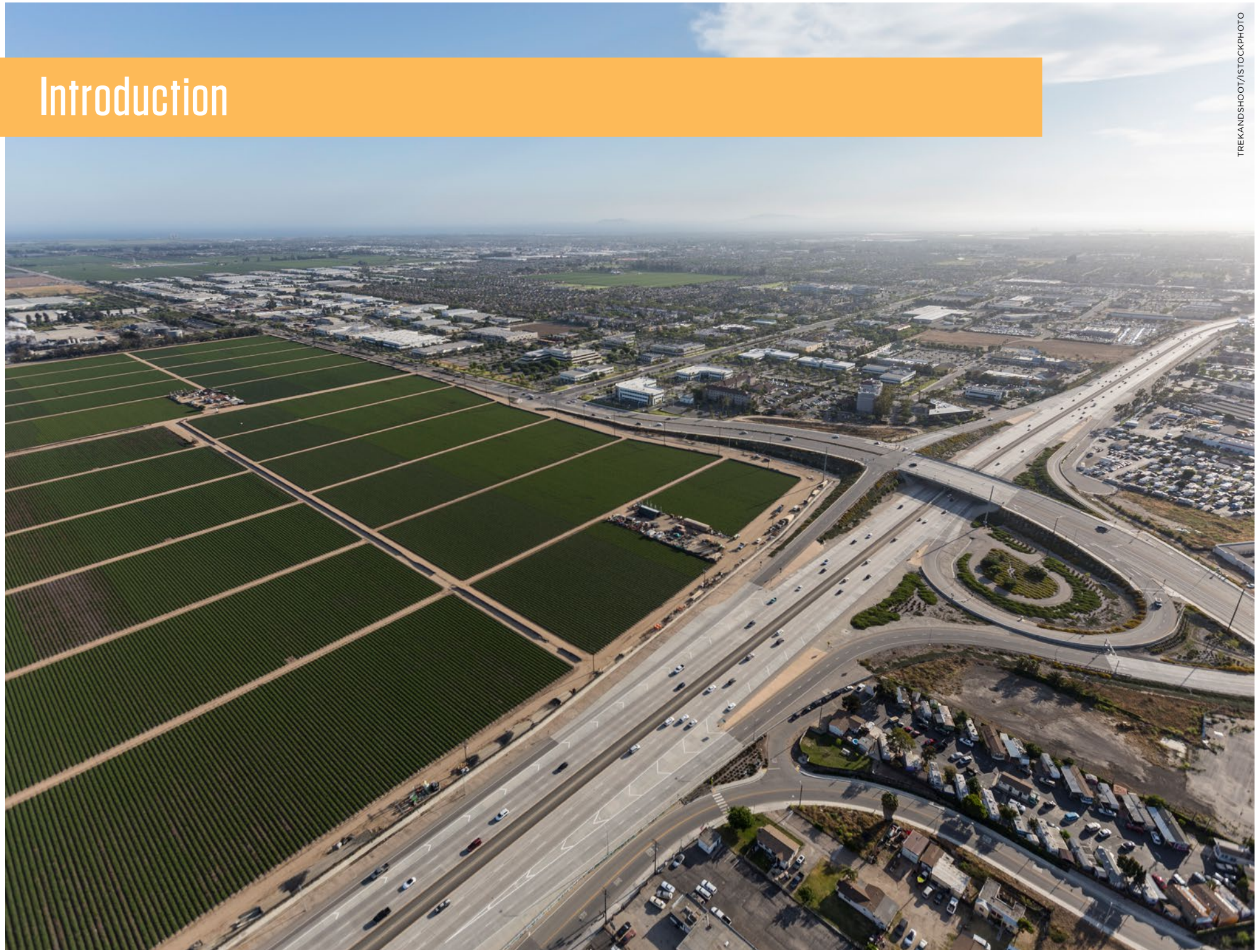
Smart Growth: Provide additional support for smart-growth planning and implementation grants, couple broadband funding with support for community planning, and encourage rehabilitation and conversion of commercial spaces.

Farmland Protection: Increase funding for USDA's Agricultural Conservation Easement Program (ACEP) and improve its function, strengthen the Farmland Protection Policy Act, and increase funding for the Heirs' Property Relending Program.

Smart Solar: Incentivize solar development on existing structures, brownfields, and marginal lands; fund research on best practices for developing solar on agricultural lands, including advancing dual-use; equip local, state, and regional leaders with smart solar resources; and expand interagency cooperation.

Farmland Access: Create tax incentives for lifetime farm transfers, improve Buy-Protect-Sell in ACEP-Agricultural Land Easements, provide additional support for business technical assistance that includes farm transfer, and allow producers to reduce Farm Service Agency debt in exchange for keeping land in agriculture.

Introduction



TREKANDSHOOT/ISTOCKPHOTO

LAND IS THE CRITICAL starting point for resilient and regenerative food systems that can both keep people fed and heal the planet. But poorly planned development is paving over productive agricultural lands both in the U.S. and around the globe.[2,3] This report focuses on the unsustainable impacts of development on American farmland and ranchland. It quantifies what our nation could lose if sprawling development continues—or save through more compact growth—by the year 2040.

Agricultural lands in the U.S. grow an astounding array of food, fiber, biofuels, and other raw materials. This abundance has made the U.S. one of the most food-secure nations in the world.[4] Yet it can also mask vulnerabilities. For too many Americans, it is easy to brush off farmland loss or view it as inevitable. This puts our future at risk.

When the coronavirus pandemic rattled the U.S. food system in spring of 2020, many growers swiftly pivoted to delivering produce to local markets, helping keep their communities fed.[5] This showed the underlying strength of shorter supply chains, providing a timely reminder about the importance of maintaining productive agricultural lands near cities and towns as a hedge against an uncertain future.

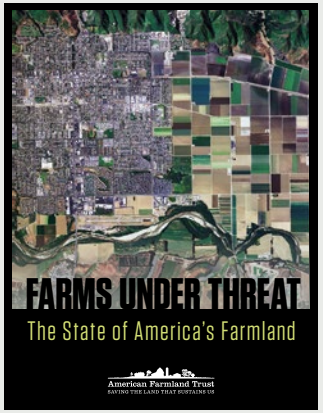
At the same time, the fallout from the war in Ukraine is a reminder that agricultural lands around the globe work in tandem to produce food for the world's population. In a world already battered by COVID-19 and climate change, Russia's invasion of Ukraine is severely disrupting food, energy, and financial markets.[6] Russia and Ukraine together provide around 30% of the world's wheat and barley, one-fifth of its corn, and over half of its sunflower oil. The war will further erode food security for hundreds of millions of people around the globe unless other countries can fill the gap.[6]

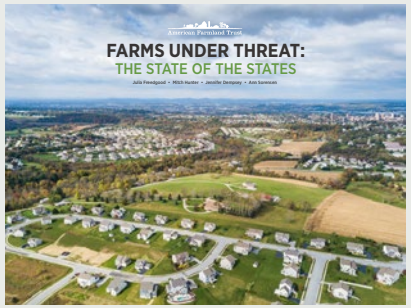
In the face of these cascading threats to global food security, every acre of productive capacity is essential. Simply put, "Food requires agriculture. Agriculture requires land."[7]

But our nation needs its agricultural lands for more than just food. Farmland and ranchland are also essential due to their capacity to improve the environment and help mitigate climate change.[8,9] It is important to acknowledge that today's agricultural systems, if not managed appropriately, can cause unsustainable levels of greenhouse gas emissions, soil erosion, nutrient loss to waterways, and

About Farms Under Threat

For over four decades, American Farmland Trust has been leading the charge to protect farmland and ranchland from a multitude of threats. Our research has informed policymaking and the practice of land protection. This report is part of a long-term partnership with the USDA Natural Resources Conservation Service called *Farms Under Threat.* In 2016, American Farmland Trust launched the *Farms Under Threat* initiative to harness the latest technological advancements to accurately document the extent, diversity, location, and quality of agricultural land in the continental U.S.—as well as to quantify trends and threats. First, AFT mapped and analyzed past development patterns between 1992 and 2012.[10] Subsequently, AFT incorporated updated datasets and refined our methods to map conversion threats at the state, county, and sub-county levels between 2001 and 2016.[2,11] We included an extensive analysis of how states were responding to development pressure, weakened farm viability, and the challenges of transferring land to a new generation of farmers. In late 2020, AFT, in partnership with Conservation Science Partners and the Center for Sustainability and the Global Environment at the University of Wisconsin, Madison, started an ambitious modeling effort to project how development and climate change will affect agricultural land under several different future scenarios. This report summarizes the results of the projection of future development through 2040. A report on climate threats to agriculture will be released later this year.





degradation of wildlife habitat.[12] Since agricultural lands make up roughly half of the continental United States, these impacts can add up. But this also means that agriculture is an essential part of the solution to these challenges. Coordinated efforts to hasten the adoption of conservation practices have improved agriculture's environmental performance, and there is great potential to do even more.[13]

Farmers can greatly reduce nutrient losses, erosion, and greenhouse gas emissions on cropland while building soil carbon.[9] And pastureland, rangeland, and woodland can produce nutrient-dense food while also supporting diverse native wildlife species and sequestering large amounts of atmospheric carbon.[8] By adopting sustainable and regenerative systems, farmers and ranchers can enhance the immense benefits that agricultural lands already provide and turn them into an indispensable part of the solution to our environmental challenges.[14,15,16,17,18] Even intensive row crop systems in the U.S. can be managed to contribute to clean water, biodiversity, carbon sequestration, and long-term soil fertility in addition to high yields.[19]

To maximize the environmental benefits of agriculture, it is essential to protect the best farmland in the U.S. from development and keep it in production. *Farms Under Threat* has mapped America's most productive, versatile, and resilient agricultural land. The highest-quality land for long-term, sustainable farming is termed "Nationally Significant" land, constituting just 39% of the nation's total agricultural lands (see page 30).[2] These are the acres that can produce the highest yields of crops and livestock with the least environmental impacts. When they are converted to poorly planned development, farmers may bring marginal land into production to make up for the losses, heightening risks to the environment.[20,21]

This unequal tradeoff is playing out on a global scale as well. A recent analysis found that cropland converted by expanding cities in China, Indonesia, and Nigeria was 30 to 40% more productive than the new cropland that replaced it.[3] As early as 2030, urban expansion will gobble up croplands that were responsible for 3–4% of worldwide crop production in 2000.[22] This dynamic will put even more stress on already strained food systems around the world, making every acre saved here increasingly valuable.

When agricultural land—especially America's best land—is converted to development, it undermines food production, environmental benefits, the economy, and rural communities. In short, American farms and ranches are a critical life-support system for our nation and the planet.

Every acre counts. Yet rapid farmland loss continues.

DON JOHNSON_BI/ALAMY

> “We need farmland not just to feed a growing population, but to provide essential ecological services that nurture wildlife, cleanse water, and capture atmospheric carbon. If we remain on our current development path, we will ultimately run out of land to grow our food; but long before that, I fear we will run out of the farmland we need to heal an environmentally degraded planet.”
>
> —**JOHN PIOTTI**, PRESIDENT AND CEO, AMERICAN FARMLAND TRUST

JERRY AND MARCY MONKMAN/ECOPHOTOGRAPHY.COM/ALAMY

Why Save Farmland?

HEALTHY FOOD

Development threatens our food supply.

Nearly 60% of U.S. farm market value is **produced near cities** (in metro or metro-influenced counties). That includes 90% of **fruits, nuts, and berries**, 81% of **vegetables**, 66% of **dairy,** and 55% of **eggs and poultry**.[2]

90% 81% 66% 55%

HEALTHY FOOD

Billions go hungry—in the U.S. and beyond.

Nearly **40 million people in the U.S.—and over 2 billion worldwide**—went hungry in 2020. There is no food without farmland. Climate change, conflict, and COVID-19 have all exposed vulnerabilities in the food system.[23,24]

HEALTHY ECONOMY

Agriculture strengthens our economy.

In 2020, agriculture and its related industries contributed over **$1 trillion** to the U.S. GDP (5.2%) and generated **19.7 million full- and part-time jobs** (10.3%). It also supports a cluster of businesses that contribute to a **strong local economy**.[25]

HEALTHY ECONOMY

Farmland contributes to the fiscal well-being of communities.

Farmland generates more in public revenues than it receives back in public services, **helping to balance local government budgets**.[33]

HEALTHY ENVIRONMENT

Farmland emits fewer greenhouse gases than development.

In California, cropland emits **58-70 times fewer greenhouse gases (GHGs)** per acre than developed land. Farmland in New York emits **66 times fewer GHGs** per acre than developed land.[26,27]

HEALTHY ENVIRONMENT

Regenerative cropland can help combat climate change.

Implementing **no-tillage** and **cover crop**s on ~35 million acres would reduce net greenhouse gas emissions by the equivalent of ~30 million metric tons of CO_2 per year—equivalent to **taking more than 6 million cars off the road**.[9]

HEALTHY ENVIRONMENT

Farmland can help protect communities from wildfires.

Irrigated cropland has served as a **natural firebreak** throughout the western United States, helping protect houses, buildings, oak forests, and grasslands but **at a great cost to the farmers and their crops**.[28]

HEALTHY ENVIRONMENT

Farmland provides wildlife habitat.

Agricultural landscapes **harbor a substantial portion of native plant and animal species**, including threatened species like the Greater Sage-Grouse, Lesser Prairie Chicken, New England cottontail, bog turtle, and monarch butterfly.[29,30]

JIM EKSTRAND/ALAMY

Farmland Faces Concurrent Threats

Between 2001 and 2016, Americans paved over, built up, or compromised 11 million acres of farmland and ranchland—an average of 2,000 acres every day.[2]

This top-line finding is from the previous report in this series, *Farms Under Threat: The State of the States*, which also highlighted disturbing underlying trends:

- Low-density residential areas were the largest driver of conversion—fragmenting or compromising nearly 7 million acres of farmland—while urban development paved over an additional 4 million acres. Urban growth has slowed significantly since its peak between 1992 and 1997.[31] However, the more traditional ways of mapping are missing an important part of the land conversion story since they do not fully capture this LDR expansion.

STEVEGEER/ISTOCKPHOTO

- Low-density residential areas also paved the way for further urbanization. Agricultural land that was in low-density residential areas in 2001 was 23 times more likely to be urbanized than other agricultural lands by 2016. Other researchers have documented this same transition from low-density to more-intensive land use.[32]
- Unlike urbanization, expansion of low-density residential areas was not closely tied to population growth. In fact, this type of land use expanded rapidly even in states that lost population, as residents relocated from cities into dispersed, large-lot housing in the countryside. This clearly shows that *how* Americans develop land has a huge effect on farmland conversion, regardless of the level of new housing demand.
- The nation's best farmland and ranchland was not spared: 4.4 million acres of Nationally Significant land were paved over or compromised.
- While every state has implemented policies that help protect and retain agricultural land, most state policy responses are woefully inadequate, and all states could do more.

New development is both desirable and inevitable as the country's population and economy grow. However, development can be done in a way that minimizes the loss and fragmentation of agricultural land. By directing new growth within existing cities and towns and building compact, livable communities—part of a strategy known as "smart growth"—Americans can limit sprawl and help preserve land for open space, farmland, wildlife habitat, and other natural resources (see **Smart Growth** on page 17). This approach also benefits local government finances, since farmland typically generates more tax revenue than it costs in public services, unlike residential development.[33]

Unfortunately, societal shifts stemming from the coronavirus pandemic could exacerbate the proliferation of low-density residential areas. The pandemic accelerated the existing trend of people moving outward from urban areas.[34] Now that many companies have implemented remote and flexible work options, it is even easier for workers to move away from urban cores into more suburban and rural areas to seek relief from high housing costs.[35,36,37] The expansion of high-speed broadband internet connectivity into rural areas could reinforce this outward trend. [38]

The coronavirus pandemic has also accelerated an e-commerce boom; online sales now make up 13.2% of retail sales.[39] Vast warehouses to support e-commerce are replacing farmland in places that are close to population centers and transportation corridors, such as southern New Jersey.[40]

Expanding energy production also continues to convert farmland. In the next few decades, the acres needed to produce energy from coal, oil, natural gas, and renewables (i.e., solar, wind, biofuels, etc.) may impact the land base at more than double the historic rate of urban development.[41] This will put a lot more agricultural land at risk. At the same time, America must transition off fossil-fuel energy sources to slow climate change. For a discussion of the path forward on this front, see **Farmland and Energy: A Smart Solar Test Case** on page 37.

Effective policies and land-use strategies are needed at the local, state, and federal levels to confront these new realities and protect working farms and ranches.

Climate Change Raises the Stakes

Climate change heightens the need for far-sighted policymaking. Climate disruption makes each acre more important, even as it undermines farm viability and thereby increases the risk of converting land out of agriculture. The effects of climate change also have the potential to reshape human settlement patterns in the coming decades, though it is unclear exactly how, where, and how this shift will occur. What is already painfully clear is that climate change is exacerbating long-standing water shortages in the West, creating an existential challenge for many critical agricultural regions (see **Drought and Development: Intersecting Threats** on page 8).

Climate change is significantly increasing risks to agricultural production.[42] Crops and livestock must now survive hotter days and nights, more consecutive dry days, and untimely frosts that can decimate tree fruit production.[43] Severe weather events like extreme droughts, torrential rains, explosive wildfires, and hurricane-like winds are increasing in frequency and severity and pose huge risks for agriculture.[44,45,,46,47,48] Flooding due to sea-level rise is inundating and salinizing coastal farmlands.[49] Increased heat and reduced precipitation will also increase rates of inland soil salinization, which already threatens crop production on up to 77 million acres in the U.S.[50,51] Compounding these threats, farmers can expect even more crop damage from pests, pathogens, and viral diseases, which currently cause 10–40% of crop production losses around the world.[52,53,54]

This litany of climate threats puts tremendous pressure on the nation's dwindling farmland and ranchland to keep up with increasing food demand.[55] While farmers and ranchers have shown a tremendous capacity to adapt to changing conditions in the past, traditional strategies may not suffice in the next two decades. Retaining as much productive, versatile, and resilient agricultural land as possible will provide a critical bulwark against future climate shocks.

Severe weather events can devastate agricultural lands

- In 2012, severe drought impacted 80% of U.S. agricultural land. More than two-thirds of U.S. counties were declared disaster areas and the federal crop insurance program paid out $14.5 billion in loss payments.[56]
- In 2017, the Thomas Fire in Ventura and Santa Barbara counties in California affected about 60,000 acres of pasture and about 10,000 acres of irrigated cropland, including more than 6,000 acres of avocados.[57]
- In 2019, heavy rainfall and flooding took 19.6 million acres of cropland out of production and resulted in payouts of $4 billion in claims.[58]
- In 2020, a widespread, long-lived derecho (high winds coupled with severe thunderstorms) moved through a 770-mile stretch from Nebraska to Indiana and decimated more than 40% of Iowa's corn and soybean crop.[59]

LANCE CHEUNG/USDA

Climate change will also significantly raise the stakes for better urban planning—which is already insufficient to protect farmland in every U.S. state.[2] Approximately one in three houses are currently in or near undeveloped wildland vegetation and face elevated fire risks.[60] Over the next 30 years, risks from flooding of streams, rivers, and coastal waters could impact as many as 23.5 million properties in the U.S.[61] While people typically resist relocating in the face of natural disasters, more flooding, more fires, hotter temperatures, and increasing water scarcity may eventually affect where people choose to live, driving a wave of "climate migration."[62,63,64]


US FOREST SERVICE

As people relocate to areas with fewer climate threats, climate migration will compound the existing development pressure facing agricultural land. See **Rising Seas: A Mounting Threat Across All Scenarios** (page 40) for an estimate of how much new development pressure will be caused by in-migration from coastal areas due to sea-level rise. While it is still unclear where this additional development pressure will occur, minimizing the loss and fragmentation of agricultural land now can help communities prepare for the unexpected.

Drought and Development: Intersecting Threats

Historic droughts driven by climate change, combined with many competing demands for water, are rapidly increasing water stress.[65] The Western U.S. is currently experiencing the worst megadrought in 1,200 years.[66] By 2040, nearly half of the water basins in the U.S. could experience high or extremely high water stress due to declining supply and increasing demands (Figure 1 on page 9).[67] As water becomes scarce, it is increasingly difficult to balance the multitude of water users and associated issues, including:

- instream flows for fish and wildlife,
- viability of fisheries and agriculture,
- land subsidence (sinking and settling) due to groundwater pumping,
- increased growth and development,
- quality of drinking water, and
- respect for treaty rights.

In the context of this report, however, we focus solely on the nexus of irrigated agriculture and development. To show the intersection of future development and mounting water stress, the web mapping tool for this report includes the map in Figure 1 as an overlay that can be added to the development projections (see farmland.org/development2040). The map, developed by the World Resources Institute, shows the degree of water stress in the year 2040 across 370 water basins (average size = 10,600 square miles) based on the ratio of total water withdrawals to renewable supplies of surface and groundwater.[67] By coupling this map with the future scenario projections, the web mapping tool will allow users to visualize the intersection of water scarcity and development across the country.

Irrigated agriculture is an essential part of the American food system. Only 14% of U.S. croplands are irrigated, but they account for more than 54% of the total value of U.S. crop sales, including over 70% of vegetables and 80% of fruits and nuts.[68,69] Nationally, about 58% of irrigation water withdrawals are from surface waters and the remainder are mainly from groundwater.[70]

Climate change affects the availability of both surface and groundwater across every major basin and groundwater system in the country. The local effects vary by region, but the patterns are alarming: Western basins, such as the Colorado, Columbia, Upper Rio Grande, and Sacramento-San Joaquin, continue to experience moderate, severe, and extreme drought.[71,72] Groundwater levels in key agricultural areas, such as the California Central Valley aquifer, the Ogallala aquifer, and the Mississippi Embayment aquifer, are declining at unsustainable rates.[73]

While water supply declines, population continues to climb.[74] This heightens competition for water between agriculture and development. Policymakers in some areas have already responded by requiring groundwater sustainability plans and curtailing surface water allocations to agriculture. In some over-drafted water basins, local groups have been tasked with

developing plans to achieve long-term groundwater sustainability.[75] Water-use limitations are likely to proliferate in coming decades: 608 counties will be at high risk and 412 counties at extreme risk of water shortages by 2050.[76]

Agriculture currently uses a large majority of freshwater supplies across the West, but it often loses out to commercial, industrial, and residential users as water competition mounts. Reductions in irrigation water availability threaten the viability of irrigated agriculture.[77] As groundwater becomes scarcer and surface water allocations are curtailed, farmers may adapt by improving irrigation efficiency or by growing more drought-tolerant crops. Others will be forced to permanently fallow their land. As water limitations make farming less profitable, selling farmland to developers will be even more tempting.

To an increasing extent, non-agricultural water users are buying agricultural land and water rights to transfer that water to municipal, residential, or other uses.[78] The land may transition to dryland production or be taken out of production entirely, sharply cutting food production. Depending on where this land is located, it might remain undeveloped. But without active management of noxious weeds or living roots to hold moisture and soil in place, the ecosystem services that the agricultural land can provide may decline.

Water scarcity can affect development patterns too. In the arid West, some areas have imposed restrictions on development due to dwindling water supplies. For example, in Arizona's Pinal County, state officials will no longer allow any future development using groundwater sources within a 4,000 square-mile management area.[79] And in Oakley, Utah, the city council voted in May 2021 to pause new development for 180 days.[80] A vulnerability assessment of climate-induced water shortages in Phoenix concluded that more native desert landscaping, fewer swimming pools, slower growth, and higher urban densities might help.[81] This smart-growth approach could help meet the needs of growing communities while conserving water and steering development away from

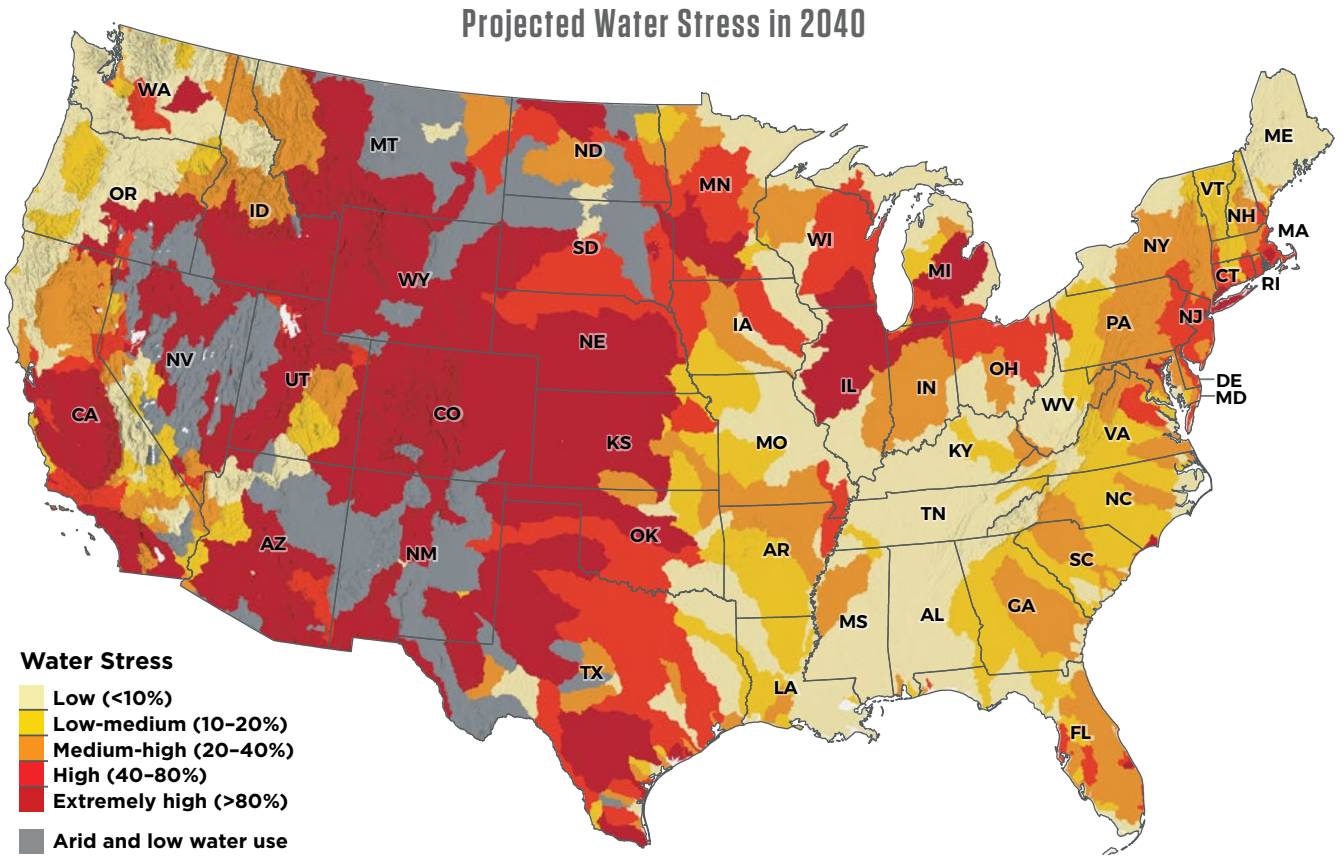


Figure 1. Projected 2040 water stress at the basin level across the contiguous United States. Data is from the World Resources Institute Aqueduct Water Risk Atlas under the "business as usual" scenario that reflects the world's current trajectory of high greenhouse gas emissions and mid-range population growth.[67]

prime farmland (see **Smart Growth** on page 17).

As water scarcity intensifies across the West, farmers and cities will need to work together to find collaborative solutions. Some communities are already investing in new strategies to shape their future. In Hermiston, Oregon, a collaboration between the city and a local irrigation district diverted city wastewater to agricultural canals in the summer months. However, in some cases, farmers are being penalized for the evapotranspiration from their cover crops, despite research that shows cover crops may increase water infiltration.[82] Bringing farmers, researchers, and local constituents to the table during water scarcity planning can lead to better outcomes.

Farmland Needs Farmers

America needs a thriving population of farmers and ranchers to keep us fed, reinvigorate our soils, and fight off climate change. Yet demographic and economic challenges are threatening the future of this profession, especially near cities, where development pressure is highest.

Farming in the U.S. has traditionally been a family business that is passed down through generations, but that is changing as younger generations choose to pursue other economic opportunities.[85,86] Farmland owners who are 65 or older now own more than 40% of the agricultural land in the U.S.[87] As they begin to retire, up to 370 million acres of farmland could change hands over the next 20 years.[87] The resulting land turnover could leave a massive quantity of agricultural land vulnerable to development.

The effects will be most acute on the urban fringe, where land is crucially important for local food systems. In these areas, regulatory challenges, conflicts with neighbors, and rising land values may persuade farmers to sell out to development.

To keep land in agriculture, especially around cities, it will be critically important to attract new farmers and help them succeed. However, from 2007 to 2019, the number of beginning farmers and ranchers dropped 9%. Despite the impending turnover in agricultural land ownership, land access for the next generation of farmers has become a serious challenge. Good farmland is expensive, and aspiring farmers must compete for land with developers, farmland investors, established farmers, even their own family members.[88,89] When farmland comes up for sale, developers can easily out-compete new or beginning farmers to purchase the land.[90,91]

Collaborating for Comprehensive Solutions

The Central Valley of California shows why it is important to address development pressure, water scarcity, and agricultural viability in an integrated way. California grows over a third of the nation's vegetables and two-thirds of its fruits and nuts, yet it also faces severe water shortages and rapid development. To reduce groundwater use to sustainable levels per California's Sustainable Groundwater Management Act, 4% (212,000 acres) of San Joaquin Valley cropland could be permanently retired, and 27% (1.3 million acres) could be intermittently fallowed.[75,83] Given the productivity of California's cropland and the infrastructure that supports fruit and vegetable production, these lands will be difficult to replace.

The strategic importance of the San Joaquin Valley to U.S. agriculture prompted AFT and the Conservation Biology Institute (CBI) to assess the capacity and resilience of agricultural production in the valley.[84] AFT and CBI created a mapping tool to evaluate data on groundwater recharge potential, critical agricultural land, water stress, and more. This research can help farmers and policymakers in the valley plan for future threats. In partnership with local entities and the USDA Natural Resources Conservation Service, AFT is now spearheading implementation of farmland protection, regenerative agricultural systems, and water conservation throughout the region (for more information, see farmland.org/sjv).

ROBERT DESTEFANO/ALAMY

Land access is especially challenging for aspiring farmers from races, ethnicities, and genders that have historically been and remain marginalized in agriculture.[92] As of 2012–2014, farmers who identify as women, Hispanic, or People of Color (African American/Black, Asian American, Native American, or Hawaiian/Pacific Islander) were deeply underrepresented among farmers and farmland owners compared to their share of the population.[92] This reflects a long history of discrimination and land dispossession[93] Even today, land speculators can more easily take advantage of farmers of color and other historically marginalized groups. These groups are more likely to operate smaller, lower-revenue farms; to have weaker credit histories; and to lack clear title to their agricultural land.[94] For example, at least 35% of Black farmers have inherited property from family members without clear titles to prove their ownership status (known as heirs' property).[95] Farmers of color may also have been denied educational opportunities, technical assistance, and USDA funding that could have helped their farm businesses thrive.

New approaches are needed to address the numerous hurdles that these farmers face in gaining access to land and holding onto it.[93] This will not only make agriculture more just and inclusive, but will also bring new insights, innovation, and knowledge that can help agriculture confront future challenges.

Smart Choices Spare Farmland

Americans—and all of humanity—have a fundamental and perpetual need for agricultural land. Too often, policymakers overlook this need when making important policy decisions. As threats to farmland escalate, it will be critical to make smarter choices.

A complex set of interconnected challenges impact our agricultural lands, including development pressure, climate change, energy production, and barriers to land access for the next, more diverse, generation of farmers. There are established and emerging policy solutions that can address these threats in ways that protect long-term food production capacity while regenerating natural resources (see **Policy Recommendations** on page 44).

But it all starts with the land. This report focuses on the land itself, because we must secure our irreplaceable farmland and ranchland, or all other efforts to help farmers and ranchers thrive will be for naught.

We, as a society, have an important choice to make. Are we going to sit back and watch this critical resource disappear, eroding our food security, rural communities, and environment? Or will we join together now in a nationwide effort to secure an abundant future?

This report, and the accompanying web mapping tool, are designed to help Americans explore these alternatives.

What Will Your Town Look Like in 2040?

AFT created an interactive web mapping tool (farmland.org/development2040) to help Americans understand the implications of their development choices. We invite you to explore these alternative futures and consider a few key questions: What do you want the landscape of your town, state, and country to look like in 2040? Do you want to see an abundance of healthy farmland and ranchland, or more big-box stores, warehouses and sprawling, large-lot housing? Which development choices would best reflect your values?

Brief Methods

PRESTON KERES/USDA

To illustrate the tradeoffs among contrasting approaches to development, AFT and our partners used advanced geospatial analysis to project three development scenarios from 2016 to 2040. The scenarios are described in detail below in the section titled **Visions of the Future: The Scenarios** (page 18). The differences among them represent broad policy pathways that the country might take, rather than the results of specific, individual policies. The scenarios are neither predictions nor prescriptions.

The modeling is based on a dataset that documents the historical conversion of agricultural lands, which was developed for *Farms Under Threat: The State of the States*.[11] This dataset documents conversion of agricultural land to two different types of land use: urban and highly developed (UHD) and low-density residential (LDR) (see **A Tale of Two Threats**, page 14).

The rates and patterns of conversion documented from 2001 to 2016 were used to train the model's projections of future development from 2016 to 2040. The model did not incorporate city and county zoning laws, since there is no national database of local land-use regulations.[96,97] The model reflects local development patterns to a certain extent because it is based on real-world observations between 2001 and 2016 at the county level. However, the results should be seen as broadly illustrative of development patterns and should not be evaluated against specific zoning ordinances in precise locations. Detailed methods are described in **Appendix 1** (page 53).

The challenges of balancing competing demands for water may impact future development rates and patterns in water-stressed areas. It is difficult to predict how this will play out, so the future scenarios modeled in this report do not account for the effects of water stress on development.

Land permanently protected by conservation easements was excluded from development. This includes protected farms and ranches identified in AFT's Protected Agricultural Lands Database (farmland.org/pald), which contains geospatial data on easements that protect agricultural lands.[98] The Protected Agricultural Lands Database was created to serve as a resource for the land protection community and to inform *Farms Under Threat* modeling efforts. The spatial data was provided by land trusts and state and local government agencies. While the Protected Agricultural Lands Database is the most complete database of protected agricultural lands in the U.S., AFT is continually collecting new spatial data. If you or your organization has data on agricultural conservation easements that you would like to contribute, please reach out to our mapping team at maps@farmland.org. AFT respects landowner privacy and will not share information with the public unless the data provider gives permission for us to do so.

AFT and our partners also modeled how the sea-level rise expected due to climate change will affect land use in 2040, compounding the effects of expanding development.

Finally, we quantified how both future development and sea-level rise will impact agricultural land. The *Farms Under Threat* dataset documents where agricultural land was located in 2016 and differentiates among four agricultural land cover types: cropland, pastureland, rangeland, and woodland associated with farms. For simplicity and improved visual presentation, *Farms Under Threat* maps sometimes combine cropland, pastureland, and woodland into a category called "farmland." The dataset also includes a measure of the land's productivity, versatility, and resiliency, which we used to map Nationally Significant agricultural land, the land best suited for long-term, intensive crop production (Figure 9, page 30).

To request access to the Farms Under Threat datasets, visit farmland.org/farmsunderthreat or email maps@farmland.org.

MGUNTOW/ISTOCKPHOTO

A Tale of Two Threats

Urban and Highly Developed (UHD) and Low-Density Residential (LDR)

THIS REPORT PROJECTS the conversion of agricultural land to two different categories of land use: urban and highly developed (UHD) and low-density residential (LDR). While these two categories look very different on the ground, they both threaten long-term agricultural viability.

Together, UHD and LDR include the full range of land impacted by development, from the urban core to the rural-urban interface (Figure 2, page 16). In simple terms, UHD is primarily made up of cities and suburbs, while LDR is made up of large-lot housing and other rural sprawl. (See **The Details**, below, for a more nuanced description of these two categories.)

This report refers to any transition of agricultural land to UHD or LDR as "conversion." However, the impacts on agriculture differ between conversion to UHD and to LDR. AFT generally considers UHD areas to be lost to agriculture, except for urban agriculture. The impact of LDR is more nuanced: some LDR areas are lost to agriculture, while in others the agricultural land has been fragmented or compromised. Agricultural land remains in some LDR areas, but the transition toward primarily residential use of that land threatens the future of farming and ranching.

This could imply that LDR conversion is preferable to UHD conversion, but the opposite is true. This is because UHD conversion is more efficient. In 2016, UHD areas contained at least 8 times more housing units per acre than LDR areas. This means that it takes at least 8 times more land to house the same amount of people in LDR as it would in UHD.

For instance, while a typical suburban subdivision on a 100-acre former farm field might house 400 families, and a compact neighborhood might house up to 800 families, LDR development might only house 50, 10, or even 5 families in that same area.[99] For the same loss of food production and environmental benefits, far fewer people benefit by having a place to live.

Large-lot housing also increases motor vehicle travel and greenhouse gas emissions while degrading wildlife habitat.[100,101,102] In the arid West, low-density sprawl increases water demand for landscape irrigation, compounding water stress from population growth and climate change.[103]

America will need more development in the coming decades to house and serve the growing population. Indeed, many states currently face a severe shortage of affordable housing. The best way to address this need while also protecting farmland and ranchland is with compact development.

The Details: A Nuanced Understanding of Land-Use Change Impacts on Agriculture

Urban and highly developed (UHD) land use is made up of commercial, industrial, and residential areas that are primarily found in and around cities and towns. Residential uses classified as UHD range from high-rise apartment buildings to subdivisions with lot sizes of up to 1–2 acres.[11] This category also encompasses highly developed rural lands such as warehouses and oil and gas well pads. The common feature of the different components of UHD is that they contain enough hard surfaces like roofs, asphalt, and concrete for satellite imagery to distinguish them from undeveloped spaces. Some spaces that are developed but still relatively open, like parks and golf courses, are also included.

CHESAPEAKE BAY PROGRAM

For the most part, UHD areas have been paved over, built up, or at the very least converted to uses that preclude most commercial agriculture. However, urban agriculture may still be an option in spaces like yards, parks, vacant lots, and rooftops, and it can make a meaningful contribution to food security, sustainable resource use, and community well-being.[104]

Researchers have been using satellite imagery to track UHD-type development for a long time. In contrast, LDR is very difficult to map with satellite imagery, although the NRCS Natural Resources Inventory includes some lower-density development (see Appendix 1 of *Farms*

Under Threat: The State of the States).[2] The impacts of LDR land use on agriculture had never been mapped in a comprehensive, national way until AFT and our partners developed an innovative method for *Farms Under Threat* (see **Appendix 1: Detailed Methods**, page 53).

Low-density residential land use represents a mounting threat to farmland: distributed, large-lot housing that may appear rural, but in fact often excludes production agriculture. While LDR exists along a continuum of housing density, there are three main forms.

The most concerning type of LDR—where agriculture is essentially shut out—occurs where farmland and ranchland are cut up into large housing lots. These may be 2–5 acres in size near cities, or even 10–40 acres in the countryside; the commonality is that the land is no longer used to produce food and fiber, but instead has effectively become a yard. Although some LDR properties may be farmettes or ranchettes with a couple of horses or a hay field, they are not typically commercial farms or ranches.

In other areas, LDR occurs as individual houses and small housing clusters spread out along rural roads, fragmenting what used to be contiguous blocks of agricultural land. Here, the impacts on farming may be mixed. For direct-to-consumer operations that manage farm stands or community-supported agriculture businesses, more neighbors might mean more customers. On the other hand, new residents can also create tension when confronted with slow-moving vehicles, smells, noise, and other facts of agricultural life. While incremental additions of rural housing may not seem threatening to agriculture, they can eventually shift an area from being primarily agricultural to primarily residential.

Another form of LDR is found where traditional subdivisions are expanding into active agricultural areas around cities and towns. While some farming might still be occurring in this type of LDR, the agricultural land that remains is highly threatened with further conversion to non-agricultural land uses. Indeed, from 2001 to 2016, agricultural land in LDR areas was 23 times more likely to be converted to UHD than all other agricultural land.

Figure 2. Urban and highly developed (UHD), low-density residential (LDR), and rural land uses exist on a continuum from high-density urban areas to low-density rural areas. The UHD category encompasses dense urban cores, suburbs, and highly developed areas like warehouses. UHD transitions into LDR in residential areas where house lots exceed 1–2 acres. The LDR category also encompasses very large-lot residential areas, which might appear rural at first glance but are primarily used for housing, not for production agriculture.

Smart Growth

Smart growth encompasses a multitude of land-use planning policies that seek to influence the pattern and density of new development.[105] Smart-growth principles favor locating new development in cities and older suburbs rather than fringe areas; supporting public transit and pedestrian-friendly development; encouraging mixed-use development; and preserving farmland, open space, and environmental resources. By promoting community involvement in decision-making, smart growth can also help communities prepare for the changing climate. It can help local officials learn who in their communities are vulnerable to flooding, wildfires, and sea-level rise and then prepare for what is coming.[106] Although smart growth can help overcome decades of costly sprawl, it has not always been beneficial for low-income communities and communities of color. This is changing as more and more communities integrate smart growth, environmental justice, and equitable development approaches to design and build healthy, sustainable, and inclusive neighborhoods.[107]

The community benefits from smart growth can be significant.[108,109,110,111,112,113,114] Community tax dollars go further because compact development reduces the cost of providing services and infrastructure over the long term. The Minneapolis-St. Paul Metropolitan Council found that smart-growth policies could save the region $3 billion because local communities would no longer need to spend so much money on roads and sewers.[115] By paying attention to street design and offering multiple transportation choices, people no longer need to solely rely on cars but can walk, bike, use rail transit, or catch a bus. This helps reduce traffic and air pollution.

By protecting open spaces like parks, natural areas, and scenic landscapes, communities become more desirable places to live and can attract tourism and recreation. At the same time, protected working lands like farms and ranches help support local economies, strengthen the tax base, increase the availability of local food, and add scenic open spaces.

BEYOND DC/CC BY-NC 2.0/ FLICKR.COM/PHOTOS/BEYONDDC/5212191941 7/IN/ALBUM-72157711208688446/

Visions of the Future: The Scenarios

In this scenario, communities across the country continue to see farmland converted to subdivisions, shopping centers, office parks, and large-lot housing. Development remains on the same trajectory that it was on from 2001 to 2016, as documented in *Farms Under Threat: The State of the States*, driven by existing land-use policies and consumer preferences. However, the amount of future conversion to urban and highly developed (UHD) and low-density residential (LDR) land uses is adjusted by state to reflect projected population growth.

The *Business as Usual* scenario establishes a baseline from which the alternative scenarios deviate due to changes in development policy and practice.

In this scenario, rising housing costs in metropolitan areas and remote work arrangements increase demand for far-flung rural residences, even above the level in the *Business as Usual* scenario. Large-lot housing sprawls beyond the outskirts of cities and towns. At first, some new rural homeowners enjoy the freedom of the open road and the beauty of the surrounding farms and forests. But eventually, farmland and natural areas are chopped up by houses and roads, while traffic soars. Local government coffers become strained by the increased costs of providing water, sewer, and public safety services to dispersed houses. Commercial farmers and ranchers, and the many businesses that support them, are pushed further out, reducing access to local food in nearby cities and towns.

The *Runaway Sprawl* scenario was modeled by holding UHD conversion rates at the same level as in *Business as Usual* and increasing LDR conversion rates by 50% (see Table 1, page 19).

In this scenario, policymakers and land-use planners focus on reducing sprawl and increasing the livability of cities and towns. Federal, state, and local governments deploy a coordinated portfolio of smart-growth policies that make new development more efficient. This greatly reduces pressure on farmland located near cities, while improving the fiscal health of local governments. Cities invest in the existing urban footprint by rehabilitating older structures and building on previously underutilized lands, further reducing demand for new subdivisions. Meanwhile, cities retain space for urban agriculture to enhance food access for lower-income urban populations. Walkability and public transportation are prioritized, resulting in better access to businesses, schools, parks, farmers markets, and grocery stores. The rural agricultural land base is stabilized as conversion slows down, creating opportunities to develop local, resilient food systems.

The *Better Built Cities* scenario was modeled by reducing UHD conversion rates by 25% and LDR conversion rates by 50% compared to the *Business as Usual* scenario (see Table 1, page 19).

Table 1. Key modeling assumptions for the three scenarios. See **Appendix 1: Detailed Methods** for more information.

Scenario	Rate of UHD Conversion	Rate of LDR Conversion
Business as Usual	Historical rate (2001–2016) adjusted for future population growth	Historical rate (2001–2016)
Runaway Sprawl	Same as *Business as Usual*	50% higher than *Business as Usual*
Better Built Cities	25% lower than *Business as Usual*	50% lower than *Business as Usual*

How You Can Use the Projections

Interactive maps that illustrate these alternative futures are available at farmland.org/development2040. You can zoom in to your area of interest, compare how farmland and ranchland fare in the different scenarios, and access quantitative data to evaluate the trade-offs. A two-page report on each state is available for download, along with the underlying geospatial data. Our hope is that you will use this information to advocate for policies that protect and retain America's farmland and ranchland so that the land we need to feed future generations does not disappear. See *Policy Recommendations* to learn what can be done at the local, state, and federal levels.

While reviewing the maps, it is important to remember that they are neither predictive nor prescriptive. Instead, they illustrate three potential futures. At the local level, the results should be seen as broadly illustrative of development patterns and should not be evaluated against specific zoning ordinances in precise locations.

American Farmland Trust acknowledges that all maps can potentially be misused or cause unintended consequences. There is a risk that land speculators and developers could use these maps to inform their activities, driving poorly planned growth and potentially leading to land dispossession in historically marginalized farming communities. We acknowledge these risks and call on our partners to use these maps to protect our irreplaceable agricultural land and ensure its long-term resiliency—especially in communities of color.

For more information and help combatting threats to land owned or operated by farmers and ranchers of color, we recommend you reach out to regional organizations that support these communities. For assistance in identifying a group working in your region, you may contact AFT's Farmland Information Center: (800) 370-4879, farmlandinfo.org/ask-an-expert.

KIRK HEWLETT/ALAMY

The Future of Farmland: Development Choices Matter

THERE ARE STRIKING CONTRASTS among these potential futures. Americans' development choices will strongly shape the fate of our nation's farmland and ranchland. Unless policymakers and land-use planners at the local, state, and federal levels make far-sighted choices to pursue compact-growth strategies, the relentless loss of our country's agricultural resources will continue (see **Policy Recommendations**, page 45). This ongoing conversion will have cascading impacts on the economy, local-to-national-scale food systems, and the delivery of ecosystem services—including the critical effort to lock up atmospheric carbon in agricultural soils. It will also affect the character of communities across America. But there is hope, since smart-growth policies that reduce sprawl can save farmland while making cities more livable and vibrant.

Key Findings

On our current trajectory (*Business as Usual* scenario), from 2016 to 2040:

- Another 18.4 million acres of farmland and ranchland will be lost or compromised.
- Highly inefficient, low-density residential areas will drive two-thirds of the new conversion.
- Smaller farms will be disproportionately impacted.
- Nationally Significant land—the nation's most productive, versatile, and resilient farmland and ranchland—will be over 50% more likely to be converted than other agricultural land.
- Some of the most important food-producing areas of the country, including the Central Valley of California, will see large areas of cropland paved over by urban and suburban development.

Americans' development choices matter:

- If rural sprawl accelerates, as in the *Runaway Sprawl* scenario, conversion will jump to 24.4 million acres between 2016 and 2040.
- But, if policymakers and planners across the country embrace more compact development as in the *Better Built Cities* scenario, it will slash conversion by 55% compared to *Runaway Sprawl*—saving 13.5 million acres of irreplaceable farmland and ranchland from conversion, including nearly 7 million acres of Nationally Significant land.
- States and communities that want to secure their agricultural land in perpetuity can complement smart growth by partnering with farmers and ranchers on conservation easements (see **The Next Level: Expanding Permanent Farmland Protection**, page 32).

Farmland faces concurrent threats:

- Tens of millions of additional acres of rural land will be used for energy production and transmission in the coming decades (see **Farmland and Energy: A Smart Solar Test Case**, page 37).
- On our current climate trajectory, a total of nearly 450,000 acres of farmland will experience coastal flooding by 2040 (see **Rising Seas, Inland Migration: A Threat Across all Scenarios**, page 40).

These projections are illustrative of possible futures, not predictive or prescriptive. As with any future projection, there are significant uncertainties. Yet they show that much is at stake as Americans decide where to live and work in the coming decades. The following sections delve deeper into these findings and identify hotspots of conversion at the state and local levels.

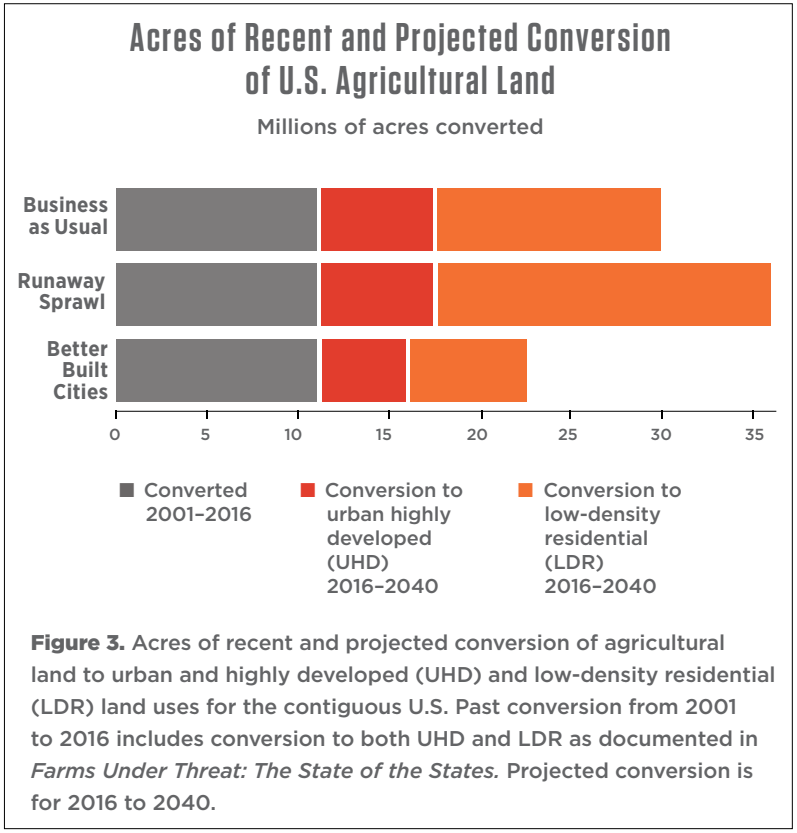


Figure 3. Acres of recent and projected conversion of agricultural land to urban and highly developed (UHD) and low-density residential (LDR) land uses for the contiguous U.S. Past conversion from 2001 to 2016 includes conversion to both UHD and LDR as documented in *Farms Under Threat: The State of the States.* Projected conversion is for 2016 to 2040.

BUSINESS AS USUAL

If development continues at its current pace, 18.4 million additional acres of agricultural land will be paved over, fragmented, or compromised between 2016 and 2040—an area nearly the size of South Carolina (Figure 3). This land is equivalent to half of the U.S. wheat crop, an essential food source whose value has become even more apparent as Russia's war on Ukraine has severely disrupted the global trade in wheat and other commodities, potentially pushing millions of people around the world deeper into hunger and poverty.

Of these acres, 6.2 million (34%) will be lost forever to urban development and 12.2 million (66%) will be built on, fragmented, or compromised through conversion to low-density residential land use (Figure 3). All told, roughly 2,100 acres of agricultural land, more than 3 square miles, will be lost or compromised every day from 2016–2040. This *Business as Usual* projection is on the conservative end of a range of future development projections from the academic literature.[116]

The projected conversion will disproportionately affect smaller farms, largely because it is concentrated near cities and towns, where farms tend to be smaller. The average farm size in the quarter of counties with the highest rates of projected conversion is 146 acres. In the quarter of counties with the lowest rates of projected conversion, the average farm size is 1,056 acres—7 times greater. Smaller farms near cities often serve local markets with fresh produce, eggs, dairy, and meat, providing critical resiliency in the face of supply chain disruptions.[5] These farms also tend to incubate new farmers, especially those from groups that are underrepresented in agriculture.[159,117]

The onslaught of impending land conversion is most concerning in the Southeast, where six states (North Carolina, Tennessee, Georgia, Florida,

Table 2. States with the most acres and the highest percentage of agricultural land projected to be converted to urban and highly developed (UHD) and low-density residential (LDR) uses between 2016 and 2040. For a complete list of states, see **Appendix 2**, and to explore data for every state in the contiguous U.S., visit farmland.org/development2040.

Acres Projected to Be Converted by 2040

	Business as Usual	Runaway Sprawl	Better Built Cities
Texas	2,192,700	2,770,100	1,375,500
North Carolina	1,197,300	1,678,100	661,500
Tennessee	1,014,600	1,409,200	564,800
Georgia	798,400	1,062,300	474,500
California	797,400	935,300	522,100
Florida	620,200	762,500	410,400
Virginia	594,100	836,200	328,700
Missouri	568,200	794,400	309,400
Alabama	545,000	751,600	310,800
Pennsylvania	543,800	760,000	309,300
Ohio	518,500	696,800	298,700
Wisconsin	515,200	688,000	304,800
Contiguous U.S.	18,415,000	24,403,800	10,869,900

Percentage of Agricultural Land Projected to be Converted by 2040

	Business as Usual	Runaway Sprawl	Better Built Cities
New Jersey	16.0	20.1	10.0
Connecticut	15.8	20.9	10.3
Massachusetts	14.8	17.9	10.0
Rhode Island	14.5	17.6	9.8
Delaware	12.5	16.6	8.1
North Carolina	11.6	16.2	6.4
New Hampshire	8.3	10.0	5.2
Tennessee	8.2	11.5	4.6
Maryland	7.8	10.8	4.3
South Carolina	7.5	10.1	4.4
Florida	7.4	9.1	4.9
Virginia	7.3	10.2	4.0
Contiguous U.S.	2.0	2.6	1.1

Alabama, and Mississippi) will convert from 500,000 to over a million acres of agricultural land between 2016 and 2040 (Table 2). Texas alone will convert over 2 million acres of agricultural land as its cities continue to grow at a breakneck pace. Most of the states facing massive farmland conversion currently have only weak or moderate policies designed to protect and retain farmland.[2]

A cluster of smaller states in the Northeast—New Jersey, Connecticut, Massachusetts, Rhode Island, and Delaware—will see over 10% of their agricultural land lost or fragmented, severely threatening their local food supply and farm economies. These states have stronger agricultural land conservation policies, but they could still do more.[2] The state of North Carolina stands out with the ignominious distinction of being a sizable state that nevertheless will convert 11.6% of its agricultural land—nearly 1.2 million acres—to subdivisions, strip malls, and scattered rural housing.

The hotspots of conversion jump out even more at the level of counties and metropolitan areas (Figures 5 and 6). Shockingly, 10 different counties in Georgia will convert over 40% of their agricultural land as the Atlanta megalopolis expands insatiably (Table 3). Three Texas counties—Tarrant, Harris, and Dallas—will convert 37-59% of their agricultural land, a total of 250,000 acres of farms and ranches. Five North Carolina counties will see more than 35% of their agricultural land converted. And at the top of the list, 67% of the farmland and ranchland in Broomfield County, Colorado, will be turned over to more-developed uses.

Looking at the top counties by acres of projected conversion tells a different story (Table 3). By far the largest threat is in Maricopa County, Arizona, where 230,100 acres are projected to be converted between 2016 and 2040. From native rangeland to highly productive irrigated

Table 3. Counties with the most acres and highest percentage of agricultural land projected to be converted to urban and highly developed (UHD) and low-density residential (LDR) uses between 2016 and 2040. For a longer list of top counties, see **Appendix 2**, and to explore data for every county in the contiguous U.S., visit farmland.org/development2040.

Acres Projected to Be Converted by 2040

County	State	Business as Usual	Runaway Sprawl	Better Built Cities
Maricopa	Arizona	230,100	247,200	164,300
Riverside	California	127,700	138,300	90,200
Bexar	Texas	117,100	147,900	66,000
Harris	Texas	112,400	131,000	83,200
Clark	Nevada	102,500	114,600	66,600
Tarrant	Texas	102,300	118,100	70,600
Fort Bend	Texas	95,200	113,700	62,900
Collin	Texas	90,400	106,100	60,700
Travis	Texas	73,800	92,600	53,100
Denton	Texas	73,200	84,300	51,800
Hidalgo	Texas	68,300	84,700	47,100
San Bernardino	California	61,800	69,200	43,500

Percentage of Agricultural Land Projected to be Converted by 2040

County	State	Business as Usual	Runaway Sprawl	Better Built Cities
Broomfield	Colorado	67	67	53
Gwinnett	Georgia	61	61	51
Mecklenburg	North Carolina	66	72	50
Cobb	Georgia	55	55	48
Harrisonburg	Virginia	63	66	48
Forsyth	Georgia	51	51	47
Muscogee	Georgia	54	69	42
Tarrant	Texas	59	68	41
Norfolk	Massachusetts	46	48	37
Henry	Georgia	55	65	37
Harris	Texas	49	57	36
Lee	Florida	37	41	32

cropland, that is nearly a quarter million acres growing everything from lettuce, carrots, and melons to hay for dairy cows.[118] Riverside County, California faces the second greatest threat, with 127,700 acres projected to be lost or compromised by 2040. Four other California counties join Riverside on the top 30 list, with over 47,000 acres under threat in each. These counties, along with many of the other counties with the highest projected conversion, are large counties that contain rapidly growing cities surrounding by agricultural land.

And yet, Texas stands out above all other states, with 11 counties in the top 30 list, totaling nearly 900,000 acres

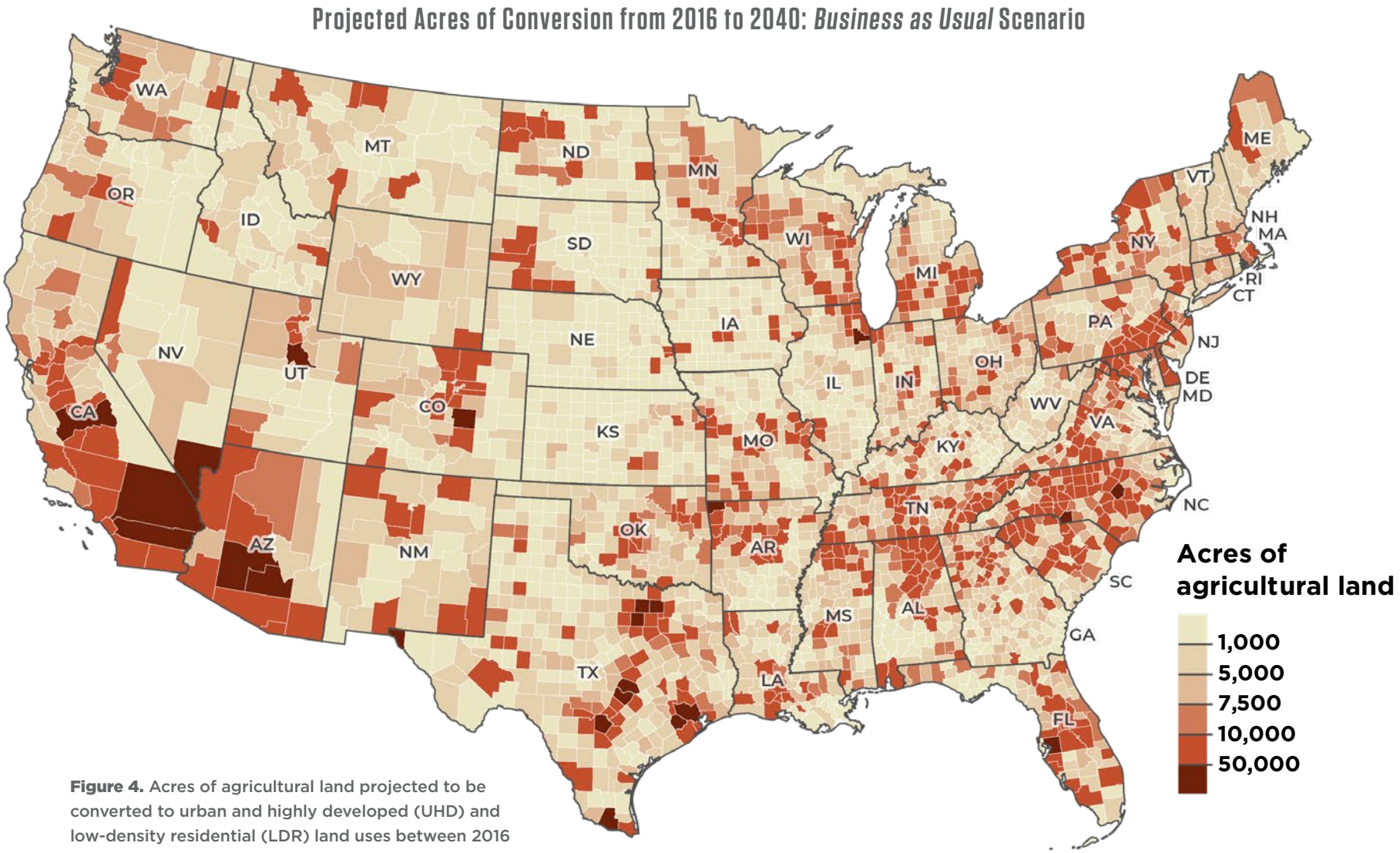


Figure 4. Acres of agricultural land projected to be converted to urban and highly developed (UHD) and low-density residential (LDR) land uses between 2016 and 2040 in the *Business as Usual* scenario, by county.

of farmland and ranchland that will be converted if states and counties continue to follow *Business as Usual* development patterns. Figure 6 (page 26) shows the results of the three scenarios in the area of Fort Worth, Texas, in Tarrant County.

In the *Business as Usual* scenario, new conversion fills in many of the remaining pockets of open farmland and rangeland that remain near the city, while also sprawling out from highways that extend into the countryside.

Beyond the hardest-hit counties, it is striking just how widespread the wanton conversion of agricultural land will become in the next 20 years. Across the U.S., 2,164 counties—nearly two thirds of the total—will convert at least 1,000 acres of

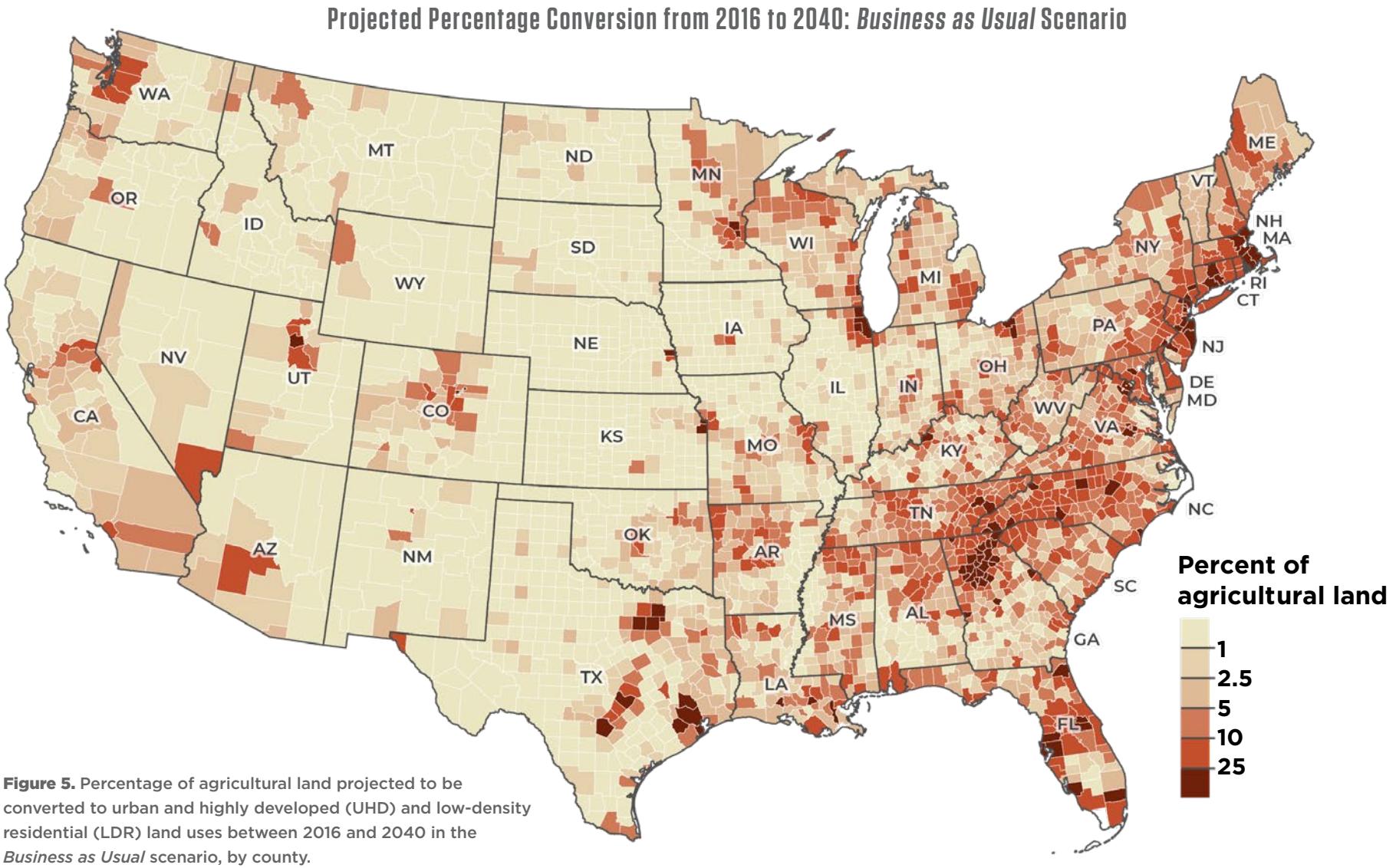


Figure 5. Percentage of agricultural land projected to be converted to urban and highly developed (UHD) and low-density residential (LDR) land uses between 2016 and 2040 in the *Business as Usual* scenario, by county.

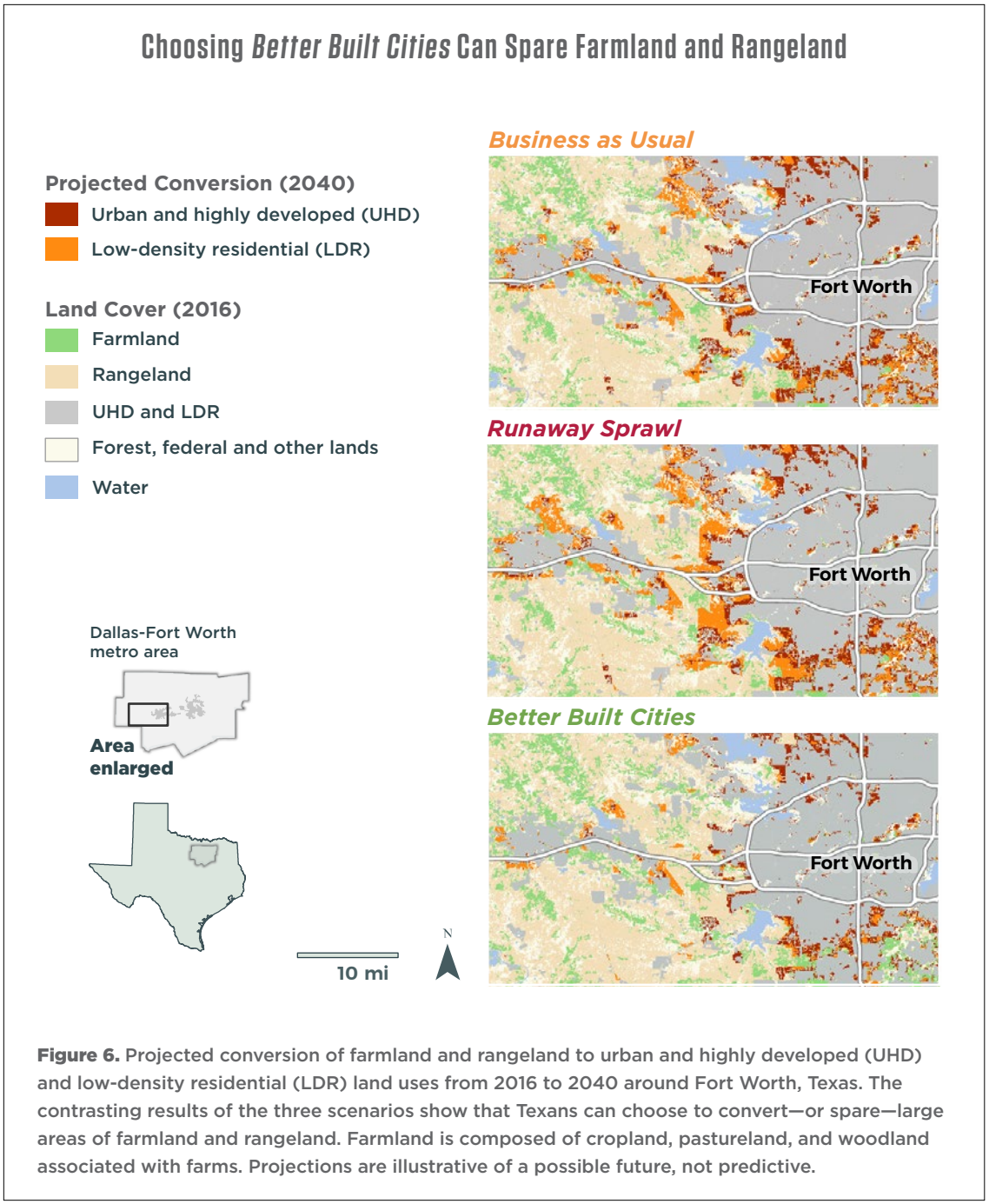


Figure 6. Projected conversion of farmland and rangeland to urban and highly developed (UHD) and low-density residential (LDR) land uses from 2016 to 2040 around Fort Worth, Texas. The contrasting results of the three scenarios show that Texans can choose to convert—or spare—large areas of farmland and rangeland. Farmland is composed of cropland, pastureland, and woodland associated with farms. Projections are illustrative of a possible future, not predictive.

farmland and ranchland, and 470 counties will see at least 10% of their agricultural land lost, fragmented, or compromised.

RUNAWAY SPRAWL

If sprawling exurban development accelerates over the next 20 years, as in the *Runaway Sprawl* scenario, all of these damages will be compounded. The projections show that 24.4 million acres of farmland will be lost or compromised in this scenario between 2016 and 2040 (Figure 3, page 21). This amounts to over 1 million acres every year. Compared to the *Business as Usual* scenario, 6 million more acres will be lost or compromised by 2040—an area roughly the size of New Hampshire. The average daily conversion rate will spike to 2,800 acres.

In *Runaway Sprawl*, 75% of the total, 18.2 million acres, will be converted to low-density residential land use, with the remaining 6.2 million acres lost to urban development. This means that the lion's share of the conversion will be woefully inefficient, using far more land than necessary to house and support the growing U.S. population.

Compared to *Business as Usual*, an additional half million acres will be converted in both Texas and North Carolina in a *Runaway Sprawl* future, with Tennessee, Georgia, and Virginia close behind (Table 2, page 22). All told, twenty-two states will convert at least an additional 100,000 acres. Meanwhile, Connecticut, North Carolina, New Jersey, and Delaware will see an additional 4–5%

of their farmland converted, over and above *Business as Usual*. At this rate of sprawling development, two of these states (Connecticut and New Jersey) will both convert more than 20% of their remaining farmland by 2040.

The implications of *Runaway Sprawl* stand out starkly in the example of Fort Worth, Texas (Figure 6). Low-density residential areas will explode across the countryside, converting farmland, ranchland, forests and other rural lands at an even faster rate than in *Business as Usual*. Farmland and ranchland that might have previously provided local food to city-dwellers will instead become residential properties, largely excluding agricultural production. The distance from urban consumers to rural producers will grow, making it harder for Fort Worth residents to access local food, learn first-hand about agriculture, and experience nature.

The *Runaway Sprawl* scenario has an outsized impact on states where low-density residential areas are the leading cause of farmland conversion. While conversion increases 33% nationwide in this scenario compared to *Business as Usual,* Vermont will see nearly 50% more farmland conversion in a *Runaway Sprawl* future, and Montana, West Virginia, Mississippi, and Michigan will have 44–46% more. Outside of recreation-driven development hotspots like Bozeman, Montana, large-lot housing developments might not register as a leading threat to agriculture, but these states would do well to ensure that low-density residential conversion does not undermine their farms and ranches.

BETTER BUILT CITIES

However, if policymakers and land-use planners across the country embrace smart-growth tools to combat sprawl and make communities more vibrant, the total conversion from 2016 to 2040 will be cut by 7.5 million acres compared to *Business as Usual*. This shows that, with smart planning that reduces the expansion of urban and suburban areas and contains the spread of large-lot rural residences, America can save an amount of farmland larger than the state of Maryland. That is enough land to produce all the vegetables, nuts, and non-citrus fruits that the U.S. currently grows. While nearly 11 million acres will still be converted by 2040 in the *Better Built Cities* scenario—a major blow to agriculture and the environment—reining in conversion rates now could mark a major turning point and lead to even more compact growth in the future.

NATE HAVEE/ISTOCKPHOTO

With the release of *Farms Under Threat: The State of the States*, American Farmland Trust set a goal to reduce the annual rate of conversion of agricultural land by 75% between 2020 and 2040 (Figure 7, page 28).[2] The *Better Built Cities* scenario illustrates the benefits of achieving that goal, since it results in an equivalent reduction in total conversion by 2040.

A *Better Built Cities* future will spare *over half* the farmland that would be converted in the *Runaway Sprawl* scenario: 13.5 million acres that are primarily located near cities and towns. That is enough land to support over 82,000 urban-edge farms, produce $7.9 billion of annual agricultural output, and provide 184,000 on-farm jobs (see **Appendix 1: Detailed Methods**). So, the smart-growth policies deployed in *Better Built Cities* will not only save farmland—the indispensable foundation for resilient, local food systems—they will also protect an important economic engine.

Saving this land is also essential to the global food system, which depends on production from the U.S. and other leading exporters to make up for shortfalls elsewhere. Despite the incredible magnitude of global grain and oilseed production, supplies can run short overnight due to geopolitical disruptions

like Russia's invasion of Ukraine, especially with climate change weighing on global productivity and global food demand increasing.[42,55] The 13.5 million acres that will be spared in *Better Built Cities* compared to *Runaway Sprawl* is equivalent to more than a third of the current U.S. wheat acreage, so it could make a substantial contribution in future supply shortages.

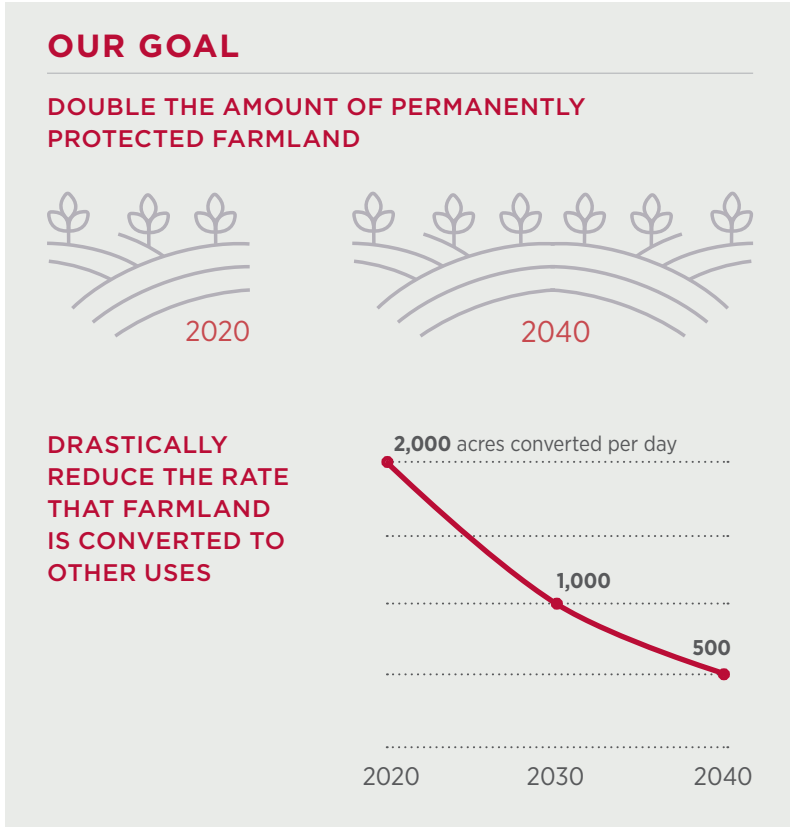


Figure 7. Goals established by American Farmland Trust based on the findings of *Farms Under Threat: The State of the States.*

But *Better Built Cities* is not just about saving farmland. Smart growth aims to improve peoples' daily lives.[115,119] Businesses can thrive on walkable main streets, and families can live close to their daily destinations. A variety of transportation options like walking, biking and public transit can help reduce air pollution from cars while saving people—and cities—money. Neighborhoods are more livable, with a variety of housing types and price ranges. There are parks and greenways for recreation and respite, not to mention abundant rural lands nearby to provide local food and access to nature.

Some of these benefits are visible in the depiction of the future of Fort Worth, Texas (Figure 6, page 26). Large areas of farms, ranches, and forests are retained near existing neighborhoods and city centers, maintaining access for city dwellers. New conversion does not extend nearly as far into the countryside as with *Business as Usual* or *Runaway Sprawl*, maintaining contiguous blocks of agricultural land that are more likely to support working farms and ranches for years to come. Overall, choosing *Better Built Cities* benefits people, the environment, the climate, working lands, and wildlife.

Addressing Low-Density Residential Conversion

Nationwide, low-density residential land use is the leading driver of conversion in all the scenarios, making up 57% of the total in *Better Built Cities*, 66% in *Business as Usual*, and 75% in *Runaway Sprawl*. From sprawling subdivisions with 2-acre lots to dispersed houses that eat up the countryside in 5-, 10-, or 40-acre chunks, this type of conversion might not have as strong of a visual impact on the land as dense urban development, but it can still sharply undermine the agricultural land base, family farmers, and our food security.

What does it mean that rural sprawl is outpacing urban development? It means that communities and states are accepting a highly inefficient form of housing at the expense of their farms, ranches, and natural ecosystems. In many cases, communities may not even know that this type of land use is so widespread and concerning. Our projections can inform communities and help them start to tackle this threat with smarter planning for future development.

Low-density residential areas are expanding in all corners of the United States, but there are important regional differences. Urban and suburban development is more prevalent in the West, while large-lot housing and rural sprawl are more prevalent in the East (Figure 8). This trend is driven by multiple landscape and economic factors. Low-density residential conversion is prevalent in heavily wooded and hilly landscapes, which are common in the East. Denser housing tends to dominate in flat, open spaces, such as those found around many large cities in the West and the Plains.

There are many exceptions to this regional breakdown. For instance, low-density

residential conversion strongly outpaces urban growth in Montana, despite being a Western state, since much of the development is driven by amenity housing on large acreages. Likewise, low-density residential areas are common in the hills outside of cities like Denver, Colorado and Austin, Texas. And of course, urban and suburban expansion is common in the East, though not as widespread as low-density residential conversion. See farmland.org/development2040 for information on the acres projected to be converted to these two land use types by state and county for each scenario.

In the *Better Built Cities* scenario, six million fewer acres will be converted to large-lot housing and rural sprawl than in *Business as Usual*, and 12 million fewer than in *Runaway Sprawl*. This will significantly reduce impacts to the environment and limit greenhouse gas emissions, since sprawling development contributes to car dependency, greater oil consumption, and more greenhouse gas emissions.[100,101] Large-lot houses and sprawling subdivisions also increase public service costs and add to water pollution from on-site septic systems.

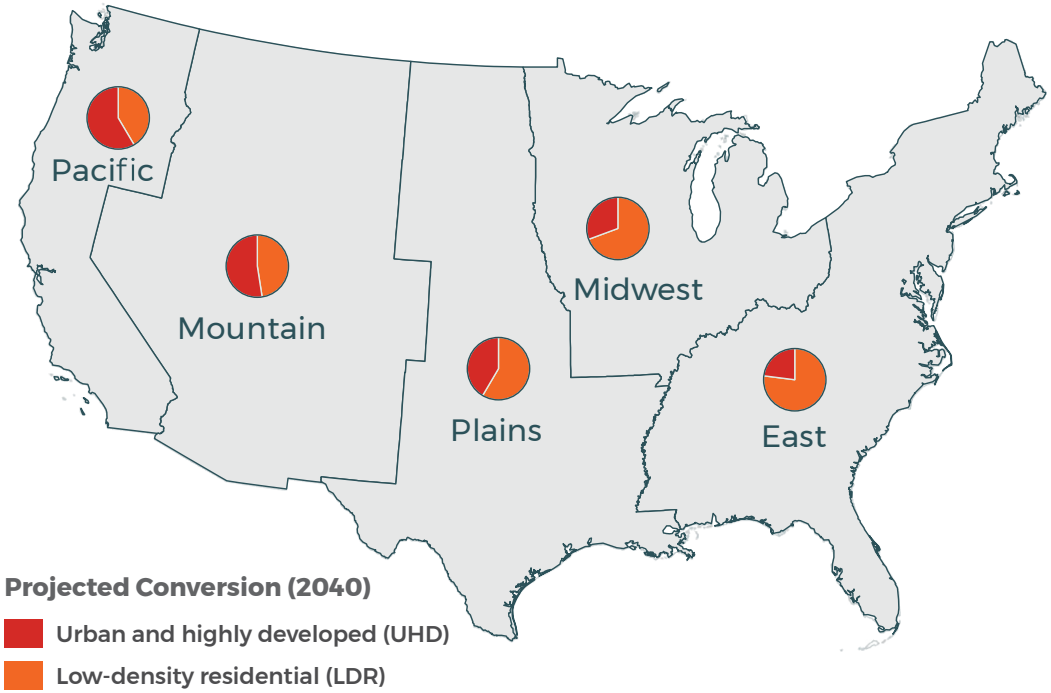


Figure 8. Projected conversion of agricultural lands to urban and highly developed (UHD) and low-density residential (LDR) land uses by 2040 in the *Business as Usual* scenario, proportion by region. Conversion to UHD is more common in the West, while conversion to LDR dominates in the East. To view the breakdown of projected UHD versus LDR conversion for each state and county, see farmland.org/development2040.

Conversion of Nationally Significant Land

While conversion of *any* agricultural land to roads, parking lots, and subdivisions can hurt food security and the environment, the tradeoffs are greatest when Nationally Significant farmland and ranchland is paved over or compromised (Figure 9, page 30). This land—the nation's most productive, versatile, and resilient—can produce the highest yields of crops and livestock with the least environmental impacts.[2] This is the land Americans will rely on to keep growing food even as the warming climate makes it harder to farm and the growing global population puts ever higher demands on agriculture.

NATIONALLY SIGNIFICANT LAND IS OVER 50% more likely TO BE CONVERTED BY 2040 THAN OTHER AGRICULTURAL LAND.

Our modeling shows that, regardless of scenario, nearly half of the projected conversion from 2016 to 2040 will occur on Nationally Significant land, even though only 38% of the nation's farmland and ranchland qualifies for this category. This means that Nationally Significant land is

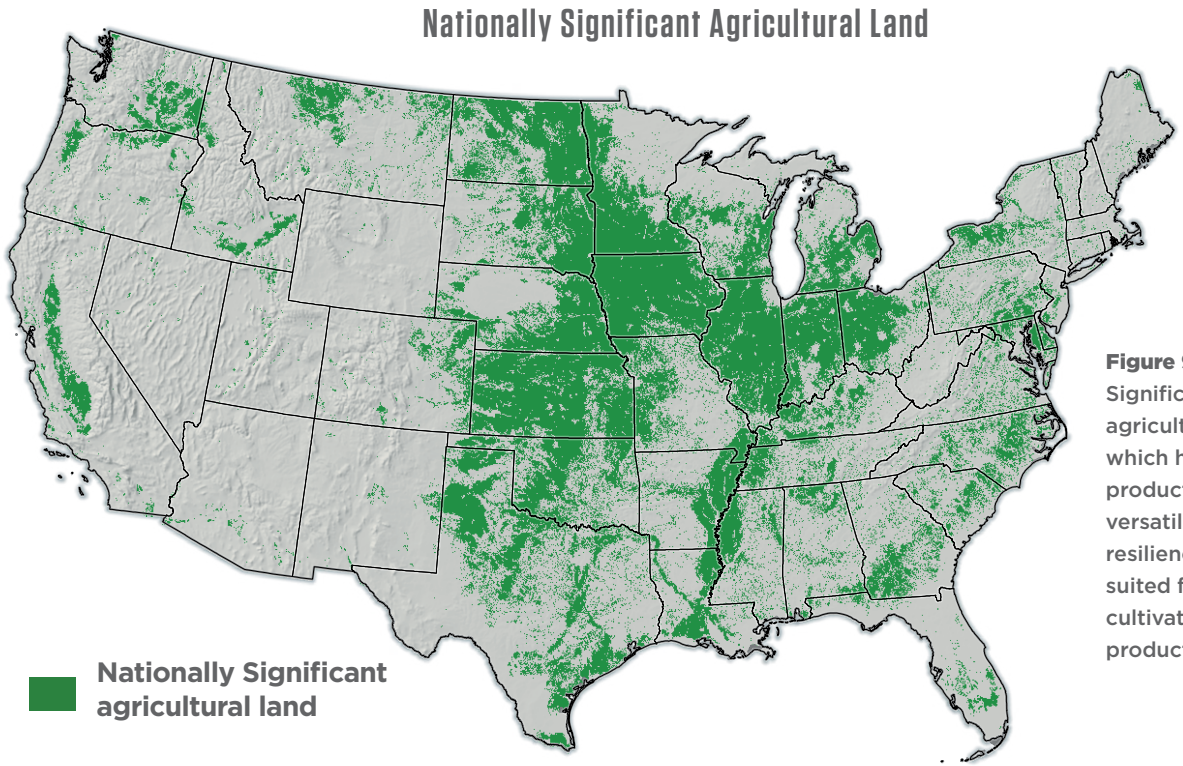


Figure 9. Nationally Significant agricultural land, which has excellent productivity, versatility, and resiliency, is best suited for long-term cultivation and food production.

Table 4. Factor by which Nationally Significant land is more likely to be converted to urban and highly developed (UHD) and low-density residential (LDR) land uses for the top 12 states, as compared to other agricultural land, in the *Business as Usual* projection from 2016 to 2040.

State	Factor
Arizona	8.6
Utah	5.6
Montana	3.2
Idaho	3.0
Nebraska	2.9
Texas	2.4
West Virginia	2.4
Oregon	2.1
New Mexico	2.0
Alabama	1.9
Pennsylvania	1.7
Vermont	1.6
Contiguous U.S.	1.6

57% more likely to be converted by 2040 than the rest of the agricultural land. In some states, where development pressure and high-quality land are concentrated in the same areas, conversion of Nationally Significant land is projected to be even more disproportionate: the best land will be converted over three times faster in Idaho and Montana, over five times faster in Utah, and over eight times faster in Arizona (Table 4). These same broad patterns hold for all three scenarios, but the amount of Nationally Significant land that is converted varies greatly among them.

If recent development trends continue (*Business as Usual*), Americans will pave over, fragment, or compromise 9 million acres of Nationally Significant land by 2040 (Table 5). And in a future with unfettered expansion of large-lot housing (*Runaway Sprawl*), over 12 million acres of Nationally Significant land will be lost or compromised. To put those losses in perspective, the U.S. devotes 10.4 million acres to growing fruit, nuts and vegetables.[159] Either loss would be a devastating blow to our productive capacity, just when the effects of climate change are biting deeper than ever.

But if cities and towns grow more compactly, as in *Better Built Cities*, Americans will convert 42% *less* Nationally Significant farmland than in *Business as Usual*, sparing 3.8 million acres. The conversion of this critical land is highly concentrated, so implementing smart-growth policies in just four states—

Texas, North Carolina, Tennessee, and Ohio—would save over a million acres of Nationally Significant farmland.

Compared to *Runaway Sprawl*, compact development in *Better Built Cities* could help retain nearly 7 million acres of Nationally Significant land. The benefits for agriculture, food security, and the environment would be immense.

The *Better Built Cities* scenario reduces conversion of Nationally Significant land for one simple reason: total conversion is lower. The model did not consider agricultural land quality when selecting areas of projected conversion.

In the real world, local planning bodies implementing smart-growth plans could direct development away from Nationally Significant land, saving even more of this essential resource.

Not every state is endowed with an abundance of Nationally Significant land, but every state still has valuable agricultural resources that are worth protecting. The same metric of agricultural land productivity, versatility, and resiliency that was used to identify Nationally Significant land can be used to identify the best land within each state or county.[120] This metric was developed in conjunction with USDA's Natural Resources Conservation Service and other outside experts for a previous *Farms Under Threat* report. AFT makes this dataset freely available to anyone who would like to use it to help protect high-quality farmland and ranchland (visit farmland.org/farmsunderthreat or email maps@farmland.org).

In the face of the millions of acres that will be lost or compromised on the current development path, every level of government must take proactive steps to promote compact growth, permanently preserve the most productive agricultural land (see **The Next Level**, page 34), and limit impacts to America's best farmland and ranchland.

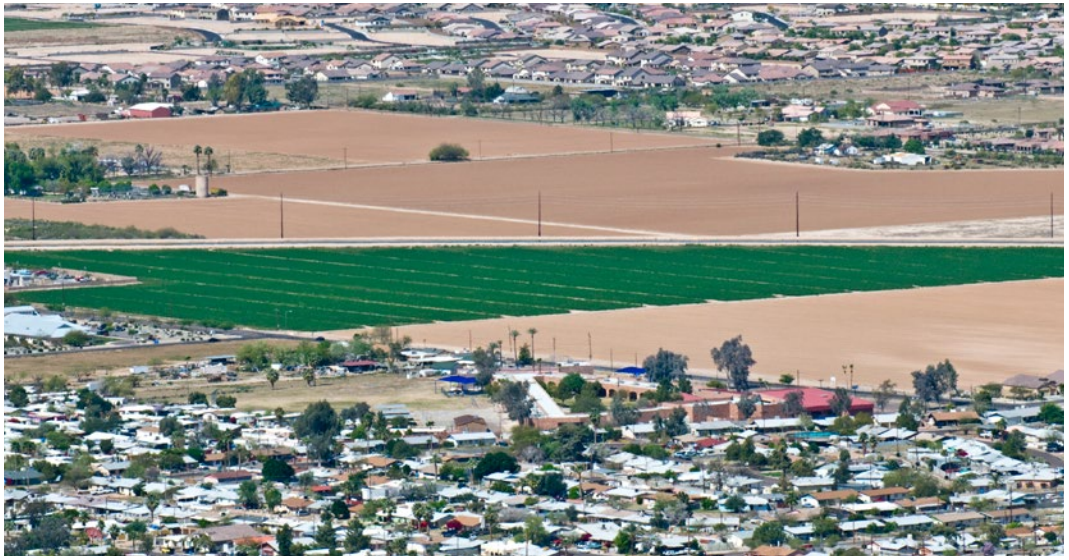
Table 5. States with the most acres of Nationally Significant agricultural land projected to be converted to urban and highly developed (UHD) and low-density residential (LDR) uses between 2016 and 2040. To explore data for every state and county in the contiguous U.S., visit farmland.org/development2040.

State	Business as Usual	Better Built Cities	Runaway Sprawl
Texas	990,900	631,500	1,232,200
North Carolina	737,000	397,700	1,042,500
Tennessee	420,000	244,100	568,000
Ohio	378,200	218,400	504,600
Pennsylvania	355,700	201,900	497,800
Georgia	347,900	209,000	467,700
Wisconsin	342,900	203,700	455,600
Alabama	337,200	188,900	459,000
Indiana	321,800	184,300	429,400
Michigan	304,000	163,400	446,000
Illinois	292,700	191,800	358,400
Mississippi	292,400	151,300	420,500
Contiguous U.S.	9,021,200	5,258,100	12,064,100

Paving the Produce Aisle: Cropland Conversion

Food security takes a direct hit when high-quality cropland is lost forever to urban development. Nationwide, we can expect to lose over 2 million acres of cropland to urban and highly developed land use in the *Business as Usual* and *Runaway Sprawl* scenarios, but the *Better Built Cities* scenario would save half a million of these acres. In all the scenarios, cropland is projected to be paved over most rapidly in California—the state that produces the widest diversity of fresh fruits, vegetables, and nuts (Table 6, page 32). Texas will lose the next highest amount of cropland to urban development, and much of the Corn Belt is also in the top 12 states.

The list of counties that will lose the most acres of cropland to urban and highly developed land uses highlights potentially alarming impacts to food security (Table 7). Maricopa, Fresno, Cass, and Weld Counties are the number one agricultural production counties in their states. Of the seven counties in California that led the nation in agricultural sales in 2017, five are make the list of top thirty counties that will lose the most cropland in the next two decades (Fresno, Tulare, Kern, San Joaquin, and Stanislaus).



PHIL AUGUSTAVO/ISTOCKPHOTO

Table 6. States with the most acres of cropland projected to be converted to urban and highly developed (UHD) land use between 2016 and 2040.

State	Business as Usual & Runaway Sprawl	Better Built Cities
California	180,100	128,000
Texas	140,500	106,900
Illinois	134,800	106,800
Ohio	102,500	76,400
Indiana	98,700	71,900
Wisconsin	94,000	68,200
North Carolina	89,900	71,100
Pennsylvania	79,200	55,500
Iowa	73,800	55,000
Minnesota	72,100	49,700
Tennessee	69,300	51,400
Colorado	52,100	39,500
Contiguous U.S.	2,041,700	1,515,600

Note: projected conversion of cropland to UHD land use does not differ between the *Business as Usual* and *Runaway Sprawl* scenarios.

Table 7. Counties with the most acres of cropland projected to be converted to urban and highly developed (UHD) land use between 2016 and 2040.

County	State	Business as Usual & Runaway Sprawl	Better Built Cities
Maricopa	Arizona	34,600	26,000
Will	Illinois	33,600	25,400
Fresno	California	24,900	14,600
Riverside	California	21,200	14,900
Kern	California	19,900	19,900
Polk	Iowa	19,000	16,400
San Joaquin	California	18,900	17,200
Hidalgo	Texas	16,900	16,100
Hamilton	Indiana	16,600	11,800
Tulare	California	16,000	7,500
Collin	Texas	15,400	11,900
Cass	North Dakota	15,300	11,800

Note: projected conversion of cropland to UHD land use does not differ between the *Business as Usual* and *Runaway Sprawl* scenarios.

The Next Level: Expanding Permanent Farmland Protection

An AFT-protected farm in Michigan

BUILDING MORE COMPACT CITIES helps preserve farmland, open space, and environmental resources. But even with compact growth, in some areas the development pressure is so intense that most or all of the local farmland could be lost in just a few decades. These areas must apply a coordinated suite of farmland protection approaches to save their farmland before it is too late.[121]

To quickly stabilize the land base, states and communities can use land-use planning along with other approaches.[2,122] For example, Oregon's exclusive farm use (EFU) zoning has helped the state retain more than 16 million acres in agriculture. In addition, creating agricultural districts can help states bundle benefits for farmers, save land, and support viability. Top state agricultural district programs have enrolled from 30 to more than 90% of their state's farmland. Investments in farm viability can help farmers diversify their operations, add value to their products, and improve their economic viability, reducing the chance that they will sell to developers. All these steps can help slow down the rate of development on farmland.

To go to the next level and ensure that local farmland will be available in perpetuity, local and state governments can implement Purchase of Agricultural Conservation Easement (PACE) programs. PACE programs pay farmers for the development rights on their land, permanently protecting the land from non-farm development and keeping the land available for agriculture. These programs send a signal to farmers and ranchers that the community wants to partner with them to ensure the future of agriculture. PACE programs take time to implement, but they can reinforce the efforts described above. Large blocks of permanently protected land can act as a sprawl management tool when they are coordinated with other planning efforts such as urban growth boundaries.[121,123] To date, communities and states have permanently protected nearly 7 million acres of farmland, ensuring that there is a supply of local land for agriculture that will never be converted.[124,125,126]

To show the relationship between compact growth and farmland protection, AFT modeled what it would look like to add a substantial increase in permanent farmland protection to the smart-growth approach simulated in the *Better Built Cities* scenario—a thought experiment that can inform future research and practice on the ground.

This intensive modeling was restricted to 10 metropolitan areas (Table 8). AFT selected these ten metro areas based on geographic representation and where AFT is actively working to create or strengthen PACE programs. Most of these regions are formal Metropolitan Statistical Areas as defined by the U.S. Office of Management and Budget. They are made up of contiguous counties that contain both urban and rural areas. The number of counties in the metro areas modeled ranges from one to 29, with most having fewer than 15 counties. Except for Pittsfield, Massachusetts, they do not currently have high concentrations of permanently protected farmland.

The first step of the modeling was to determine how much land to select for permanent protection. AFT chose to model protecting an area equivalent to 10% of the agricultural land in each metro area (Table 8). AFT viewed 10% as a reasonable down payment that would get communities started toward the higher rates of permanent protection achieved by leading counties and states. Fayette County, Kentucky has protected over 25% of its agricultural land and Baltimore County, Maryland has protected 60%.[125] Even entire states have achieved high rates

Table 8. Acres of projected permanent farmland protection, equivalent to 10% of the agricultural land in each metro area.

Metro Area	Acres of Projected Permanent Protection
Boise City-Nampa, ID	209,300
Pittsfield, MA	2,600
Fresno, CA	324,200
Washington-Arlington-Alexandria, DC-VA-MD-WV	86,500
Madison-to-Milwaukee corridor in Southeast Wisconsin	148,600
Austin-Round Rock, TX	89,500
Atlanta-Sandy Springs-Alpharetta, GA	83,400
Buffalo-Cheektowaga, NY	27,500
Chicago-Naperville-Elgin, IL-IN-WI	196,400
Raleigh-Durham-Cary, NC	36,400

of protection: New Jersey has protected roughly one-third of its farmland since 1983 and Delaware has protected roughly 26% since 1991.[126]

The next step was to select individual parcels for permanent protection. Within each metro area, the model chose parcels to protect based on two factors: 1) high agricultural land quality as measured by the *Farms Under Threat* analysis of land productivity, versatility, and resiliency;[2] and 2) proximity to other protected farms that are included in AFT's Protected Agricultural Lands Database (farmland.org/pald). These factors are among the criteria used by many local, state, and federal efforts to permanently protect farmland and were straightforward to model.

The modeled approach reflects a strategy designed to secure a critical mass of high-quality farmland that is less likely to be fragmented or isolated by development in the future. Farmers in urbanizing landscapes face challenges such as traffic congestion and the loss of agricultural infrastructure like large-animal veterinarians, packing houses, and grain elevators.[90,127] For this reason, some easement programs try to protect parcels that are close to other working farms and ranches and agricultural infrastructure.[128] However, this is only one approach to permanent farmland protection; other approaches may be a better fit for local needs.

After identifying these parcels and protecting them from conversion, the

Permanent Farmland Protection Can Reinforce Smart Growth

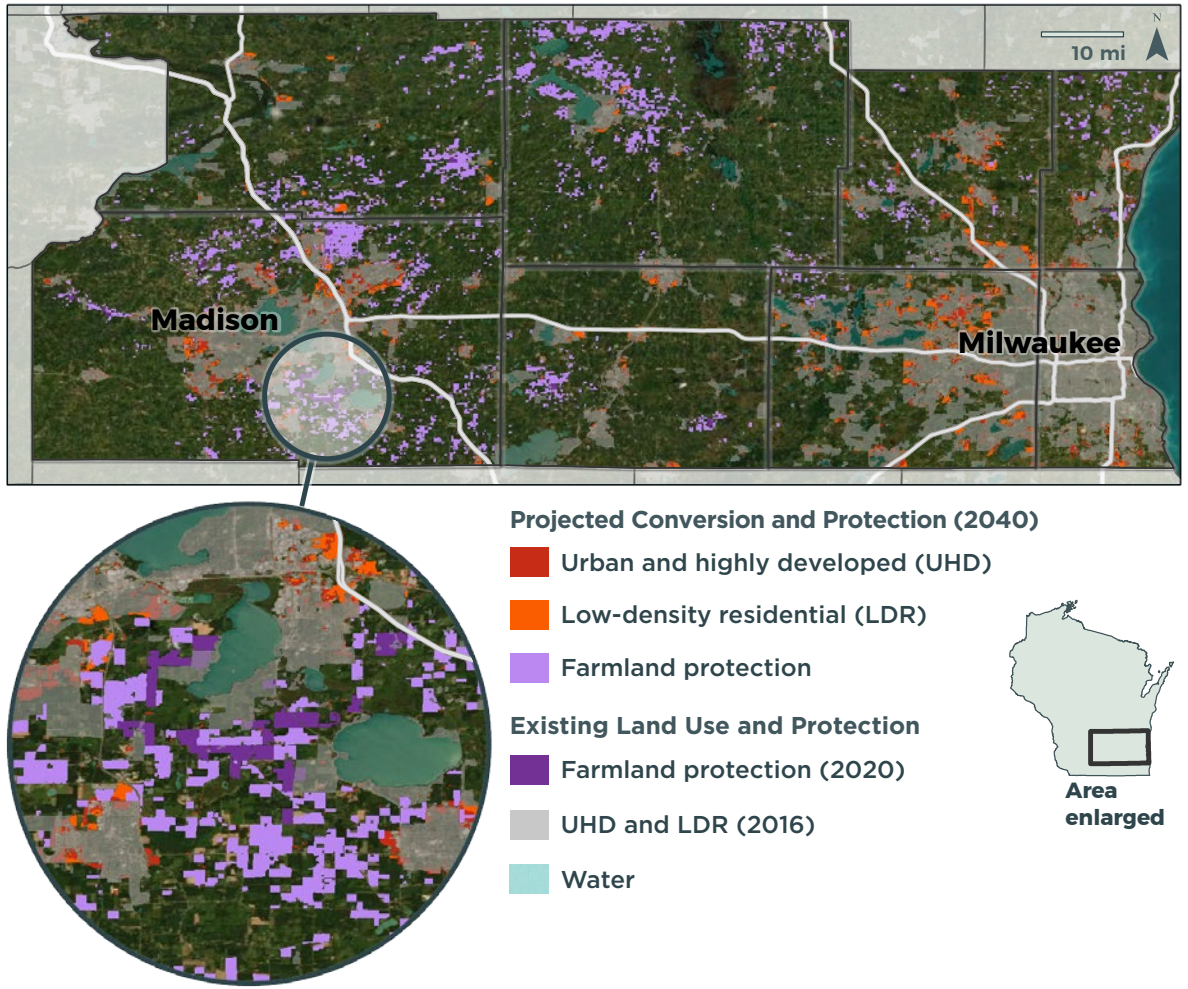


Figure 10. An illustration of how an expansion of permanent farmland protection could reinforce smart-growth policies in the corridor between Madison and Milwaukee, Wisconsin. The magnified area shows new protected parcels clustering around existing protected parcels in the Town of Dunn, helping to protect a critical mass of agricultural land. Existing farmland protection in 2020 is from AFT's Protected Agricultural Lands Database. Projected farmland protection covers an area equivalent to 10% of the farmland in the eight-county area shown. Projected conversion to urban and highly developed (UHD) and low-density residential (LDR) land uses from 2016 to 2040 is based on the *Better Built Cities* scenario, with all protected farmland (existing and projected) ineligible for conversion.

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model then reran the *Better Built Cities* scenario in these metro areas. The amount of new conversion was kept the same; the only difference was that new conversion was not allowed to be projected where the new farmland protection was applied. It was beyond the scope of this analysis to estimate how the rate of new development in each area would be affected by expansion of permanently protected farmland.

The resulting maps of projected farmland protection in these metro areas can be accessed via our website, farmland.org/development2040. Figure 10 (page 35) shows an example for southeast Wisconsin.

These maps paint a picture of what it could look like if these communities take proactive steps to ensure that there will always be a local supply of farmland and ranchland. They show how important it is for communities to get out in front of development by first reducing conversion pressure using land-use planning and other tools, and then permanently protecting priority parcels. The projected areas of permanently protected high-quality farmland might otherwise be lost to development. But instead, these acres can help anchor the local farm economy, keep local agricultural supply stores from leaving, and stop development from surrounding remaining farms. A thriving agricultural community and a sense of permanency is one of the best defenses against encroaching development. This protected farmland will always be there to provide fresh food and agricultural enterprises that can support nearby cities and towns. It can help buffer communities against future climate disruptions. It holds space on the landscape for necessary transitions to regenerative, resilient food systems. And based on past surveys, most easement holders have on-farm conservation plans, so all the while, it will be providing the many other benefits of well-managed farmland.[129]

While achieving the scale of permanent protection that we have simulated—10% of all agricultural land—will be neither easy nor cheap, this strategy may be the most durable way to safeguard the future of local and regional food systems. If rapidly growing metro areas across the country took up the charge and protected 10% of their agricultural land, the nation would exceed AFT's goal to double the amount of permanently protected farmland by 2040 (Figure 7, page 28). However, to be successful in countering intense development pressure, these areas will also need to implement strategies like land-use planning and agricultural districts that can quickly slow down conversion, while their permanent protection programs gain momentum.

Combining permanent farmland protection with more compact growth, as this thought experiment simulates, can help secure a future for agriculture—and humanity—in the face of unrelenting development pressure. The sooner communities get started, the better. Permanently protecting 10% of a community's best farmland is just a starting point; much more is needed to ensure that this fundamentally important resource is available for future generations.

Farmland and Energy: A Smart Solar Test Case

HEIDI KOLBECK-URLACHER/AGRISOLAR CLEARINGHOUSE

U.S. ENERGY CONSUMPTION is expected to increase in the coming decades as the population grows.[130] Poorly planned energy development can convert or compromise farmland. If the U.S. follows a path dominated by fossil fuel energy, there could be an additional 37 million acres of coal, oil, and gas development by 2040.[41] However, to combat climate change—and minimize future challenges farmers and ranchers will face from droughts, floods, extreme heat, and beyond—America must transition quickly to renewable energy.

While the rapid expansion of solar and wind energy is just starting, it has the potential to reshape rural landscapes. Some see a conflict between growing food and producing renewable energy. But America needs *both*—clean energy *and* productive, resilient, and viable farms and ranches. Here, we examine "smart solar" on farmland as a test case for how we can achieve both goals.

Estimates of the amount of land needed for solar photovoltaics installations vary widely. Without further policy intervention, 2.9 million acres of utility-scale solar are expected to be built between 2020 and 2040 (*Mid-Case Scenario* in ref. [131]). However, the Biden administration has called for eliminating all fossil fuels from the electricity sector.[132] Estimates of the amount of utility-scale solar needed to achieve this goal by 2040 range from 5.3 to 7.4 million acres (*E+ High Electrification Scenario* in ref. [133]*; Decarbonization with Electrification Scenario* in ref. [134]).

Additional low-carbon energy would also be needed from sources including wind turbines, hydroelectric dams, and nuclear power plants, further increasing land impacts. To fully electrify transportation, heating, and other energy needs, even more of all these energy sources would be needed.

According to a projection from the U.S. Department of Energy, solar energy will be widely distributed across the country (Figures 11 and 12). By 2040, four states could have over 500,000 acres of solar, and Texas could have over 1 million acres. Many Eastern states are projected to build enough solar to take up 1.5-6% of their farmland, forestland, and other undeveloped land, with the majority expected on farmland. These are statewide totals—the concentrations in communities with good siting and transmission opportunities will be substantially higher. For instance, proposed solar projects would cover 35% of the active farmland in one New York county, a total of 4,000 acres.[135]

Without good planning and effective permitting processes, the impact of solar development on U.S. agricultural lands could be significant. In preliminary modeling of solar placement in the U.S., AFT projected that more than 80% of new solar built by 2040 will be sited on agricultural lands.[136] Likewise, a recent study in New York State found that farmland accounted for 84% of the land most suitable for utility-scale solar, even if prime and statewide important soils were avoided.[137]

Solar developers favor the attributes of high-quality farmland since it is more likely to be flat, dry, cleared, and close to existing infrastructure.[138] AFT's modeling found that if standard siting practices mirror historical patterns, 49% of new solar installations on agricultural land could go on Nationally Significant land, the nation's best land for long-term production.[136]

AFT works to advance "smart solar" approaches to enable the transition to renewable energy while protecting our nation's farmland (farmland.org/solar). Smart solar minimizes impacts on agricultural land and makes any solar built on farmland more beneficial for farmers and for agriculture. AFT has developed the following smart solar principles:

- Maximize solar siting on disturbed, contaminated, and marginal lands and on rooftops.
- Minimize conversion of our best agricultural lands to conventional ground-mounted solar.
- Protect or enhance soil health for solar projects on agricultural land.
- Maximize agrivoltaics, otherwise known as dual-use solar, on lands well-suited for agriculture.
- Ensure that solar built on agricultural lands prioritizes farmer interests.
- Promote an equitable, ethical, and inclusive process for solar development.

Agricultural dual-use solar (agrivoltaics) shows substantial promise as an

alternative to conventional ground-mounted solar. In dual-use systems, agricultural production occurs under or around the solar installation itself.[131] Sheep grazing is a common example, but novel systems are being developed for vegetable production, vineyards, and small grains. Encouraging research shows that shading from the panels can help conserve water and increase crop yields in some production systems, especially in hot, dry climates.[139]

While AFT is working to expand dual-use, most new solar installations will be conventional for the foreseeable future. Therefore, it is critical to better understand the potential impact of solar energy development on farmland, agriculture, and rural communities. We need further research investigating the site-specific impacts of different scales of new solar development, including on soil health and farm viability. More research is also needed to define best practices for construction and decommissioning so all solar installations preserve the land's suitability for farming in the future, should panel removal occur.

Done right, renewable energy can provide reliable income streams for farmers while helping fight climate change. To help states and communities plan and develop policies to drive smart solar, AFT collaborated with Vermont Law School's Farm and Energy Initiative to compile a farmland solar policy design toolkit.[140] AFT's Farmland Information Center provides additional information on smart solar and dual-use opportunities at farmlandinfo.org/solar-siting.

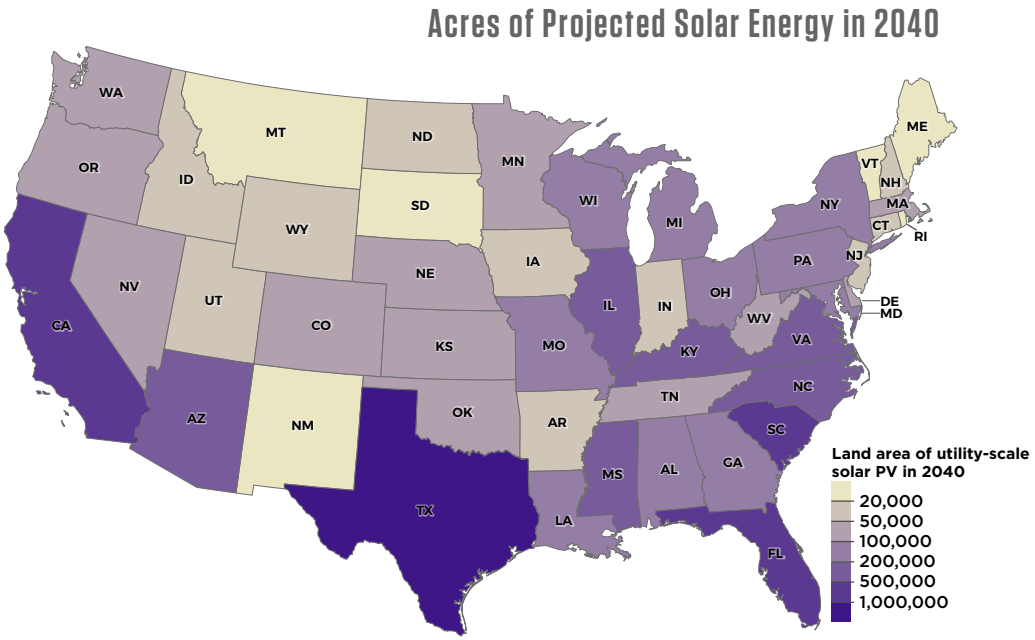

Figure 11. Projected acres of utility-scale solar photovoltaics (PV) energy generation facilities by state in 2040 in the *Decarbonization with Electrification* scenario of the Department of Energy's Solar Futures Study.[134]

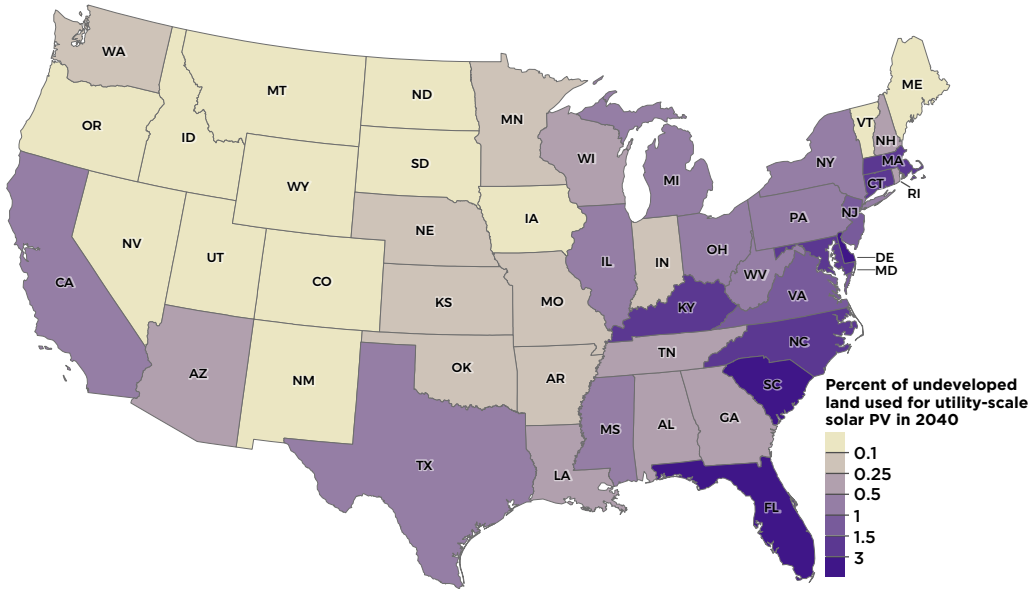

Figure 12. Projected percentage of undeveloped land remaining in 2016 that will be required for utility-scale solar photovoltaics (PV) energy generation facilities by state in 2040 in the *Decarbonization with Electrification* scenario of the Department of Energy's Solar Futures Study.[134] Undeveloped land includes all land area except the urban and highly developed, low-density residential, and transportation categories of the *Farms Under Threat* geospatial dataset.

LANCE CHEUNG/USDA

Rising Seas, Inland Migration: A Threat Across All Scenarios

The warming climate will affect agricultural land in countless ways. Perhaps the most direct is by causing the seas to rise, thereby flooding farmland and ranchland along the coasts. Our models predict that, on our current climate trajectory, a total of nearly 450,000 acres of farmland will be affected by coastal flooding by 2040 (Table 9). California and Louisiana stand to lose 298,000 and 73,000 acres of agricultural land, respectively, to sea-level rise. Salinization of soils and groundwater will jeopardize many more acres, even before the land is inundated.[49] Saltwater intrusion has already sparked a statewide planning response in Maryland.[141]

Sea-level rise will also spur in-migration from the coasts, increasing pressure on nearby lands. Nationwide, 442,000 acres of existing urban and highly developed and low-density residential areas are projected to be flooded by 2040. While not everyone will choose to move their home or business out of a potentially flooded area—thanks to dikes, levies, and the common human reluctance to leave the land people have known and lived on—many will have no choice. Since 61% of new conversion from 2016-2040 is projected to occur on agricultural land, relocating 442,000 acres of built-up areas could cause the conversion of nearly 270,000 additional acres of farmland and ranchland by 2040 (see **Appendix 1: Detailed Methods**).

This threat will be concentrated in coastal regions since people tend to move to adjacent counties when natural disasters force them to leave their homes.[142,143] Table 10 shows the top 12 states where sea-level rise is likely to cause additional conversion of agricultural land when developed areas are inundated and people are forced to move elsewhere.

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While coastal flooding will advance regardless of our development choices, following a path of sprawling development will put more homes at risk of inundation. This portends greater cost, environmental damage, and loss of human life as storm surges reach homes and residents choose to fight mother nature. In addition to the 442,000 acres of *existing* development projected to be flooded, sea-level rise will also flood *new* UHD and LDR areas that expand between 2016 and 2040. This area will total 104,600 acres in *Business as Usual*, 146,800 acres in *Runaway Sprawl*, and 54,100 acres in *Better Built Cities*. Choosing compact development patterns today could greatly reduce the number of newly built houses and businesses that are subject to flooding by 2040, saving money and heartache.

Table 9. States with the most acres of agricultural land projected to be flooded by sea-level rise by 2040.

State	Acres Projected to Be Flooded by Sea-Level Rise
California	298,500
Louisiana	73,000
Washington	39,300
North Carolina	17,400
Oregon	4,400
Texas	4,000
Maryland	3,600
Virginia	1,600
Delaware	1,600
New Jersey	1,500
Florida	1,300
South Carolina	800
Contiguous U.S.	449,000

Table 10. States with the most acres of agricultural land that might be at risk due to sea-level rise displacing existing development.

State	Acres at Risk
Louisiana	75,000
Florida	32,600
California	32,300
North Carolina	14,300
Washington	10,900
South Carolina	9,800
Virginia	8,500
New Jersey	8,200
New York	7,700
Texas	5,700
Maryland	5,700
Oregon	4,600
Contiguous U.S.	267,400

Which Future Will We Choose?

PRESTON KERES/USDA

We, as a society, have an important choice to make. Are we going to sit back and watch farmland and ranchland disappear, eroding our food security, rural communities, and environment? Or will we join together now in a nationwide effort to secure an abundant future?

Without proactive policymaking and land-use planning, the relentless march of *Business as Usual* development across the American landscape will continue, converting over 18 million acres of farmland and ranchland between 2016 and 2040. If *Runaway Sprawl* accelerates, it could push the toll above 24 million acres—1 million acres every year.

The consequences will be local, global, and even atmospheric. Consumers will have fewer local farms to turn to the next time a pandemic or supply chain disruption leaves grocery store shelves bare. The global food supply will be further pinched, compounding crop losses due to climate change and putting millions more people at risk of severe hunger across the globe. And low-density sprawl will drive up greenhouse gas emissions, while undermining opportunities to sequester soil carbon on farms and ranches.

However, if policymakers and land-use planners band together with farmers, ranchers, and concerned citizens to choose *Better Built Cities*, conversion can be cut by up to 13.5 million acres. This means following smart-growth principles and prioritizing farmland and ranchland in land-use policies. It will also require supporting the farmers, ranchers, and farmworkers who bring in the bounty and keep pantries full, including by helping the next generation access land.

If Americans choose abundance—if we embrace smart growth and minimize sprawl, secure our most productive land in perpetuity, implement smart solar, and usher in a new generation of farmers and ranchers—we will feel the benefits beyond our dinner tables.

Every American can help. Developers can choose to revitalize urban spaces and build compact communities. Citizens can attend county board meetings and promote land-use decisions that protect farmland and ranchland. Individuals can also make a difference by supporting local land trusts, buying locally produced food, and choosing to live in compact cities and town centers. If you own farmland or ranchland, you can protect it with an easement so that your land becomes a legacy that feeds future generations.

But ultimately, policymakers and land-use planners are the key to achieving a *Better Built Cities* future from coast to coast.

KEVIN KEENAN

Policy Recommendations

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Reaching this goal will require rapid, widespread, and sustained efforts to improve policy and land-use planning at all levels of government. This will be a major undertaking, but Americans have come together in the past to forge a new approach to development and safeguard agricultural land.

Since the 1950s, state and local governments have been refining innovative policies and approaches that slow down conversion and keep land in agriculture. Every state has now taken steps to protect their agricultural resources.[2] In 1974, there were no permanently protected farmland acres—today there are 6.9 million acres protected and counting.[124,125,126] Congress has been working since 1981 to avoid unnecessary conversion of agricultural land by federal agencies and to support voluntary efforts to permanently protect critical farmland and ranchland.

America must now build on these successes to counter the concurrent threats facing our irreplaceable agricultural resources. We offer the following policy recommendations to help our nation secure an abundant future:

1. ***Embrace smart growth.*** Guided by a set of ten principles developed by the Smart Growth Network, smart-growth approaches like compact development and preservation of open spaces can protect farmland from conversion, reduce greenhouse gas emissions, maintain wildlife habitat, and reduce the costs of community services. While largely implemented at the local level, state and federal policy is instrumental to supporting and incentivizing smart growth.
2. ***Protect agricultural land.*** Agricultural conservation easements protect farm and ranch land in perpetuity, ensuring availability of land for future food production while enabling land access for the next generation, improving the environment, maintaining rural economies, and much more. Because of this, AFT's goal is to double the amount of acres under permanent protection by 2040 (Figure 7, page 28), which will require concerted protection efforts at all levels of government. While easements are an indispensable tool, other policy mechanisms for protecting critical acres are also described in this section.
3. ***Advance smart solar.*** The buildout of renewable energy, particularly solar, is critical to addressing climate change. However, recent studies project that the vast majority of solar development is expected to take place in rural areas.[134] The research investments and policy decisions we make today will determine how solar development impacts future agricultural land use, availability, and productivity. Smart solar approaches that account for agricultural resources will be key to balancing these critical goals.
4. ***Support farmland access.*** Because more than 40% of our nation's agricultural land is owned by seniors aged 65 and above, we expect over 370 million acres to change hands within the next two decades.[144] Public policy can help ensure that this massive transition keeps land in agriculture and creates land access opportunities for a new generation of farmers, particularly historically marginalized producers. Such policies are more important than ever as land prices soar in the face of increasing competition between investors, corporations, established producers, and developers.

Local Policy Actions

Most development decisions are made at the municipal and county levels, giving local governments the power to determine what their communities will look like in the future. Unfortunately, many communities face barriers such as lack of technical expertise and financial resources that make it challenging to create and implement comprehensive development plans shaped by broad stakeholder input that encourage compact development and protect farmland.

SMART GROWTH

- ***Engage in comprehensive planning processes and adopt land-use regulations that embody smart-growth principles.*** Every state has legislation enabling local planning, and most states either encourage or

ERIC VANCE/US EPA

require planning at the municipal or county level. Communities should create comprehensive plans that lay out their vision for local land use, including transportation, housing, economic development, clean energy goals, and protection of resources like agriculture. Communities should also embrace zoning approaches that encourage compact development and affordable housing options in urban centers. Such plans and regulations should be developed with broad stakeholder input to ensure they reflect the needs of all community members.

- ***Plan for agriculture***. Communities of all sizes—from rural towns to large cities—should proactively plan *for* agriculture to foster resilient food systems, support agricultural viability, and protect agricultural resources for food production and ecosystem services. Planning should reflect the important roles that local farms and ranches can play in economic development, resource protection, climate resiliency, emergency preparedness, and food security. In addition, the needs and concerns of producers should be reflected in decisions regarding housing, transportation, taxes, building and health codes, and zoning.

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FARMLAND PROTECTION

- ***Identify priority agricultural resources.*** Communities should understand the quality, quantity, and current use of their farmland to inform efforts to protect these critical resources. Sources of data may include local tax maps, records, and other geospatial information that is typically available through government agencies, planning entities, and land trusts. Information about soil resources is especially useful and may be obtained from USDA NRCS online. AFT's *Farms Under Threat* maps showing the productivity, versatility, and resiliency (PVR) values of agricultural lands are another useful tool.
- ***Protect agricultural land identified as a priority by the community.*** There are many different types of tools, depending on state law, that communities can use to protect agricultural land, either on a permanent basis or on a shorter time horizon. These include: local Purchase of Agricultural Conservation Easement (PACE) programs, transfer of development rights programs, agricultural districts, property tax relief, mitigation ordinances, and urban growth boundaries. Many of these can be used in combination to maximize impact.

SMART SOLAR

- ***Incorporate smart solar siting into local land-use decisions.*** Renewable energy permitting should be incorporated into local land-use plans and laws with the goals of


EMILY COLE

strengthening the local agricultural economy and keeping high-quality farmland in farming. This can include 1) prioritizing and/or incentivizing (e.g., accelerated permitting) solar on the built environment (e.g., carports, warehouses), brownfields, and marginal farmland; 2) ensuring that projects on prime farmland are dual-use; and 3) considering the impact of solar development on farm viability, and minimizing displacement of farmer-renters.

- ***Develop solar land-use laws and permitting through inclusive processes.*** Permitting costs, project delays, and community opposition are major barriers to renewable energy development. Some of these challenges can be alleviated by engaging in proactive and inclusive planning processes with stakeholders to identify "least-conflict" areas for solar prioritization. Such efforts should consider the agricultural economy and the quality of agricultural land. These processes help developers know where solar projects are least likely

to cause tension with the community, thereby preventing potentially lengthy and contentious permitting processes.

- ***Ensure best practices are followed when siting solar on farmland***. Local governments can require that solar installations follow best practices for construction, operation, and decommissioning to preserve soil health, water resources, and the ability to farm the land during and after the life of the project.

FARMLAND ACCESS

- ***Make public land available for agriculture***. Many local governments own land suitable for agricultural production. Where feasible, local governments should consider making this land available for lease, prioritizing new or historically marginalized producers. Lease terms of at least five years could provide the stable land tenure these renters need to establish successful operations and invest in practices that improve soil health.
- ***Help match farm seekers with agricultural landowners.*** Connecting farmland seekers and agricultural landowners (whether farmers or non-operating landowners) looking to pass on their land is an important first step toward land access opportunities, especially for first generation farmers. Local governments can foster these connections, whether through direct engagement with landowners or by partnering with and supporting agricultural service providers, community land trusts, and others that do this type of work.

State Policy Actions

State-level policies can shape development and prevent the loss of agricultural lands. AFT's *Farms Under Threat: The State of the States* provides an in-depth look at policies states can enact to reduce farmland loss.[2] Through the Agricultural Land Protection Scorecard, AFT ranked how all 50 states have—or have not—responded to the leading threats to agricultural land.

SMART GROWTH

- ***Adopt smart-growth principles within every state agency.*** Every state agency can play a role in advancing smart growth through their programs and investments by prioritizing those that promote infill, compact development, farmland protection, and renewable energy in the built environment and on marginal lands.
- ***Encourage and support local alignment with state smart-growth goals.*** As AFT's Agricultural Land Protection Scorecard indicates, most states should do more to align local planning and development decisions with state smart-growth goals. While local governments are charged with planning for their communities, many need financial and technical assistance to enable them to align their local plans and land-use regulations with statewide goals and standards around smart growth. A 2021 Brookings Institution report provides examples of how states have provided such support or incentivized local alignment.[145]
- ***Plan for agriculture across state agencies.*** As with local government, agriculture is not always top of mind in state planning processes, nor is cross-agency collaboration often encouraged. Yet agriculture touches and is impacted by many state programs as well as regulations and should be expressly considered and addressed in state plans related to: 1) climate resiliency, adaptation, and mitigation; 2) disaster planning and emergency preparedness; 3) economic development; 4) environmental justice and equity; 5) food security; 6) housing; 7) infrastructure; 8) water resources, and 9) energy development.

ISTOCKPHOTO

FARMLAND PROTECTION

- ***Identify priority agricultural resources.*** Many states have mapped the quantity and quality of their agricultural land. An important next step is to identify land that is considered a priority for permanent protection based on its productivity, access to markets, proximity to other protected land, or ecosystem benefits and values,


ANTHONY AQUINO

and to adopt a statewide goal around permanent farmland protection. This identification and goal-setting process could be part of a formal state farmland plan, which might also identify important state-owned agricultural resources and set goals for expanding land access opportunities for new and historically marginalized producers in both rural and urban communities.

- ***Permanently protect more agricultural land.*** All states should do more to accelerate their farmland protection efforts. Just thirty-one states have enacted state Purchase of Agricultural Conservation Easement (PACE) programs. States without such programs should consider establishing one. States with PACE programs that lack a dedicated funding source should consider creating one to provide continuous program funding and greater program stability. If not yet allowed, states should also enable local governments to assess taxes that can be used to fund local PACE programs.

- ***Require mitigation for conversion of priority agricultural resources.*** California, Massachusetts, and Vermont all have statewide farmland conversion mitigation programs or policies that can serve as models for the rest of the nation.[146,147] These programs and policies generally require impact fees when certain agricultural land is converted to non-agricultural development. The fees are then used to permanently protect other agricultural land.

- ***Incentivize keeping land in agricultural production.*** Every state has some form of property tax relief program for agriculture, recognizing that such land has a smaller impact on municipal coffers than residential development. Most states could do more, though, to incentivize keeping land in active agricultural use. This can be achieved through the use of agricultural districts, which support landowners with additional tax or zoning incentives in exchange for a commitment to keep their land in agricultural use for a period of years, or by linking other forms of agricultural support with keeping land in active agricultural use. For instance, Massachusetts' Farm Viability Enhancement Program offers farmers grants to implement business plans in exchange for an agreement to not develop their farmland for ten to fifteen years, depending on the grant size.

- ***Pass the Uniform Partition of Heirs' Property Act (UPHPA).*** Heirs' property occurs when land or property is inherited without a will, causing it to be co-owned by sometimes dozens or more family members spanning multiple generations. Heirs' property occurs most often for economically disadvantaged and historically marginalized individuals, especially in the Southeast. This lack of clear ownership can result in property being sold at auction at below market value without the consent of the landowners. The UPHPA helps to keep property in the family by making auction sale the last resort and, in the event an auction, it helps families receive a fair price. Currently, the UPHPA has been passed in twenty states, and introduced in an additional nine.

SMART SOLAR

- ***Incentivize solar development on the built environment, previously disturbed, and marginal agricultural land.*** States can incentivize solar development on certain types of land to limit pressure on productive agricultural land. Tools can include financial incentives, accelerated permitting processes, and more. States should also ensure new transmission is not planned for areas with high concentrations of quality farmland. For example, the Massachusetts SMART solar program provides price adders and subtractors for solar projects that impact the return on investment for developers depending on the type of land proposed for conversion. New York State acts to facilitate solar development on previously disturbed lands through the Build Ready program.

- ***Require mitigation for solar development that displaces farming from productive agricultural land.*** States should consider implementing a mitigation fee or other measures to minimize projects sited on highly

productive farmland that displace farming. These proceeds can be used to fund permanent farmland protection projects in the affected community as well as local agricultural economic development or soil health initiatives.

- ***Provide guidance and resources to communities for smart solar.*** State agencies should equip local governments with the resources they need to achieve smart solar on farmland, including: 1) Maps of critical resources (e.g., soil quality) and more marginal areas for potential solar development; 2) Information on best management practices for construction and decommissioning that retain soil quality; 3) Model solar land-use laws that protect important farmland resources; and 4) Funding for least-conflict and other inclusive community engagement processes.
- ***Fund research on dual-use solar (agrivoltaics).*** Dual-use could present an opportunity to expand solar development while also maintaining active agricultural production. Some states are funding research to identify the types and scales of cropping and livestock systems that are possible and profitable within a dual-use system. Some are also analyzing the impacts of dual-use solar on farm yields, regional economies, and next-generation farmers. More research should be funded to maximize the potential benefits of this practice.
- ***Pending proof of concept, define and incentivize dual-use solar.*** With proof of concept and strong definitions made through inclusive stakeholder processes led by agricultural agencies, states should financially support additional innovative dual-use projects that may require more complex design (e.g., crops, dairy). This could be done by sustaining agricultural preferential tax assessment for dual-use solar and/or through payments. For instance, the Massachusetts SMART solar program provides adders that serve as incentives for developers to do dual-use solar projects that meet program requirements. These incentives should be structured so they do not increase costs for ratepayers, and so that payments discontinue if the project ceases to be dual-use.

FARMLAND ACCESS

- ***Support FarmLink programs and invest in farm succession and transfer planning.*** FarmLink programs can be as simple as online listings of farmland for sale along with listings of individuals seeking to buy or lease land. While such programs are helpful, the most effective FarmLink programs provide one on one technical assistance and support for farm transfer and succession planning and/or land access. States can administer their own programs or provide financial support to organizations experienced in these areas.
- ***Create transition incentives and address farmland affordability.*** Escalating farmland values have made access to land even more challenging, especially for new and historically marginalized producers. States can play a more active role in helping these producers gain access to farmland. Several states have adopted beginning farmer and rancher tax credits, while others are helping with land acquisition financing.[148,149] States can also do more to address affordability through their PACE programs by incorporating affirmative covenants to farm and affordability mechanisms such as Options to Purchase at Agricultural Value or Preemptive Purchase Rights.
- ***Make state-owned land available for leasing.*** As with local governments, state-owned agricultural land represents an important resource that can help provide new and historically marginalized farmers with access to land. Longer lease terms are important in allowing and incentivizing producers to improve soil health and implement climate-smart agricultural practices which can increase productivity.

Federal Policy Actions

While many development decisions are made at the local level, the federal government can play a key role in preventing conversion of agricultural land, conducting supporting research, and providing additional resources to local and state governments.

CVANDYKE/DREAMSTIME

SMART GROWTH

- ***Provide additional support for smart-growth planning and implementation grants.*** The federal government should increase funding for federal programs that support communities in developing smart-growth plans, and should work to expand partnerships with smart-growth organizations to ensure all communities have access to technical assistance. Agriculture should be included as part of this planning, and additional efforts should be made to ensure that federal agencies—including USDA Rural Development—are collaborating, or at least not working at cross-purposes, in achieving smart-growth goals.

CRAIG LOVELL/EAGLE VISIONS/ALAMY

- ***Couple broadband funding with support for community planning.*** Broadband is essential to participation in modern life, but it could serve as an accelerant for farmland conversion, especially as more people are able to move away from cities due to remote work opportunities. To balance the need for this critical infrastructure while addressing this threat, broadband funding should be complemented with smart-growth planning and implementation funding.

- ***Encourage Rehabilitation and Conversion of Commercial Spaces.*** Tax incentives should be provided to encourage the conversion of existing commercial space to residential space as a means of revitalizing downtowns and other areas. Legislation, such as the REHAB Act, the Revitalizing Downtowns Act, the Revitalizing Small and Local Businesses Act, and the Historic Tax Credit Growth and Opportunity Act have been proposed to address these types of opportunities. Furthermore, barriers that prevent USDA Rural Development from maximizing infill opportunities should be examined and removed.

FARMLAND PROTECTION

- ***Increase funding for USDA's Agricultural Conservation Easement Program (ACEP) and improve its function.*** ACEP's Agricultural Land Easements (ALE) component is the sole federal program providing matching funds to land trusts and state programs to purchase agricultural conservation easements. Demand for the program far outpaces its available funding. In the next Farm Bill, Congress should significantly increase ACEP funding.

- ***Strengthen the Farmland Protection Policy Act (FPPA).*** The FPPA was created to prevent the unnecessary conversion of farmland from federally funded projects, yet these projects still significantly contribute to farmland loss. The Administration could require that federal agencies track "actual," rather than just "proposed," farmland conversion. Congress should strengthen the FPPA by adding mitigation requirements for conversion of farmland by federally funded projects and requiring that agencies not fund projects that convert prime, Nationally Significant, or permanently protected farmland unless there is no feasible alternative. Additional FPPA recommendations from AFT can be found on our website, farmland.org.

- ***Increase funding for the Heirs' Property Relending Program (HPRP).*** Created in the 2018 Farm Bill, HPRP offers low-interest loans through intermediary lenders to enable Heirs' Property owners to resolve title issues. Increasing funding for this program can help additional producers protect their land from auction sales and improve access to federal programs and financing opportunities. In the next Farm Bill, consideration should be given to converting this program into a grants program, as many Heirs' Property owners may not be in a position to take on debt to address these challenges.

SMART SOLAR

- ***Incentivize solar development on existing structures, brownfields, and marginal lands.*** Providing incentivizes, such as streamlined permitting and approvals, for solar development on existing structures, brownfields, marginal farmland, etc., could reduce development pressure on our best agricultural lands. These incentives should be structured in ways that do not

increase rates for energy consumers, but also offer opportunities to reduce costs for renewable energy developers.

- ***Research best practices for developing solar on agricultural lands, including dual-use.*** Through additional research, the federal government can help develop regional guidelines and standards for locating, constructing, and decommissioning solar projects in ways that support continued agricultural viability. More research is needed to advance models for dual-use (agrivoltaics) in various cropping systems and climates by better understanding the economic implications and scalability of dual-use for producers, developers, communities, and ratepayers.
- ***Equip local, state, and regional leaders with smart solar resources.*** The federal government is uniquely positioned to provide maps of critical resources (e.g., soil quality, water availability) to help identify siting opportunities on marginal land and areas near existing infrastructure ideally suited for potential solar development. It can also help disseminate models and provide funding for least-conflict and other community engagement processes, as well as resources on land-use planning that strengthens farm economies in tandem with solar development.
- ***Expand interagency cooperation.*** The Department of Energy and USDA should engage in additional collaboration on solar and agricultural issues. One option is reestablishing a formal MOU between the departments. Such a partnership would include collaboration on solar siting, transmission siting, research on dual-use, and creation of best management practices for solar on agricultural lands.

FARMLAND ACCESS

- ***Create tax incentives for lifetime farm transfers.*** Treating the sale of farmland, often held over a long period of time, as a capital gain discourages producers from transferring land during their lifetimes, making the land more vulnerable to conversion if the heirs are not interested in farming. An exclusion from capital gains for the sale of land to young, beginning, historically marginalized, and veteran producers could help incentivize the transfer of land to a new generation.
- ***Improve Buy-Protect-Sell in ACEP-ALE.*** Buy-protect-sell is a transaction where a land trust or state PACE program purchases land, places it under easement, then sells it to a new farmer. This is a powerful tool for increasing land access for new producers, especially historically marginalized producers. While the 2018 Farm Bill enabled these transactions through ACEP-ALE, the current language and rules impose significant barriers to its use by requiring that eligible land be under "imminent threat", placing stipulations on the sale price, and other factors.
- ***Provide additional support for business technical assistance that includes farm transfer***. As part of a broader business technical assistance program or initiative, support should be offered to help retiring farmers develop transition plans as well as to help aspiring farmers identify land, access capital, develop business and marketing plans, and meet other important needs.
- ***Allow producers to reduce Farm Service Agency debt in exchange for keeping land in agricultural use.*** A Debt for Working Lands program would enable producers with FSA loans to reduce and restructure debt in exchange for a permanent agricultural conservation easement or a shorter-term non-development covenant.[150] This could also be offered at the time of a new FSA loan, thereby making land more affordable for new and historically marginalized producers.

PRESTON KERES/USDA/FPAC

PRESTON KERES/USDA/FPAC

Appendices

Appendix 1. Detailed Methods

THE METHODS USED for this analysis were developed in partnership with Conservation Science Partners (CSP) and the Center for Sustainability and the Global Environment at the University of Wisconsin-Madison (UW-Madison), in consultation with national experts from academia, the Natural Resources Conservation Service, and the farmland protection community.

This work builds on our mapping of historical conversion of agricultural lands to urban and highly developed (UHD) and low-density residential (LDR) land uses between 2001 and 2016, which was developed for our previous report, *Farms Under Threat: The State of the States*.[11] In this report, we project the expansion of UHD and LDR land uses from 2016 to 2040 at a 30-meter spatial resolution. To illustrate the tradeoffs among different approaches to development, we devised three scenarios: an extension of 2001-2016 trends, accelerated sprawl, and compact development. A separate model was used to project sea-level rise. The technical methods are fully documented in the accompanying technical reports.[151,152]

We present more details on these methods below, as well as additional calculations used to 1) estimate housing unit density in UHD and LDR areas; 2) estimate impacts of agricultural land conversion on economic indicators; and 3) evaluate the relationship between conversion rates and farm size.

Scenarios

The baseline scenario, *Business as Usual,* simply extends historical development rates and patterns. While the name *"Business as Usual"* may sound benign, the status quo in America is unsustainable growth patterns and alarming rates of farmland conversion.[153,154,155,2]

Runaway Sprawl simulates what might happen if accelerated flight to the rural-urban fringe produces even more dispersed, inefficient development patterns. This scenario differs from *Business as Usual* by increasing the rate of LDR conversion by 50%. The rate of UHD conversion is not changed.

Better Built Cities imagines a future in which policymakers and land-use planners embrace smart growth, thereby reducing UHD conversion by 25% development and LDR conversion by 50%. The reduction in UHD conversion would be achieved by prioritizing in-fill development within the existing urban footprint and by building more compactly as cities expand. Past research indicates that a 25% reduction in new urban development footprint may be achievable if the appropriate policy incentives are put in place, and that even larger reductions could be feasible if policymakers use all available tools to prioritize infill development, transit, and energy efficiency.[156,157] The 50% reduction in LDR conversion would be achieved through land-use planning that curtails large-lot rural housing. Since LDR areas, by definition, do not contain many residents, this level of reduction would be achievable without large disruptions in where people live.

The three scenarios all assume the same level of demand for housing and other development at the county level. They only differ in the pattern of projected development.

Projecting Urban and Highly Developed and Low-Density Residential Growth

We projected two types of conversion between 2016 and 2040:

1. ***Urban and highly developed (UHD) land use:*** built-up and other developed lands identified as developed open space and low-to-high-intensity developed land uses in USGS's National Land Cover Database (NLCD).[158]
2. ***Low-density residential (LDR) land use:*** a new land-use class developed in *Farms Under Threat* to identify distributed, low-density housing development in rural and exurban areas. This is not captured by NLCD, so AFT and our partners developed a new method to identify LDR land use.[11] We assumed that commercial farm or ranch viability is threatened below a certain minimum farm size because production options become more limited. Because this minimum size varies across the United States, we identified a conservative minimum size threshold using the 10th percentile of each county's farm size distribution from the 2017 Census of Agriculture.[159] Then we identified U.S. Census blocks where the average acreage per dwelling was below the county's minimum farm size threshold and

classified all non-UHD land in these blocks as LDR.

Our modeling followed these steps:

1. ***Estimate UHD and LDR conversion rates at the county level.*** *Business as Usual* UHD conversion rates were calculated by extending annual UHD conversion rates from 2001-2016 across the 24 years from 2016-2040. These rates were then adjusted slightly to account for projected increases or decreases in the rate of future population growth at the state level.[160,74]. *Business as Usual* LDR conversion rates were calculated in the same way, but were not adjusted for population growth because there is a weak relationship between LDR conversion and population growth rate.[151] The *Runaway Sprawl* and *Better Built Cities* conversion rates were calculated by increasing or decreasing the *Business as Usual* conversion rates as described above.
2. ***Create a suitability layer for new UHD land use.*** UHD suitability was based on the conditions where existing (2016) UHD land use was found and combined factors including terrain; land value; proximity to existing urban areas, transportation networks, and water resources, and other land resources (e.g., protected natural resources); and nighttime light intensity. We did not create a separate LDR suitability layer, since UHD suitability is a strong predictor of LDR expansion.
3. ***Remove lands unlikely to be converted to UHD or LDR.*** We removed the following lands from the suitability layer: lands that were already urbanized (UHD); protected lands included in AFT's Protected Agricultural Lands Database (PALD) and the Protected Areas Database of the U.S.; and federal lands.[161] We also identified residential forest areas, often classified as LDR, that are unlikely to experience further development and removed them from the available land base for conversion to UHD. Other LDR areas were allowed to be converted to UHD, since LDR-to-UHD conversion is common in the historical record from 2001-2016.
4. ***Create a probability layer.*** We multiplied the suitability layer described above with a layer showing the historic rate of conversion to UHD, calculated at the county level. This captured local trends of converting specific land uses and land covers: LDR, cultivated lands, forests, herbaceous areas, wetlands, and bare land. The result was a layer showing probability of conversion for each pixel in the lower 48 states.
5. ***Allocate new UHD and LDR to the landscape.*** We projected the location of future UHD and LDR land use at the county level based on the probability layer described above, starting with the areas most likely to be converted and continuing until projected demand for new UHD and LDR land for each scenario was met. New UHD was allocated first because it can occur in areas that were previously LDR, while new LDR can only occur on undeveloped land.
6. ***Summarize impacts on agricultural lands.*** We compared the projections of new UHD and LDR areas to our 2016 land cover/use map to summarize the effects of conversion on agricultural land. This allowed us to estimate impacts on the four agricultural land use types (cropland, pastureland, rangeland, and woodland associated with farms) as well as on Nationally Significant agricultural land.

We did not include Alaska and Hawaii in this analysis due to lack of data. Our modeling also does not account for several factors that influence the rates and spatial patterns of development, including water scarcity, economic growth rates, and climate migration, due to lack of data or prohibitive complexity.

The model was refined with multiple rounds of feedback from AFT, CSP, UW-Madison, and academic peer reviewers. To quantitatively validate model performance, we ran the model in ten metropolitan areas for the period of 2001-2016 and compared the results to the historical record. Model accuracies for predicting UHD growth at the pixel level averaged 67.1% (range 56.2-76.0%). Accuracy was slightly lower for LDR, but still relatively high (average 60.5%, range 52.9-67.5%). These accuracy rates indicate that the model is well suited for making future projections.[151]

We compared the results of our *Business as Usual* scenario to several peer-reviewed modeling efforts that projected changes in urban land cover/use at the CONUS scale out to 2050 or 2100.[116] All but one projected substantial increases in total urbanized area. Because of differences in starting points, definitions, data sources, and scenario assumptions, these models projected a range of roughly 40-170 million acres of urban area for the year 2040. We projected 60 million acres of UHD area by 2040 in *Business as Usual*. This indicates that our projection is likely conservative and certainly within the range of similar efforts. Including LDR areas, we projected that a total of 133 million acres of land will be impacted by development by 2040. It is difficult to compare this total number with the other models due to

different assumptions and definitions, but it is notable that it is still within the range of other leading projections.

Projecting Sea-Level Rise

Under the high emissions climate scenario that aligns with our current climate trajectory (Representative Concentration Pathway 8.5), sea level is projected to rise by 7.5 inches by 2040.[162] We projected sea-level rise in coastal areas following methods developed by the National Oceanic and Atmospheric Administration. [151,163] In brief, we first mapped the average height of the highest daily tide along the coasts, then added 7.5 inches. This produced a map of the elevation of high tides in 2040. We then used a digital elevation model to identify coastal areas that fall below this future high tide mark. We did not include California's Death Valley and Salton Sea, which are already below sea level but are not connected to the ocean and therefore will not be impacted by its rise.

We quantified loss of farmland due to sea-level rise via two pathways. First, we quantified the amount of farmland projected to be inundated (Table 9). Second, we considered the effects of in-migration: when sea levels rise in coastal areas and existing development becomes flooded, new development will need to be built inland to replace it. We quantified the projected amount of flooded UHD and LDR areas and then estimated the amount of inland farmland that would be converted when these areas are replaced (Table 10). In doing so, we assumed that the same percentage of new conversion would occur on farmland as we found in the *Business as Usual* projection. Our UHD and LDR projections did not avoid placing new conversion in areas that are projected to be flooded, nor did they identify new areas that will be converted due to in-migration.

Estimating Residential Housing Density in UHD and LDR Areas

We estimated median housing unit density (housing units per acre) for UHD and LDR land uses to better understand how development intensity differs between them. We overlayed our 2016 UHD and LDR layers with the estimated 2016 Census block-group-level housing unit density developed for *Farms Under Threat: The State of the States*.[11] Then we calculated the median housing unit density for each land use. For the UHD calculation, we restricted the analysis to pixels with more than 1 housing unit per 10 acres to avoid including developed open spaces and other UHD pixels outside of urban and suburban residential areas. This is a conservative threshold that likely resulted in a low estimate of median housing unit density in UHD areas. For the LDR calculation, we removed pixels with values of zero, which were certainly artifacts due to how LDR areas were identified. The median housing unit density for UHD areas was 1.4 housing units per acre and for LDR areas was 0.18. The equivalent average lot sizes are 0.7 acres for UHD and 5.6 acres for LDR. Since LDR pixels are often found in Census blocks that include UHD land use, which would inflate the housing unit density in those blocks, we believe the true median LDR housing unit density is likely lower than 0.18.

Estimating Effects on Economic Indicators

We calculated the effects of agricultural land conversion on key economic indicators at the county level and then summed the results to the national level. We multiplied the number of farms, number of farm jobs, and annual commodity total sales by the percentage of agricultural land in each county that is projected to be converted. County economic indicators were from the 2017 Census of Agriculture.[159] The number of farm jobs was calculated as the sum of number of producers and number of hired workers.

Evaluating the Relationship Between Conversion and Farm Size

To assess potential disparities in the size of farms that will be impacted by projected conversion, we evaluated the relationship between 1) percentage conversion of agricultural land (total of UHD and LDR conversion) under the *Business as Usual* scenario and 2) measures of county farm size from the 2017 Census of Agriculture.[159] First, we evaluated the relationship between percentage conversion and the percentage of farms in each county that were smaller than 180 acres and found a Pearson's correlation coefficient of .74 with $p < .001$. Then, we calculated the average farm size for all counties in the top and bottom quartiles of percentage conversion by dividing the total acres of farmland in these counties by the total number of farms.

Appendix 2. Supplemental Data Tables

Table A1. Acreage and percentage of agricultural lands converted to UHD and LDR land uses, by state.
To explore the breakdown of UHD versus LDR conversion, visit farmland.org/development2040.

State	Acres of agriculture in 2016	Business as Usual		Runaway Sprawl		Better Built Cities	
		ACRES	%	ACRES	%	ACRES	%
Alabama	9,793,100	545,000	5.6	751,600	7.7	310,800	3.2
Arizona	34,629,600	444,500	1.3	518,700	1.5	302,600	0.9
Arkansas	13,767,600	480,400	3.5	663,900	4.8	258,200	1.9
California	34,005,800	797,400	2.3	935,300	2.8	522,100	1.5
Colorado	32,584,900	417,500	1.3	525,300	1.6	267,200	0.8
Connecticut	347,200	55,000	15.8	72,600	20.9	35,800	10.3
Delaware	519,400	65,100	12.5	86,300	16.6	42,200	8.1
Florida	8,417,000	620,200	7.4	762,500	9.1	410,400	4.9
Georgia	11,769,900	798,400	6.8	1,062,300	9.0	474,500	4.0
Idaho	14,097,300	113,100	0.8	146,300	1.0	64,800	0.5
Illinois	27,380,600	363,400	1.3	448,400	1.6	237,000	0.9
Indiana	16,362,500	451,100	2.8	602,200	3.7	259,700	1.6
Iowa	30,982,600	183,400	0.6	219,500	0.7	117,000	0.4
Kansas	46,565,900	196,900	0.4	249,500	0.5	123,100	0.3
Kentucky	12,287,100	456,500	3.7	639,000	5.2	249,300	2.0
Louisiana	7,816,000	306,000	3.9	395,000	5.1	187,100	2.4
Maine	1,129,600	53,400	4.7	72,500	6.4	28,400	2.5
Maryland	2,292,500	178,200	7.8	248,600	10.8	97,700	4.3
Massachusetts	500,100	73,800	14.8	89,400	17.9	50,100	10.0
Michigan	11,740,000	483,800	4.1	696,700	5.9	260,600	2.2
Minnesota	24,959,300	369,500	1.5	500,900	2.0	205,200	0.8
Mississippi	11,117,200	513,300	4.6	740,300	6.7	270,900	2.4
Missouri	27,581,800	568,200	2.1	794,400	2.9	309,400	1.1
Montana	55,498,100	171,700	0.3	249,900	0.5	92,700	0.2
Nebraska	44,877,400	103,800	0.2	123,400	0.3	64,400	0.1

State	Acres of agriculture in 2016	Business as Usual		Runaway Sprawl		Better Built Cities	
		ACRES	%	ACRES	%	ACRES	%
Nevada	9,180,100	155,700	1.7	178,700	1.9	104,100	1.1
New Hampshire	431,900	35,600	8.3	43,200	10.0	22,400	5.2
New Jersey	782,300	125,000	16.0	157,200	20.1	78,500	10.0
New Mexico	43,864,000	205,000	0.5	263,700	0.6	109,000	0.2
New York	9,194,600	452,000	4.9	642,200	7.0	247,500	2.7
North Carolina	10,361,900	1,197,300	11.6	1,678,100	16.2	661,500	6.4
North Dakota	36,875,900	198,500	0.5	243,500	0.7	125,700	0.3
Ohio	15,280,100	518,500	3.4	696,800	4.6	298,700	2.0
Oklahoma	32,464,000	458,900	1.4	607,400	1.9	271,300	0.8
Oregon	17,505,100	109,100	0.6	142,300	0.8	61,100	0.3
Pennsylvania	9,034,600	543,800	6.0	760,000	8.4	309,300	3.4
Rhode Island	56,000	8,100	14.5	9,800	17.6	5,500	9.8
South Carolina	5,791,600	436,700	7.5	586,000	10.1	253,000	4.4
South Dakota	41,465,000	156,900	0.4	215,000	0.5	86,900	0.2
Tennessee	12,298,200	1,014,600	8.2	1,409,200	11.5	564,800	4.6
Texas	131,772,700	2,192,700	1.7	2,770,100	2.1	1,375,500	1.0
Utah	11,800,800	210,100	1.8	242,700	2.1	144,400	1.2
Vermont	1,320,300	41,200	3.1	61,800	4.7	21,500	1.6
Virginia	8,184,400	594,100	7.3	836,200	10.2	328,700	4.0
Washington	15,398,400	192,300	1.2	238,600	1.5	120,500	0.8
West Virginia	2,819,700	157,600	5.6	229,000	8.1	83,600	3.0
Wisconsin	14,996,600	515,200	3.4	688,000	4.6	304,800	2.0
Wyoming	29,303,400	86,600	0.3	110,100	0.4	50,700	0.2
Contiguous U.S.	941,204,200	18,415,000	2.0	24,403,800	2.6	10,869,900	1.2

Table A2. Counties with the highest acres of agricultural land projected to be converted to urban and highly developed (UHD) and low-density residential (LDR) uses by 2040.

To explore data for every county in the contiguous U.S., and to view the breakdown of UHD versus LDR conversion, visit farmland.org/development2040.

County	State	Acres of agriculture in 2016	Business as Usual		Runaway Sprawl		Better Built Cities	
			ACRES	%	ACRES	%	ACRES	%
Maricopa	Arizona	2,003,900	230,100	11.5	247,200	12.3	164,300	8.2
Riverside	California	1,365,200	127,700	9.4	138,300	10.1	90,200	6.6
Bexar	Texas	328,100	117,100	35.7	147,900	45.1	66,000	20.1
Harris	Texas	231,700	112,400	48.5	131,000	56.5	83,200	35.9
Clark	Nevada	425,500	102,500	24.1	114,600	26.9	66,600	15.7
Tarrant	Texas	172,600	102,300	59.3	118,100	68.4	70,600	40.9
FortBend	Texas	358,200	95,200	26.6	113,700	31.7	62,900	17.6
Collin	Texas	337,500	90,400	26.8	106,100	31.5	60,700	18.0
Travis	Texas	246,800	73,800	29.9	92,600	37.5	53,100	21.5
Denton	Texas	365,400	73,200	20.0	84,300	23.1	51,800	14.2
Hidalgo	Texas	793,300	68,300	8.6	84,700	10.7	47,100	5.9
SanBernardino	California	2,199,700	61,800	2.8	69,200	3.1	43,500	2.0
Will	Illinois	289,800	58,900	20.3	64,500	22.2	42,000	14.5
Williamson	Texas	508,300	57,700	11.4	69,800	13.7	40,800	8.0
Hillsborough	Florida	215,300	56,200	26.1	66,600	30.9	37,800	17.6
El Paso	Colorado	952,800	54,500	5.7	67,200	7.0	36,000	3.8
Fresno	California	2,008,600	52,900	2.6	64,900	3.2	30,100	1.5
Pinal	Arizona	2,533,800	52,700	2.1	65,100	2.6	33,300	1.3
Johnston	North Carolina	237,500	52,500	22.1	76,100	32.1	28,300	11.9
Benton	Arkansas	302,800	51,700	17.1	66,100	21.8	31,000	10.2
El Paso	Texas	396,400	51,700	13.0	59,700	15.1	34,100	8.6
Utah	Utah	431,100	51,500	11.9	58,900	13.7	35,400	8.2
Union	North Carolina	208,000	51,500	24.7	71,300	34.3	27,700	13.3
Hays	Texas	216,100	49,500	22.9	60,900	28.2	30,500	14.1
Madison	Alabama	251,100	48,700	19.4	62,000	24.7	29,600	11.8

County	State	Acres of agriculture in 2016	Business as Usual		Runaway Sprawl		Better Built Cities	
			ACRES	%	ACRES	%	ACRES	%
Oklahoma	Oklahoma	196,200	48,500	24.7	57,100	29.1	32,400	16.5
York	Pennsylvania	335,300	48,400	14.4	67,100	20.0	24,300	7.3
Polk	Florida	473,100	48,300	10.2	59,500	12.6	29,200	6.2
Kern	California	3,411,000	48,100	1.4	55,000	1.6	39,000	1.1
LosAngeles	California	1,000,000	48,000	4.8	53,300	5.3	34,000	3.4
Pittsylvania	Virginia	381,700	48,000	12.6	69,900	18.3	24,800	6.5
Wake	North Carolina	116,300	46,600	40.1	56,700	48.7	31,900	27.5
Douglas	Colorado	266,300	45,100	16.9	52,800	19.8	28,300	10.6
Pasco	Florida	151,200	45,100	29.8	58,600	38.7	28,700	19.0
Bell	Texas	457,000	44,600	9.8	55,300	12.1	26,900	5.9
SanDiego	California	1,255,200	43,900	3.5	49,600	4.0	30,100	2.4
Dallas	Texas	116,800	42,900	36.7	46,200	39.6	33,600	28.8
Iredell	North Carolina	242,100	42,700	17.6	61,600	25.4	22,100	9.1
Limestone	Alabama	262,900	41,000	15.6	58,200	22.1	20,400	7.7
Ellis	Texas	493,800	40,900	8.3	56,300	11.4	23,900	4.8
Lexington	South Carolina	189,600	40,800	21.5	52,000	27.4	24,300	12.8
Pima	Arizona	3,772,600	40,500	1.1	48,200	1.3	29,800	0.8
Rutherford	Tennessee	194,000	40,100	20.7	49,900	25.7	25,800	13.3
Johnson	Kansas	140,600	40,000	28.5	46,500	33.0	25,900	18.4
Sevier	Tennessee	96,900	40,000	41.3	43,300	44.7	26,900	27.8
Williamson	Tennessee	180,200	39,200	21.8	49,200	27.3	22,900	12.7
Bernalillo	New Mexico	441,900	37,800	8.5	49,300	11.1	24,900	5.6
Wilson	Tennessee	247,100	37,700	15.3	50,100	20.3	22,600	9.1

Table A3. Counties with the highest percentage of agricultural land projected to be converted to urban and highly developed (UHD) and low-density residential (LDR) uses by 2040.

To explore data for every county in the contiguous U.S., and to view the breakdown of UHD versus LDR conversion, visit farmland.org/development2040.

County	State	Acres of agriculture in 2016	Business as Usual		Runaway Sprawl		Better Built Cities	
			ACRES	%	ACRES	%	ACRES	%
Broomfield	Colorado	7,900	5,300	66.8	5,300	67.2	4,200	53.0
Mecklenburg	North Carolina	44,500	29,400	66.2	32,000	72.0	22,300	50.1
Harrisonburg	Virginia	1,800	1,100	63.3	1,200	66.4	900	48.3
Gwinnett	Georgia	28,100	17,300	61.4	17,300	61.4	14,200	50.7
Tarrant	Texas	172,600	102,300	59.3	118,100	68.4	70,600	40.9
Henry	Georgia	59,400	32,700	55.0	38,800	65.3	21,900	36.8
Cobb	Georgia	5,500	3,000	54.6	3,000	54.6	2,700	48.4
Muscogee	Georgia	6,300	3,400	54.1	4,400	68.9	2,700	42.2
Forsyth	Georgia	21,600	11,000	51.2	11,000	51.2	10,100	46.7
PrinceWilliam	Virginia	40,000	20,200	50.4	26,000	65.1	12,600	31.6
Clayton	Georgia	7,500	3,700	49.3	4,400	58.2	2,400	31.5
Harris	Texas	231,700	112,400	48.5	131,000	56.5	83,200	35.9
NewHanover	North Carolina	3,500	1,700	48.4	1,800	50.8	800	22.1
DeKalb	Georgia	2,400	1,100	47.2	1,200	50.3	700	31.0
Barrow	Georgia	43,100	20,000	46.4	20,000	46.5	11,600	26.8
Norfolk	Massachusetts	4,000	1,800	46.0	1,900	48.4	1,500	36.9
Fulton	Georgia	14,800	6,400	43.1	8,400	56.9	3,900	26.3
Cherokee	Georgia	39,100	16,900	43.1	19,500	49.8	11,100	28.4
Sevier	Tennessee	96,900	40,000	41.3	43,300	44.7	26,900	27.8
Middlesex	New Jersey	19,300	7,900	41.0	8,700	44.9	5,100	26.2
Transylvania	North Carolina	18,500	7,600	40.9	8,600	46.3	4,700	25.3
Marion	Indiana	37,800	15,400	40.9	18,000	47.5	9,600	25.4
Wake	North Carolina	116,300	46,600	40.1	56,700	48.7	31,900	27.5
Lake	Illinois	44,000	17,600	40.0	21,200	48.2	11,300	25.7
Duval	Florida	26,800	10,500	39.3	11,600	43.3	7,800	28.9
Paulding	Georgia	26,300	10,100	38.6	13,400	51.0	6,600	25.0

County	State	Acres of agriculture in 2016	Business as Usual		Runaway Sprawl		Better Built Cities	
			ACRES	%	ACRES	%	ACRES	%
Cuyahoga	Ohio	7,700	2,900	37.8	3,100	39.8	2,300	29.6
Lee	Florida	68,300	25,300	37.0	28,300	41.5	21,600	31.6
Dallas	Texas	116,800	42,900	36.7	46,200	39.6	33,600	28.8
Clay	North Carolina	16,100	5,900	36.6	7,000	43.6	3,300	20.1
Orange	Florida	98,000	35,700	36.5	38,900	39.7	28,000	28.6
Bexar	Texas	328,100	117,100	35.7	147,900	45.1	66,000	20.1
Ascension	Louisiana	51,800	18,400	35.6	23,600	45.5	12,100	23.4
Chesterfield	Virginia	29,300	10,400	35.5	12,400	42.5	5,700	19.5
Jefferson	Kentucky	16,500	5,800	35.3	7,400	45.0	3,700	22.6
Fairfax	Virginia	11,800	4,100	34.9	4,500	38.1	3,000	25.6
Rockwall	Texas	56,300	19,000	33.8	23,400	41.5	11,400	20.3
Denver	Colorado	19,100	6,300	32.9	6,800	35.8	3,400	18.0
Watauga	North Carolina	40,300	13,200	32.9	17,500	43.5	8,500	21.0
Milwaukee	Wisconsin	18,600	6,000	32.3	6,500	34.8	4,500	24.2
Macon	North Carolina	28,400	9,200	32.2	10,500	36.8	7,000	24.5
Seminole	Florida	18,900	6,100	32.2	6,600	34.7	4,300	22.8
New Haven	Connecticut	20,500	6,600	32.1	9,200	45.1	4,400	21.3
White	Georgia	28,500	9,100	32.0	13,800	48.5	5,400	19.0
Middlesex	Massachusetts	27,100	8,600	31.9	9,400	34.9	6,400	23.6
Lumpkin	Georgia	24,800	7,900	31.9	11,200	45.1	4,200	16.7
Putnam	NewYork	7,000	2,200	31.5	2,600	37.9	1,700	24.7
Douglas	Georgia	18,700	5,800	31.3	7,600	40.8	3,400	18.4

GLOSSARY

Agricultural District Programs: Programs that allow owners of farmland and ranchland to form special areas where commercialized agriculture is encouraged and protected. Programs are authorized at the state level but implemented at the local level. Enrollment is voluntary, and participating landowners receive a set of protections and tax incentives. Protections may include limits on annexation, eminent domain, and siting of public facilities and infrastructure. Tax incentives may include exemptions from special assessments and reductions in property taxes.

Agricultural Land: Non-federal cropland, pastureland, rangeland, and woodland associated with farms. Commonly referred to as farmland and ranchland by the public.

Agricultural Land Protection Scorecard: A state-by-state analysis of policies and programs that support agricultural viability and address the loss of farmland to development. Intended to inform decision-making and legislative action, it assesses state actions, measures their performance, and highlights effective aspects of the following programs and policies: purchase of agricultural conservation easement programs, land-use planning and growth management, property tax relief for agricultural land, agricultural district programs, Farm Link programs, and state leasing programs. AFT conducted the analysis between 2017 and 2019.

Better Built Cities: See **Visions of the Future: The Scenarios**.

Brownfields: As defined by U.S. Environmental Protection Agency, these are properties where the potential presence of a hazardous substance, pollutant, or contaminant complicates any expansion, redevelopment, or reuse of the property.

Business as Usual: See **Visions of the Future: The Scenarios**

Climate: The average weather in a place over many years. Climate change is a shift in those conditions.

Climate Change: The ongoing and accelerating changes in weather patterns that are caused by human emissions of greenhouse gases. These changes have a range of effects on agriculture, including lengthening the growing season, reducing chilling hours for fruit crops, and increasing both the intensity of rainstorms and the severity of droughts.

Conservation Easement: A deed restriction that landowners voluntarily place on their property to protect resources such as productive agricultural land, ground and surface water, wildlife habitat, historic sites, or scenic views. AFT's Farmland Information Center provides a factsheet on agricultural conservation easements.

Conversion: A change in land cover and/or land use. This report models future scenarios of the conversion of agricultural land to urban and highly developed (UHD) and low-density residential (LDR) land uses.

Development: A combination of land cover/use categories that are dominated by human activity. These include concentrated urban and built-up areas comprised of residential, commercial, industrial, energy, and transportation uses, as well as dispersed built-up areas, which are predominantly residential and include large-lot housing and distributed energy production (e.g., well pads or wind turbines).

Dual-use Solar Installations: Solar installations that integrate solar arrays and farming activities on the same land. The potential of dual-use solar arrays to minimize conflict between food and energy production is promising but conditional on continued research, field testing, and, ultimately, economic viability.

Ecosystem Services: Ecosystem services are the services or benefits gained from the natural environment and other properly functioning ecosystems and include supporting services (like nutrient cycling, soil formation, and pollination), provisioning services (like food, water, energy), regulating services (like carbon sequestration and water purification), and cultural services (like heritage value or recreation).

Environmental Benefits of Agriculture: Agricultural lands can be managed to improve the quality of water, air, and soil; support wildlife and biodiversity; sequester carbon; store floodwaters; and suppress fires. They also improve quality of life by supporting community and economic development, local food, beautiful viewsheds, and recreational opportunities.

Greenhouse Gas (GHG): A gas in the Earth's atmosphere that traps heat. The primary GHGs are water vapor, carbon dioxide, methane, and nitrous oxide. Fossil fuels and other human activities, including agricultural practices, are rapidly increasing GHG concentrations in the atmosphere, leading to climate change.

Heirs' Property: Property that is passed to family members by inheritance, usually without a will, or without an estate planning strategy.

Land Use: The purpose of human activity on the land. It refers to the functions people use land for, rather than the land's natural or physical features, and involves both the modification and the management of the natural environment for human use.

Land-Use Planning: A public process to envision and prepare for the future. In the U.S., most states delegate land-use planning authority to local governments. Some states, however, play a more active role through state-level planning entities, state land-use goals, state support for community planning, and state requirements for communities

to develop comprehensive plans consistent with state goals. A few states direct or encourage localities to identify important agricultural resources and to adopt policies to protect them.

Low-Density Residential (LDR) Land Use: A new land-use class developed in *Farms Under Threat* to identify agricultural lands in areas where the average housing density is above the level where agriculture is typically viable. It is the first nationwide attempt to map the impact of large-lot residential development on the agricultural land base. It is concentrated in areas where development pressure is increasing and developed and undeveloped land are interspersed, often on the edges of cities and towns.

Nationally Significant Land: A *Farms Under Threat* designation for the agricultural land that is best suited for long-term cultivation and food production. It was identified using the PVR analysis following consultation with experts.

Productivity, Versatility and Resiliency (PVR): A *Farm Under Threat* geospatial metric of the agricultural potential of U.S. land based on its productivity, versatility, and resiliency. The analysis incorporates feedback from a group of national experts to prioritize and weight a set of criteria to determine which agricultural lands are best suited for long-term cultivation. Maps representing soil productivity and capacity, land cover and use, crop type, and length of growing season were developed and combined using weights elicited from the national experts. The resulting PVR values indicate the land's suitability for producing food and other crops with 30-meter spatial resolution. The higher the value, the more productive, versatile, and resilient the land is for long-term cultivation when treated and managed according to acceptable farming methods.

Protected Agricultural Lands Database (PALD): AFT's geospatial database of easements that, at least in part, protect agricultural land. As of May 2022, the database included nearly 7 million acres. For more information, see farmland.org/pald.

Purchase of Agricultural Conservation Easements (PACE) Programs: Programs that permanently protect agricultural land from non-farm development and keep land available for agriculture. They compensate property owners for selling agricultural conservation easements to a government agency or private conservation organization. Also known as purchase of development rights (PDR) in many locations.

Regenerative Agricultural Systems: A holistic system of agricultural conservation practices that improve soil health and help soils absorb more water during heavy rains, hold more water during droughts, and sequester more carbon. Common components of regenerative systems include practices that minimize disturbances by reducing tillage depth, intensity, and frequency; maximize soil cover through planting cover crops, retaining crop residues, and mulching; maximize the continuous presence of plant roots with cover crops, longer rotations, and incorporating perennial crops into rotations; and maximize biodiversity by using more diversified crop rotations and/or integrating livestock into the cropping systems.

Runaway Sprawl: See **Visions of the Future: The Scenarios**.

Smart Growth: Land-use policies that seek to influence the pattern and density of new development and to preserve farmland, open space, and environmental resources. For smart growth policies to successfully protect farmland, they need to include a coordinated portfolio of farmland protection policies that work together to slow conversion, protect farmland, support agricultural viability, and provide access to land.

Smart Solar: Smart solar seeks to maximize renewable energy generation while minimizing negative impacts on agricultural land and to make any solar that is built on farmland more beneficial for farmers and for agriculture.

Urban and Highly Developed (UHD) Land Use: A *Farms Under Threat* land-use class including largely built-up areas where most of the land has been converted into commercial, industrial, or residential uses, though opportunities may exist for urban agriculture. Also includes parks, golf courses, and other developed open spaces. Residential areas with less than one housing unit per two acres are typically not included. Commonly found in and around cities and towns, but also may include distributed energy production (e.g., well pads or solar panels) and other rural industrial sites.

Utility-Scale Solar (USS): Large-scale solar arrays that feed directly into the electricity grid. Their minimum size is approximately 1–5 megawatts, with a footprint of approximately 5–35 acres.

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How American Farmland Trust Can Help

Do you have questions about Farms Under Threat, farmland protection, improving on-farm conservation, or finding land? If so, contact AFT's **Farmland Information Center**. Through a free phone and online request form, our staff helps people wanting to save farmland and ranchland for agriculture. Browse our online resources and tools, including fact sheets, laws, sample documents, and a directory of land trusts and state and local programs that protect agricultural land. Call us at 800-370-4879 or visit us online at farmlandinfo.org.

The **AFT research team** is interested in partnering with academic researchers, agency staff, and non-profits to leverage the Farms Under Threat datasets for additional insights. If you are interested in partnering, please visit farmland.org/research to get in touch.

Interested in connecting with other professionals working to advance agricultural land retention and protection across the United States? AFT's **National Agricultural Land Network** provides networking and learning opportunities through an online community platform and a mix of virtual and in-person trainings and events. Membership is free and open to staff from public agencies and land trusts engaged in agricultural land protection, state and county planning entities, state departments of agriculture, and organizations interested in policies and programs that save farmland. For more information and to sign up, visit farmland.org/NALN.

Do you have land you would like to protect? AFT is an agricultural land trust that has permanently protected more than 200 farms and ranches in 27 states. Our **land protection staff** can help you make decisions about the future of your land. Alternatively, you can make a gift of your farm or ranch to AFT knowing we will permanently protect it through our Farm Legacy program. Depending on your wishes, this could occur as an outright gift, as a retained life estate, or through various annuity or trust arrangements. To learn more about options for partnering with AFT to permanently protect your farm or ranch, please visit farmland.org or call our Farmland Information Center at 800-370-4879.

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FARMS UNDER THREAT

About American Farmland Trust

American Farmland Trust (AFT) works to save the land that sustains us by protecting farmland, promoting sound farming practices, and keeping farmers on the land. Founded in 1980, our research and advocacy have led to major advancements in both federal and state policy, ranging from enactment of the Farmland Protection Policy Act of 1981 to creation of multiple state-based farmland protection programs and a federal easement program that has invested more than $2 billion to date in saving farmland.

For more information about AFT visit us at farmland.org

For more information about our findings and analyses, contact AFT's Farmland Information Center staff at (800) 370-4879, farmlandinfo.org

To explore our interactive maps, policy scorecard, and background data visit farmland.org/farmsunderthreat

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