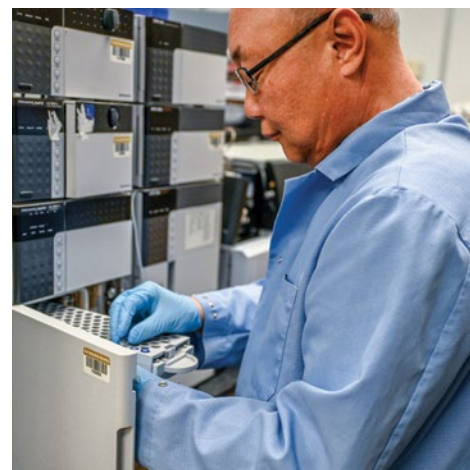


AMERICA'S PUBLIC & LAND-GRANT UNIVERSITIES

Leveraging Discovery, Education, and Engagement for Climate-Smart Solutions



PHOTOS COURTESY OF (CLOCKWISE FROM TOP LEFT):
UNIVERSITY OF GEORGIA
UNIVERSITY OF MISSOURI
FORT VALLEY STATE UNIVERSITY
UNIVERSITY OF MINNESOTA
UNIVERSITY OF GEORGIA
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Mobilizing Research, Education, and Extension to Advance Climate-Smart Solutions

Climate change is a paramount challenge of the 21st century that impacts one of society's most fundamental and critical functions—agriculture and food production. Proactively addressing this challenge also presents pivotal opportunities to increase food security, strengthen national security, and bolster public health.

In partnership with the federal government, public and land-grant universities are on the leading edge of addressing climate change, creating and implementing practical solutions, and building a sustainable future. These higher education institutions:

- Conduct innovative climate research to discover innovative technologies and advancements that result in practical applications.
- Educate a diverse and dynamic range of students who will play integral roles in addressing climate change in the coming years.
- Recognize that climate change is a multidisciplinary challenge and facilitate collaboration among scientists, engineers, educators, social scientists, economists, students, and others.
- Engage with their local community members to raise awareness, share knowledge, and encourage sustainable practices
- Increase international cooperation and foster a global approach by collaborating with universities around the world.

The three pillars of land-grant universities' mission are research, education, and Extension. By leveraging the unique integration of these mission areas as public institutions, land-grant universities identify, develop, and implement effective and comprehensive solutions to complex challenges. This collective work propels innovative climate-

smart solutions that minimize climate-related impacts on food, feed, fiber, and fuel systems in communities throughout our nation and the world.

RESEARCH: *Advancing science to feed the world*

Cutting-edge research at land-grant institutions makes the agriculture and natural resource systems more efficient, resilient, productive, and sustainable. Scientific discoveries advance knowledge, create economic opportunities, and address the needs of the state, region, and nation.

Dedicated researchers advance climate-smart solutions for a wide range of complex challenges. They work to minimize the negative impacts of extreme weather events, including excessive heat, prolonged droughts, and massive floods in ways that protect animals, crops, people, and the environment.

agInnovation (formerly known as the Experiment Station Section) is a nationwide system of agricultural research stations operated under the auspices of the nation's land-grant universities. These stations are dedicated to doing the science that feeds the world. One of agInnovation's Grand Challenges targets efforts to adapt to and mitigate the impacts of climate change on our food system. Research priorities include:

- Reduce greenhouse gas emissions and improve carbon sequestration on agricultural lands.
- Collect robust data for climate modeling and predictions.
- Develop decision-making tools that account for variability and uncertainty.
- Breed crops and livestock that can tolerate climate and water stresses.¹



PHOTO COURTESY OF UNIVERSITY OF NEVADA RENO

EDUCATION: *Preparing students for impactful careers*

By fostering critical thinking and sparking their students' curiosity, educators encourage students to solve problems and create solutions. In an era dominated by advanced technology and a global economy, educators play a pivotal role in equipping students with the knowledge, skills, and competencies needed to thrive in impactful careers.

The responsibility of land-grant educators extends to shaping the next generation of agricultural professionals, encompassing future animal and plant scientists, veterinarians, teachers, Extension agents, nutritionists, agricultural business leaders and workers, economists, policymakers, and others. Leveraging their expertise and dedication, educators ensure that their students possess a comprehensive understanding of topics integral to climate-smart agriculture. By preparing their students to work on current and future national and global challenges,

educators have a profound and far-reaching influence on our collective well-being.

EXTENSION: *Connecting to serve the public*

The Cooperative Extension System (CES) is the nationwide transformational education system operating through land-grant universities in partnership with federal, state, and local governments. Extension educators translate and disseminate university-generated research so that people and communities can rapidly apply practical tools and vital knowledge. Extension's strengths include its local presence and direct engagement with farmers, ranchers, foresters and other land managers, small business owners, community leaders and others in rural, suburban, and urban communities.

This direct engagement makes the land-grant university system uniquely positioned to address



PHOTO COURTESY OF THE UNIVERSITY OF TENNESSEE, KNOXVILLE

climate issues. Extension has a multitude of unique programs that support the adaptation, mitigation, and resiliency of U.S. agriculture to climate disruption. Extension professionals help farmers, ranchers, and land managers develop and adopt climate-smart practices that improve the profitability and sustainability of plant and animal systems. Extension's Climate-Smart management practices for forests, waterways, and other natural habitats reduce the negative impacts of climate on ecosystems and human communities. CES serves all the country's over 3,000 counties and parishes.²

Colleges that focus on agriculture, natural resources, environment, ecology, and health and human sciences at land-grant universities are crucial to innovating, increasing knowledge and understanding, and implementing climate-smart agricultural practices. Their close partnerships with the U.S. Department of Agriculture (USDA) provide important collaborative opportunities to develop and advance solutions that nourish our families, help farmers and ranchers prosper, and protect the environment.

“Providing ordinary citizens with life-changing education in agricultural sciences was at the heart of Justin Morrill’s vision for legislation that established a national network of public universities that is the envy of the world. Today, agricultural research, education, and Extension are just as critical. And it is the educators and researchers who animate this work. They broaden students’ horizons, propel our world forward through pathbreaking innovation, and partner with their communities to tackle urgent issues in their regions. Their uncompromising commitment to teaching, research, and community engagement is a mark of distinction.”

Mark Becker, President, APLU

Partnerships for Climate-Smart Commodities

USDA is investing \$3.1 billion in 141 selected projects under Partnerships for Climate-Smart Commodities to support a diverse range of farmers, ranchers, and private forest landowners. This effort involves nearly 100 universities, including over 30 minority serving institutions.

It will expand markets for America's climate-smart commodities, leverage the greenhouse gas benefits of climate-smart commodity production, and provide direct benefits to production agriculture, including for small and underserved producers. These projects:

- Provide technical and financial assistance to producers to implement climate-smart production practices on a voluntary basis on working lands.
- Pilot innovative and cost-effective methods for quantification, monitoring, reporting, and verification of greenhouse gas benefits.
- Develop markets and promote the resulting climate-smart commodities.

USDA anticipates that these projects will result in:

- Hundreds of expanded markets and revenue streams.
- More than 60,000 farms engaged in climate-smart production practices encompassing more than 25 million acres of working land.
- More than 60 million metric tons of carbon dioxide equivalent sequestered over the lives of the projects.

USDA updates the project dashboard periodically.

Source: Partnerships for Climate-Smart Commodities, USDA



PHOTO COURTESY OF MISSISSIPPI STATE UNIVERSITY

Growing Plant Health



PHOTO COURTESY OF TARLETON STATE UNIVERSITY

Land-grant university researchers, educators, and Extension professionals work every day to protect and strengthen plant health, safeguarding our national and global food supply.

They play a significant role in advancing agricultural technology (agri-tech). For example, they are improving precision agriculture, an approach that allows farmers to apply inputs more precisely. Precision technologies utilize GPS-guided machinery, drones, sensors, satellite imaging, and data analytics. By making data-driven decisions, producers can maximize yields, minimize waste, and improve overall productivity. Through precision agriculture, farmers can:

- Optimize water, fertilizers, and pesticide use by precisely targeting their resources to specific areas instead of applying uniform treatments across an entire field.

- Collect, analyze, and interpret data related to crop health and weather patterns.
- Reduce labor costs by using robots and automated systems for planting, harvesting, and sorting crops.

Plant scientists are exploring strategies to safeguard plants from pests, diseases, droughts, floods, and other climate stressors. For example, researchers are developing plant varieties that are drought-tolerant with increased resistance through traditional breeding techniques and genetic modification. They are also expanding soil management and soil health practices such as no-till farming and cover cropping to increase water retention and reduce runoff.

When plant disease emergencies emerge and expand, Extension educators are working directly with farmers to provide timely guidance to help producers and communities respond effectively. By recommending practical solutions and best practices to farmers, Extension professionals safeguard plant health by helping farmers prevent, diagnose, and treat plant diseases.

Land-grant Impacts

Land-grant expertise make specialty crops viable

Specialty crops range from fruits and vegetables to cut flowers. Specialty crops face the same pressures as traditional row crops. Land-grant university research and Extension address these issues, making specialty crops a viable, profitable market.

Multistate Research Fund Impacts

Managing Soybean Diseases

For more than 30 years, land-grant university scientists and Extension educators across the U.S. have worked together to address soybean diseases.

The committee studies soybean and disease ecology, monitors soybean diseases, tests detection and control strategies, and shares information and tools with farmers, crop consultants, breeders, government agencies, and agricultural companies across the U.S.

“When you do the common things in life in an uncommon way, you will command the attention of the world.”

George Washington Carver



PHOTO COURTESY OF SOUTH DAKOTA STATE UNIVERSITY

Improving Livestock Health



PHOTO COURTESY OF UNIVERSITY OF GEORGIA

Land-grant university researchers, educators, and Extension professionals are protecting and strengthening animal health by engaging in critical scientific exploration, offering multidisciplinary education, and providing actionable information for communities. This concerted effort not only protects human health but also safeguards the national and global food supply.

In the realm of climate-smart innovation and discovery, animal scientists are reducing the impacts of existing and emerging diseases, preparing for future zoonotic pandemics, and advancing preventative strategies to ensure the well-being of animals. This includes work on precision agriculture and antibiotic resistance, as well as vaccines, nutrition, and mitigating heat and other environmental stressors.

Based on advances in precision agriculture, ranchers can monitor their livestock's location and movement with GPS tracking devices to identify issues with grazing patterns and ensure the animals' safety. For example, scientists at Oklahoma State University are researching how managed grazing with virtual fencing can improve grazing distribution, pasture biodiversity and productivity, and wildlife and pollinator habitat. They are studying the grazing patterns of cattle through GPS-enabled collars that allow producers to see where their cattle are grazing and manage where they graze.³

Through precision agriculture, ranchers can also:

- Track individual animals' health with wearable sensors for early detection of problems, enabling prompt intervention and reduces the risk of spreading disease within the herd.

- Tailor nutrition to individual animals' needs considering age, weight, and health status so that each animal receives the proper nutrition and hydration.

Globally, antimicrobial resistance (AMR) and climate change can be considered as two interconnected public health priorities. For example, climate change can be a contributor to AMR through the spread of disease vectors.⁴ Antimicrobial use for humans and animals is a main driver of AMR.⁵

Responding to the global public health threat posed by AMR, APLU and the Association of American Veterinary Medical Colleges (AAVMC) joined forces to create the Joint Task Force on Antibiotic Resistance in Production Agriculture. The task force developed a comprehensive national strategy for diminishing the role antibiotics used in food animal production systems.⁶

In 2018, the APLU and AAVMC designated Iowa State University as the host university for the new Institute for Antimicrobial Resistance Research and Education. This national institute builds upon partnerships with USDA, University of Nebraska-Lincoln, University of Iowa, Mayo Clinic and other land-grant universities' researchers, educators, and Extension personnel.⁷

When animal diseases emerge, Extension professionals recommend practical solutions to help ranchers respond effectively and safeguard animal health. In addition, veterinary laboratories based at land-grant universities work in cooperation with Extension to provide state-of-the-art services to veterinarians and livestock producers to improve animal health.

Land-grant Impacts

Improving the health of livestock animals

Livestock producers are continually searching for new management strategies that will help them be both innovative and better animal stewards. Maintaining healthy animals may also protect human health.

Multistate Research Fund Impacts

Managing Antimicrobial Resistance

Scientists at land-grant universities have teamed up to tackle the complex problem of antimicrobial resistance in agriculture. This interdisciplinary, multistate team is uniquely positioned to develop and implement comprehensive solutions as well as targeted strategies for different types of animals, environmental conditions, and management styles.



PHOTO COURTESY OF UNIVERSITY OF MISSOURI

“We can only prevent future pandemics with an integrated One Health approach to public health, animal health, and the environment we share.”

**Tedros Adhanom Ghebreyesus,
Director-General, World
Health Organization**

Protecting Water



PHOTO COURTESY OF UNIVERSITY OF HAWAII

Water is the essence of life. A safe and reliable water supply is critical for agricultural productivity, economic prosperity, environmental safety, and public health.

Water management issues are especially relevant to colleges of agriculture and natural resources in part because the agricultural sector accounts approximately 80 percent of water consumption in the United States. Land-grant universities play a crucial role in increasing climate-smart water solutions practices in agriculture through research, education, and Extension. Strong water management practices help farmers implement tools and strategies that increase water efficiency, conserve resources, and maximize production.

Scientists are discovering and advancing solutions to water challenges. Important research areas include irrigation management (e.g., precision irrigation, automated systems, soil moisture monitoring) to optimize water use under different conditions. For example, precision irrigation systems and technologies (e.g., sensor-based irrigation systems and data-driven decision-making tools) use real-time data (e.g., soil moisture levels and weather conditions) to optimize consumption. By precisely delivering the right amount of water to crops, farmers integrate efficient irrigation practices that conserve water and reduce expenses. Virtual fences (*described in the animal section*) protect stream banks by keeping cattle out of streams.

Land-grant university educators share knowledge with their students that is critical to developing the next generation of hydrologists, climate scientists, engineers, chemists, and a range of other professions so that students are prepared to address the future's pressing water challenges. In addition, land-grants encourage interdisciplinary work so experts in agriculture, hydrology, ecology, and other fields to collaborate and address complex water efficiency challenges.

Cooperative Extension professionals encourage producers to adopt best water management practices and help communities mitigate the impacts of floods and droughts. Extension educators help farmers and ranchers implement water-efficient practices and techniques and plan for droughts, floods, and other extreme weather events. For example, they demonstrate techniques so farmers can see innovative water management in action. Extension offers technical assistance to assess producers' water practices, offer customized advice, and provide on-the-ground support.

Multistate Research Fund Impacts

Managing Water Resources

Researchers at land-grant universities and partners are working together to find ways to efficiently and fairly allocate water. This research guides water policies and programs, making them more cost-effective and easier to implement. These programs and policies can alleviate water conflicts, protect ecosystem services, and ensure enough water for all uses now and in the future.

Soil, Water, and Environmental Physics

Healthy soils enhance agricultural and environmental sustainability by storing and supplying water, energy, organic materials, and nutrients. For sixty years, researchers from over 24 State Agricultural Experiment Stations have worked together to better understand how water, energy, and nutrients move through and interact with soil. Since its inception,

“Water is the driving force of all nature.”

Leonardo da Vinci



PHOTO COURTESY OF SHUTTERSTOCK

the team has made considerable scientific advances and helped state and federal agencies develop best management practices and policies.

Safeguarding Forests



PHOTO COURTESY OF UNIVERSITY OF WISCONSIN MADISON

Forests in the U.S. and globally are experiencing heightened stress due to climate change that severely impacts their health. Key stressors include increasing temperatures, extreme weather events, pest outbreaks, and frequent intense wildfires. These conditions have devastating impacts on forest ecosystems.

Land-grant universities protect forests through their research, education, and Extension. Researchers expand the knowledge of forest ecosystems; educators train future forestry professionals; and Extension brings research-based solutions into action.

They are developing strategies to enhance forest resiliency, increase biodiversity, and reduce vulnerability to pests and diseases. For example, they explore and evaluate the impact of

temperature, precipitation, and extreme weather events on forests. They use innovative technologies to monitor and manage forests effectively. This includes detecting early signs of distress, planning adaptive strategies, and implementing measures to assess forest health, mitigate wildfire risks (e.g., through tree thinning and controlled burns), and control pests using integrated pest management practices.

Researchers study carbon sequestration and how forests capture and store carbon dioxide. A promising way to reduce net carbon emissions is to use forests as 'carbon sinks' that pull more carbon dioxide out of the atmosphere than they release. Forests and forest products capture and store almost 15% of the U.S. carbon emissions from burning fossil fuels annually with the potential

to capture nearly double that amount through initiatives such as planting more trees and using climate-smart forest practices.⁸

The AI Institute for Climate-Land Interactions, Mitigation, Adaptation, Tradeoffs, and Economy (AI-CLIMATE) leverages artificial intelligence (AI) to create more climate-smart practices that will use forests as effective carbon sinks. AI-CLIMATE is a joint effort led by the University of Minnesota that brings together national AI and climate-smart forestry experts from Cornell University, Colorado State University, Delaware State University, Purdue University, North Carolina State University, and the American Indian Higher Education Consortium. The institute was formed in 2023 and is funded by the U.S. National Science Foundation and USDA's National Institute of Food and Agriculture (NIFA).⁹

Land-grant Impacts

Taking Care of America's Forests

Forests purify air, filter water, store carbon, provide food and shelter for a diverse array of plants and animals, and produce natural resources like timber, paper, and medicine. Land-grant universities work to protect forests that are under threats from pests, pathogens, deforestation, and climate change.

“The real wealth of the nation lies in the resources of the earth—soil, water, forests, minerals, and wildlife.”

Rachel Carson

Protecting Habitats and Biodiversity

Natural ecosystems provide clean air and water, food and shelter for wildlife, and recreation opportunities. Agriculture, urbanization, climate change, pests, and other stressors put America's landscapes and native species, including essential pollinators, at risk. U.S. land-grant universities are working to restore and protect ecosystems and biodiversity.



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Preparing Young People



PHOTO COURTESY OF NATIONAL 4-H COUNCIL

Today's young people are deeply concerned about climate change's increasingly destructive impacts in their hometowns and beyond. A National 4-H Council and Harris Poll survey explored teens' attitudes and showed Gen Z is united on addressing climate issues. The survey showed that: 75 percent of Gen Z teens across demographic groups in the U.S. are worried yet optimistic, and 84 percent feel empowered to shape the future of the planet and believe it's critical to address climate issues now. As they envision the coming years and decades, they are determined to make positive differences.¹⁰

4-H, a youth development organization delivered by Cooperative Extension at land-grant universities across the nation, has provided life-changing programs and experiences for more than 100 years.

Nearly six million kids and teens are "learning by doing" with hands-on projects to address critical societal issues. A network of 500,000 volunteers and 3500 4-H professionals use land-grant universities' research to help young people discover a "sense of wonder" about the natural world. Through environmental education programming, 4-H'ers have completed more than one million environment-oriented projects to increase their knowledge and help advance solutions.¹¹

For example, the *Climate Science Education Program* teaches youth about the science, causes, and impacts on local communities and the world. This empowers young people with the knowledge and skills to take action at home, school, and in their communities. The STEM (Science, Technology,

Engineering, and Mathematics) Challenge Explorers of the Deep (authored by Rutgers University Extension and adopted by many institutions) focuses on ocean exploration and research to help adapt to changing ocean conditions such as melting glaciers and rising ocean temperatures.¹²

Future producers, scientists, and agricultural professionals will need STEM and critical thinking skills to address climate-related agriculture challenges. 4-H and land-grant universities are working today for a better tomorrow.

Land-grant Impacts

4-H Educates Youths on the Importance of Agriculture

With less than two percent of Americans living on a farm, it is imperative to inspire, educate, and cultivate the next generation of farmers and agricultural leaders. Youth need to hear authentic stories, have access to engaging and immersive education, and see demonstrations of 21st-century farming.

4-H Programs are Developing Youths and Communities

Extension 4-H programs empower youths to thrive by strengthening their self-identities, life skills, and confidence.

***“I pledge my head
to clearer thinking,
my heart to greater
loyalty, my hands
to larger service
and my health
to better living
for my club, my
community, my
country, and my
world.”***

The 4-H Pledge



PHOTO COURTESY OF NATIONAL 4-H COUNCIL

Advancing Workforce Development



PHOTO COURTESY OF PURDUE UNIVERSITY

Our nation depends on a creative, educated, and dedicated workforce to implement climate-smart solutions while producing, processing, and distributing our food. If, as scientists predict, the coming decades will include more extreme weather, increased pests, increased human population, and less available agricultural land, U.S. agriculture will need individuals capable of more complex and critical thinking than has been demanded of any previous generation. Currently, there is a high demand and low supply of prepared graduates, so the United States faces acute shortages and critical needs for a qualified agricultural workforce.

Purdue University / USDA NIFA Employment Outlook Report

In the United States between 2020 and 2025, employment opportunities are expected to remain strong for new college graduates with interest and expertise in food, agriculture, renewable natural resources, and the environment (FARNRE). Approximately 59,400 openings annually reflect a 2.6% growth in employment opportunities from the previous five years. Employer demand for college graduates with degrees and experience in FARNRE disciplines will exceed the number of available graduates.¹³

Building upon their years of education and training, tomorrow's graduates will be tasked with tackling complex agricultural and natural resources challenges. Fortunately, land-grant universities are preparing college students for productive, impactful careers in a range of professions. These future farmers, ranchers, climate analysts, agronomists, engineers, educators, water resource managers, foresters, urban agriculturists, Extension professionals, and others will serve our communities, nation, and world.

Employability Skills in Agriculture & Natural Resources—APLU

APLU's Academic Programs Section commissioned research on employability skills—the nontechnical skills used every day in the workforce to ensure the smooth operation of projects and offices. The research, which surveyed more than 11,000 employers, faculty, alumni, and students, provides data-driven insights on employers' needs that university administrators and faculty could consider when updating academic programs.

Land-grants universities are working closely with USDA to address the workforce development needs. USDA's ***From Learning to Leading: Cultivating the Next Generation of Diverse Food and Agriculture Professionals*** ("NextGen") program will enable higher education institutions to engage, recruit, retain, train, and support students to build and sustain the next generation of the food, agriculture, natural resources, health and human sciences, and USDA workforce.

Minority-serving institutions, including 1890 (Historically Black Land-grant Universities), 1994 (Tribal Colleges and Universities), Alaska-Native and Native Hawai'ian-serving, insular land-grant

“Agriculture is the most healthful, most useful, and most noble employment of man.”

George Washington

universities (six U.S. territories), and Hispanic-serving Institutions lead the projects. The \$262.5 million investment will provide training and support to more than 20,000 future food and agricultural leaders through 33 project partners across 24 states resulting in partnerships across more than 60 academic institutions and organizations.

Land-grant Impacts

Developing a Diverse and Thriving Workforce

Access to quality education and career opportunities are key components to success among underserved and at-risk communities. Land-grant universities are working to identify and address barriers to inclusion, benefitting individuals, communities, and economies.

Training the Next Generation of Farmers

In the U.S., the average age of farmers is 57.5, up 1.2 years from 2012 according to the 2017 Census of Agriculture. Land-grant universities are preparing the next generation of farmers, who face different challenges than their predecessors.

Supporting Farmers and Ranchers



PHOTO COURTESY OF SHUTTERSTOCK

With increased climate disruptions, farmers and ranchers face significant and costly challenges as they labor to produce a safe, reliable, nourishing, and affordable food supply. Their livelihoods suffer from droughts, floods, pests, and pathogens. After months of drought, farmers have witnessed their newly planted crops being wiped out during 15-minute intense rainstorms. As summer temperatures rise well above normal, ranchers need to know how to protect their animals from long stretches of record-breaking heat.

Through research, education, and Extension, land-grant universities diligently work with the producers to implement climate-smart solutions, improve productivity, reduce input expenses, and support their success.

Land-grant institutions conduct cutting-edge research to develop new technologies, practices, and crop varieties. This research directly benefits farmers and ranchers by providing solutions to challenges like pest control, soil health, crop productivity, and livestock management.

Researchers are at the forefront of advancing agricultural technology to optimize farmers and ranchers' efficiency and productivity. Agri-tech offers producers cutting-edge tools such as precision agriculture that increase productivity, improve resource management, and help ensure the success of the operation.

Land-grant universities are key to developing precision agriculture that utilizes technologies such as GPS, sensors, drones, and data analytics to

“A sustainable agriculture does not deplete soils or people.”

Wendell Berry

benefit both farmers and ranchers. By making data-driven decisions, producers can maximize yields, minimize waste, and improve overall productivity. (See *plant and animal* sections for details.)

Extension Disaster Education Network (EDEN), a collaborative multi-state effort by Cooperative Extension, provides research-based education to reduce the impact of disasters. EDEN has an extensive dashboard for Agricultural and Zoonotic “hazard resources” that includes subjects such as swine influenza, avian influenza, plant, and crop security.¹⁴

Extension educators are trusted advisors who bring innovative approaches and research-based resources directly to farmers and ranchers. They bridge the gap between research and practical applications to help farmers and ranchers make informed decisions and solve problems. This guidance is tailored to local conditions to help ensure that the applied research has impacts in the field.

These are reciprocal relationships: Extension educators disseminate best practices to farmers and ranchers by offering advice and technical assistance. In turn, producers provide insights and feedback to the Extension educators about emerging trends and research needs.

Land-grant Impacts

Staying a Step Ahead of Pests

Researchers at land-grant universities are helping protect food crops from direct insect damage and diseases spread by insect pests. Their work helps improve crop quality, crop yield, and farm profitability.

Scaling up Skills for Success in Agriculture

To remain competitive in the agricultural industry, farmers must stay current on the latest techniques and technology. Training new workers is also essential to building necessary skills in the agricultural labor force.



PHOTO COURTESY OF UNIVERSITY OF MINNESOTA

Building Controlled Environment Agriculture



PHOTO COURTESY OF UNIVERSITY OF MINNESOTA

Controlled Environment Agriculture (CEA) is a farming practice in which various conditions (e.g., temperature, humidity, light) are controlled to create an ideal environment to optimize plant growth. CEA offers new paths to produce food year-round in most locales. It strengthens resilience and builds a future with increased food security for people throughout the world.

Agricultural research, education, and Extension professionals provide critical scientific expertise, education, and outreach that leverages innovation and accelerates CEA. These efforts create opportunities to grow nourishing food with efficient and environmentally friendly methods throughout urban, suburban, and rural communities.

Land-grant universities are working on a range of CEA research projects. According to the [Multistate Research Fund Impacts](#), 24 land-grant researchers worked together to develop practices and tools that help growers efficiently manage controlled environment resources. Many technologies developed by members of this project are now widely used industry standards.¹⁵

Examples of other impacts include:

- Evaluating controlled environment production techniques in urban settings for small-scale growers.
- Developing sustainable aquaponics systems to enhance resiliency of urban, indoor, and emerging food systems.

- Mitigating food safety risks in indoor leafy greens production.

The growth of the CEA industry requires a prepared workforce to competently handle the complex operations that allows for year-round cultivation. The current shortage of skilled labor restrains the industry's growth. Fortunately, educators at land-grant universities are training students on CEA to prepare them for productive careers in this growing field. Academic programs offer a range of interdisciplinary coursework and experiential learning. Examples include:

- Engineering greenhouse systems, sensors, and automation.
- Breeding plants for improved growth, development, and adaption.
- Optimizing resource use efficiency including water, fertilizer, energy for lighting and heating, ventilation, and air conditioning (HVAC) systems.



PHOTO COURTESY OF SHUTTERSTOCK

***“To see things in
the seed, that is
genius.”***

**Lao Tzu, 6th century BCE
Chinese philosopher**

Cooperative Extension offers non-credit education relevant to CEA such as research-based food production, building new businesses, and developing workforce skills. Also, Extension professionals help scale up inner-city small farms, community and school gardens, backyard and rooftop horticulture, and CEA in communities throughout the U.S.

Multistate Research Fund Impacts

Managing Controlled Environments Efficiently

This project (referred to above) received the Northeast Region's 2018 Award for Excellence in Multistate Research.

Additional examples

Cornell University: Controlled Environment
Agriculture

Michigan State University: Expansion of controlled
environment culinary herb production

Purdue University: Controlled Environment
Agriculture (NEMALI Lab)

The Ohio State University: Ohio Controlled
Environment Agriculture Center

University of Arizona: Controlled Environment
Agriculture Center

UC Davis: Controlled Environment Agriculture

Fortifying National Security



PHOTO COURTESY OF SHUTTERSTOCK

Global food security is a critical national concern. Food insecurity in today's turbulent world creates regional conflicts that impact our nation's security. Political conflicts arise when people cannot afford essential staples. Conflict can displace farmers, destroy agricultural assets, disrupt markets, increase prices, and damage livelihoods. In this vicious circle, conflict and lack of food can lead to violence all too often.¹⁶ With the challenges of climate disruption, a consistent and reliable food supply is essential for countries around the globe to keep peace and maintain economic, social, and political stability. Land-grant universities address global hunger and boost agricultural production to protect our national security interests.

According to the *"Annual Threat Assessment of The U.S. Intelligence Community,"* climate change adversely impacts global agriculture and food production. This contributes to trigger events including political instability, terrorism, mass migration, and potential humanitarian crises.

The report also notes that Russia uses food as a weapon in its war against Ukraine. Russia has blocked or seized Ukrainian ports, destroyed grain infrastructure, occupied large swaths of agricultural land, disrupted the yield, displaced workers, and stolen grain. These actions exacerbate global food shortages and increase food insecurity, particularly in low-income countries.¹⁷

Texas A&M's College of Agriculture and Life Sciences report entitled *"Global Food Security is National Security,"* (2023) describes how global food security is related to U.S. national security. It notes that the world is on the edge of a global hunger and malnutrition crisis with as many as 828 million people, or one in every 10 people on the planet, affected by hunger. This poses significant threats to U.S. national security.

The report recommends ways the U.S. can mitigate these risks by increasing investment in worldwide long-term agricultural development, especially in developing countries, to:

- Expand global food and nutrition security programs, research, and innovation.
- Encourage more students and young scientists to focus their research and engagement on improving global food security.
- Support research into the effectiveness of different agricultural technologies and production systems under conflict dynamics in socio-politically fragile environments.

"Boots on the Ground," a 2022 report by The Bipartisan Commission on Biodefense, highlights land-grant universities' critical role in safeguarding the United States against diverse biological threats to food, livestock, crops, and wildlife. Land-grant universities have "boots on the ground" in their communities to effectively and collaboratively address serious threats to agriculture and the environment. These universities employ nationally and internationally recognized scientists who conduct vital research on emerging infectious diseases, public health, animal health, plant health, and related disciplines important for biodefense.¹⁸

Through USDA NIFA's Agricultural Biosecurity programs, land-grant universities protect the integrity, reliability, sustainability, and profitability

"Food is both a strategic weapon of war and a smart investment to foster peace."

John Hamre & Kimberly Flowers, Center for Strategic and International Studies

of the U.S. agricultural system against threats from pests, diseases, contaminants, and disasters. This includes preventing, preparing for, detecting, responding to, and recovering from known and emerging plant and animal diseases. Universities also create new tools and management strategies and provide disease information to producers and the public.¹⁹



PHOTO COURTESY OF OREGON STATE UNIVERSITY

Land-grant universities address long-term challenges that impact both national and international food security issues.

Feed the Future is the U.S. Government's global hunger and food security initiative. The Feed the Future Innovation Labs are led by U.S. universities and are advancing novel solutions to tackle some of the greatest challenges in agriculture and food security.

More than 70 U.S. colleges and universities, including 22 Minority Serving Institutions (MSIs), are engaged in partnerships with the Labs. They are generating innovations that deliver benefits for food-insecure developing countries while strengthening U.S. food systems and agriculture.

Feed the Future Innovation Labs at land-grant universities include:

- Animal Health | Washington State University
- Applied Wheat Genomics | Kansas State University
- Crop Improvement | Cornell University
- Current & Emerging Threats to Crops | Pennsylvania State University
- Food Processing and Post-Harvest Handling | Purdue University
- Food Safety | Purdue University
- Food Security Policy Research, Capacity and Influence | Michigan State University
- Fish | Mississippi State University
- Genomics to Improve Poultry | University of California, Davis
- Horticulture | University of California, Davis
- Integrated Pest Management | Virginia Tech
- Legume Systems Research | Michigan State University
- Livestock Systems | University of Florida
- Markets, Risk and Resilience | University of California, Davis
- Peanut | University of Georgia
- Reduction of Post-Harvest Loss | Kansas State University
- Small-Scale Irrigation | Texas A&M University
- Collaborative Research on Sorghum and Millet | Kansas State University
- Soybean | University of Illinois
- Sustainable Intensification | Kansas State University

Source: Feed the Future Innovation Labs



PHOTO COURTESY OF FEED THE FUTURE INNOVATION LABS



PHOTO COURTESY OF SHUTTERSTOCK

Increasing Food Security



PHOTO COURTESY OF UNIVERSITY OF CALIFORNIA

Millions of Americans struggle to feed their families each day and hunger in the U.S. rose sharply in 2022. A USDA report found that over 44 million people lived in food insecure households in 2022, up from 33.8 million people in 2021. This includes more than 13 million children, a jump of nearly 45 percent from 2021.²⁰

Americans feel the impact of rising food costs that is caused by many factors including climate disruptions. For example, hurricanes, floods, and wildfires can affect crop yields, disrupt food supply chains, and decrease food availability and affordability. According to the Consumer Price Index, food prices increased about 11% from 2021 to 2022 and increased 7.7 from April 2022 to April 2023.²¹

Through research, education, and Extension, our land-grant universities are addressing these complex and multi-faceted challenges.

Researchers are utilizing CRISPR-Cas9, which is a revolutionary and promising technology that allows for precise editing of DNA in plants, for precise and targeted crop improvements. They are working to develop improved crops varieties with increased drought-tolerance, resistance to heat, pests, and diseases as well as enhanced nutritional content. This cutting-edge research increases food security in the face of climate-related uncertainties.

Extension professionals are working to reduce food and nutrition insecurity at the individual and family scale through the Expanded Food and Nutrition

Education Program (EFNEP) that operates through land-grant universities. EFNEP is the nation's first nutrition education program for low-income populations and remains at the forefront of nutrition education efforts to reduce nutrition insecurity of low-income families and youth today. The program supports participants' efforts toward nutritional health and well-being. It combines hands-on learning, applied science, and program data to ensure program effectiveness and efficiency.²²

4-H youth are involved in increasing food production, gardening, agriculture, nutrition education, and combating food waste and loss through partnerships and collaborations. National 4-H Council has expanded opportunities for youth from across the nation to expand their involvement in increasing food production and combating food waste and loss through a grant from USDA NIFA.²³

Land-grant Impacts

Land-grant Universities Improve Local Food Security

Through creation of food pantries, community gardens, food drives, farmers markets, and more,

***“If you can’t feed
a hundred people,
then feed just one.”***

Mother Teresa

land-grant universities and local community initiatives collaborate to keep food on the table for many.

Improving Crops Key to Food Security

Research at land-grant institutions keeps the U.S. food production on the cutting edge when it comes to quality, nutrition, disease resistance, and other factors that help keep our food system safe and contribute to national security.



PHOTO COURTESY OF BEARFOTOS/SHUTTERSTOCK

Strengthening Food Safety



PHOTO COURTESY OF UNIVERSITY OF WISCONSIN

From *Salmonella* to *E. coli* to *Listeria*, foodborne illness is a complex and serious problem in the United States and globally. The Centers for Disease Control and Prevention, which regularly tracks foodborne illness outbreaks, estimates that there are 48 million foodborne illness cases, 128,000 hospitalizations, and 3,000 deaths annually in the United States due to contaminated food.

Climate-related factors such as extreme weather events, changing temperatures, and shifts in precipitation patterns can increase foodborne pathogens and threaten the safety of the food supply. For example, pathogens that are washed into rivers and irrigation systems after heavy rainfall can contaminate water sources used in agriculture for crops and livestock. In addition, higher

temperatures can promote the survival, growth, and spread of bacteria, viruses, and parasites.

With multi-faceted approaches through research and Extension, land-grant universities are essential to improved food safety technologies, strategies, and practices.

Land-grant university scientists are developing state-of-the-art technologies, interventions, and strategies to enhance the safety of the food supply chain. For example, several universities with strengths in agriculture and engineering are actively involved in interdisciplinary nanotechnology research with applications to food safety. They are advancing nanotechnology to:

- Design sensors to rapidly detect, monitor, and control foodborne pathogens.

- Improve barrier properties for packaging to reduce contamination risks during storage and transportation.
- Develop advanced purification systems to remove contaminants from water used in food production.

To minimize the risk of foodborne illnesses, Extension disseminates best practices to farmers and ranchers. This includes providing guidance on the safe measures for the production, processing, and handling of food to minimize contamination risks during harvesting and handling.

Land-grant Impacts

Increasing Food Safety and Reducing Food Waste

Protecting the nation's food supply is a top priority of land-grant institutions across the United States, including through training to ensure food safety, reducing food loss and food waste, or research to better detect and protect foods.

“Food is the moral right of all who are born into this world.”

Norman Borlaug

Multistate Research Fund Impacts

Nanotechnology in Agriculture & Food Systems

Researchers at land-grant universities are working together to develop nanotechnology that can be used to detect pathogens, develop vaccines, target drug delivery, create antimicrobial packaging, purify water, combat antimicrobial resistance, and more.



PHOTO COURTESY OF SHUTTERSTOCK

Elevating Public Health



PHOTO COURTESY OF SHUTTERSTOCK

By propelling advances in research, education, and Extension, land-grant universities provide an essential foundation to ensure a nourishing food supply and protect public health. Land-grant universities are critical to “connect the dots” among agriculture, nutrition, and health. Increasingly, this involves creating and disseminating climate-smart solutions that advance farming practices and strategies to mitigate and adapt to changing climate conditions. They are also key partners in federal initiatives to improve public health through efforts such as advancing responsive agriculture, precision nutrition, and COVID-19 vaccine access to rural and medically underserved communities.

The U.S. Department of Agriculture (USDA) launched a pilot nutrition hub under the **Agricultural Science Center of Excellence for Nutrition and Diet for Better Health (ASCEND for Better Health) initiative** in September 2023. This hub is in partnership with Southern University, a historically black 1890 land-grant university and host of the 1890 Center of Excellence for Nutrition, Health, Wellness and Quality of Life. This hub will be an engine for providing science-based, nutrition-related information at the community level, particularly in underserved communities impacted by diet-related chronic diseases.²⁴

*“Let food be thy
medicine, and let
medicine be thy
food.”*

Hippocrates

This effort builds upon the **White House Conference to End Hunger and Build Healthy Communities** held in September 2022, which was the first White House conference of its kind in 50 years. The federal government recognizes that they cannot end hunger and reduce diet-related diseases without crucial collaboration with universities; private sector; nonprofits, and others

To help accomplish the White House’s massive goals of ending hunger and building healthy communities, land-grant universities are advancing **responsive agriculture**. This encompasses a range of practices and technologies, including:

- **Precision agriculture** develops and uses technology to help farmers optimize field-level management that can impact public health (e.g., soil and water quality improvements due to the judicious use of fertilizers).
- **Data-driven farming** that utilizes data and analytics to improve decisions about farm and ranch operations (see plant, animal, and farmer sections for details).
- **Plant genomics and gene editing** provide opportunities to develop plant varieties that are more nutritious and biofortified.

Land-grants are also on the cutting-edge of **precision nutrition**, which moves from a “one-size-fits-all” to a personalized approach for dietary and lifestyle recommendations to improve health outcomes. Key components include:

- **Genetic information** that analyzes an individual’s genetic makeup to understand how their genes may influence responses to different nutrients and dietary patterns.
- **Microbiome analysis** that considers the composition of an individual’s gut microbiome to tailor recommendations that support a healthy gut environment and overall health.
- **Lifestyle habits** that consider factors (e.g., physical activity, sleep patterns, stress levels) which significantly impact how the body processes and utilizes nutrients.

Through their vision, dedication, and expertise, professionals at land-grant universities are improving the health and lives of all Americans every day.

Extension Collaborative on Immunization Teaching & Engagement (EXCITE) Program

Through a cooperative agreement, Cooperative Extension System, Centers for Disease Control and Prevention (CDC) and USDA NIFA reached more than 11 million people and delivered COVID-19 vaccines and education to hard-to-reach communities across the nation. EXCITE projects were focused on reaching rural and medically underserved communities.²⁵

Land-grant Impacts

Scientists Across the Country Working to Create More Nutrient-Dense Diets

Researchers at land-grant universities are making the foods we eat more nutrient-dense for life-long health and wellness.

Community Nutrition Programs Improve Healthful Outcomes

Extension educators deliver research-based, hands-on learning experiences on diet quality, food safety, and physical activity through virtual platforms and in-person classes.

Public and Land-Grant Universities' Ongoing Commitment

Through the integration of its research, education, and Extension missions, the public and land-grant university system shines as a unique, valuable, and potent force to address critical and emerging needs for our country. These institutions drive agricultural innovation, build a high-tech and prepared workforce, and deliver practical solutions to local communities throughout our nation.

Strong Return on Investment

Research supported by the USDA, Economic Research Service has found that spending on public agricultural R&D generated, on average, **\$20 in benefits to the U.S. economy for every \$1 of spending.**

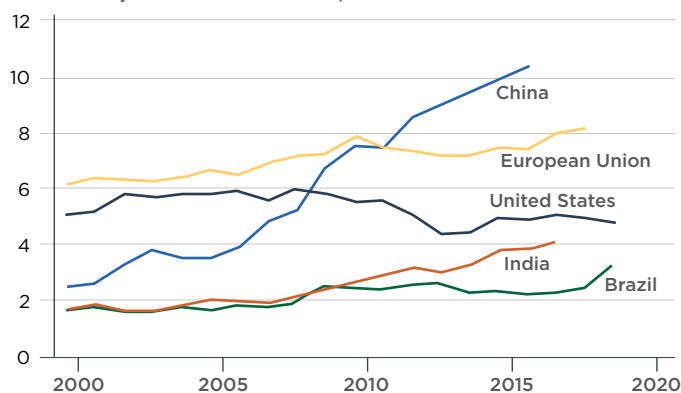
Source: USDA ERS - Investment in U.S. Public Agricultural Research and Development Has Fallen by a Third Over Past Two Decades, Lags Major Trade Competitors

The universities leverage their collective power to discover, educate, and connect for climate-smart solutions. Their efforts to address critical climate challenges by: developing and disseminating solutions result in safe, nutritious, affordable food; helping farmers and ranchers prosper; protecting national security; safeguarding America's global leadership in innovation; and improving public health.

The United States has been losing ground to other countries in public agricultural research and development (R&D) investment

Inflation-adjusted 2015 U.S. dollars, billions

USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE



Notes: R&D spending is presented in constant 2015 purchasing power parity (PPP) dollars by first deflating by national Gross Domestic Product (GDP) price indexes and then converting into dollars using the 2015 PPP exchange rate, allowing for comparisons over time and across countries.

Source: USDA, Economic Research Service (ERS) using data from the ERS data product Agricultural Research Funding in the Public and Private Sectors (U.S. expenditures); ERS Economic Research Report 249, Agricultural Research Investment and Policy Reform in High Income Countries (European Union expenditures); International Food Policy Research Institute's Agricultural Science and Technology Indicators (expenditures for China, India, and Brazil); and the World Bank's World Development Indicators (GDP price indexes and PPP exchange rates).

These institutions are grateful for federal commitments to fund crucial strategic initiatives that align with and advance our national priorities. While the current federal funding levels serve as an essential and commendable foundation, increased federal investment is required to address today's and future critical climate challenges. Universities look forward to ongoing collaboration with federal policymakers to explore avenues for additional financial resources.

Public and land-grant universities are committed and determined to ensure a healthy, safe, and climate-resilient future for our communities, nation, and world.

Brief History

A land-grant college or university is a higher education institution designated by its state legislature or Congress to receive the benefits of the Morrill Acts of 1862, 1890, or the Equity in Educational Land-Grant Status Act of 1994.

Senator Justin Smith Morrill from Vermont sponsored and secured the passage of the first **Morrill Act (1862)**. The original land-grant mission, as set forth in the First Morrill Act, was to teach agriculture, military tactics, mechanic arts, domestic arts and sciences, and classical studies so members of the working classes could obtain a practical education that had direct relevance to their daily lives. This land-grant legislation resulted from a growing demand for agricultural and technical education since higher education at the time focused on study of the classics and was mostly unavailable to all but the elite in the United States.

The Agricultural Experiment Stations created by the **Hatch Act (1887)** are key components of the land-grant system. The Hatch Act authorized federal grant funding to each state to establish an Agricultural Experiment Station, a scientific research center that investigates potential improvements related to agriculture, in connection with its land-grant institution. The specific purpose of Hatch Multistate Research Fund is to conduct research by institutions within a state and by institutions in multiple states to solve problems that concern more than one state.²⁶

The second **Morrill Act (1890)** extended access to higher education by providing additional

endowments for all land-grants, but prohibited distribution of money to states that made distinctions of race in admissions. However, states that provided a separate land-grant institution for black people were eligible to receive the funds. The institutions that were founded or designated the land-grant for black people in each of the then-segregated Southern states are known as “the 1890 land-grants.”

The Smith-Lever Act (1914) created the Cooperative Extension Service associated with each land-grant institution to disseminate information developed from the Agricultural Experiment Stations’ research.

The Equity in Educational Land-Grant Status Act of 1994 conferred land-grant status to 36 Native American tribal colleges. These colleges are called the “1994 land-grants” in reference to the year they were granted land-grant status.

There is at least one land-grant institution in every U.S. state, six territories and the District of Columbia. Some states have more than one land-grant institution due to the second Morrill Act and the Equity in Education Land-grant Status Act of 1994. Today, land-grant universities improve the quality of lives and are integral to the overall economic vitality of their communities, states, regions, and the nation.²⁷

Resources

The Association of Public and Land-grant Universities (APLU)

APLU is a membership organization that fosters a community of university leaders collectively working to advance the mission of public research universities. The association's membership consists of 248 public research universities, land-grant institutions, state university systems, and affiliated organizations spanning across all 50 states, the District of Columbia, six U.S. territories, Canada, and Mexico. Annually, member campuses enroll 5.4 million undergraduates and 1.4 million graduate students, award 1.4 million degrees, employ 1.3 million faculty and staff, and conduct \$51 billion in university-based research.

APLU's Board on Agriculture Assembly (BAA)

The Board on Agriculture Assembly (BAA) is a unit of the APLU's Commission on Food, Environment, and Renewable Resources. BAA's purpose is to promote agricultural research, education, and Extension in public and land-grant universities throughout the United States.

AgIsAmerica

AgIsAmerica highlights the collective power and impact of land-grant universities' research, education, and Extension that support people and communities across America. Agriculture, a vital industry in America, is integral to national security, public health, food security, and economic prosperity.

National Land-grant Impacts Database (NIDB)

NIDB is the nation's most extensive repository of the land-grant system's collective impacts statements in research, education, and Extension. It serves as a comprehensive and important resource for the land-grant system to tell their stories. APLU's BAA manages the database.

agInnovation*

agInnovation, a nationwide system of agricultural research stations operated under the auspices of the nation's land-grant universities, is dedicated to the science that feeds the world. Scientists are making discoveries that sustainably transform agriculture and life sciences and solve global challenges to enrich lives.

*Formerly known as Experiment Station Section

Cooperative Extension System (CES)

Extension is the nationwide transformational education system that translates research into action. It brings cutting-edge discoveries from research laboratories to those who can put knowledge into practice. CES empowers farmers, ranchers, and communities to meet their challenges, adapt to changing technology, improve nutrition and food safety, prepare for and respond to emergencies, and protect our environment. CES is operated through the nation's land-grant university system in partnership with the federal and state and local governments.

Multistate Research Fund (MRF)

Administered by USDA-NIFA since 1998, the MRF supports agricultural innovation and sustainability by providing federal funds to collaborative research projects led by State Agricultural Experiment Stations and land-grant universities. These projects bring together scientists, Extension educators, and other university, federal, and industry partners to tackle high-priority regional or national issues in agriculture.

National Registry of Cooperative Extension Programs and Assets

This tool enables Cooperative Extension professionals to register their projects, programs, or curriculum for nationwide collaboration among Extension colleagues.

U.S. Department of Agriculture (USDA) / The National Institute of Food and Agriculture (NIFA)

USDA NIFA provides leadership and funding for programs that advance agriculture-related sciences. NIFA invests in and supports initiatives that ensure the long-term viability of agriculture. NIFA applies an integrated approach to ensure that groundbreaking discoveries in agriculture-related sciences and technologies reach the people who can put them into practice.

National Climate Change Roadmap— A Research Framework for Agriculture, Forestry and Working Lands

(November 2023) is a new resource that provides valuable insights for developing strategies that address climate change through agriculture and forestry. Researchers from Colorado State University with support from the Meridian Institute led this horizon scan analysis, which is an assessment process that looks at emerging issues, threats, and innovations.

This science roadmap process involved over 60 national experts in climate-related agricultural research and Extension with further input from over 100 leading scientists. It includes an assessment of the state of climate adaptation research in agriculture, forestry and working lands, along with key needs and gaps. For each

gap, the authors identified research questions to address the impacts of climate change on agriculture, food systems, forests and natural resources, which are aligned with seven themes.

1. Systems-based innovations.
2. Participatory research processes.
3. Mitigation and adaptation through ecosystem management.
4. Climate-informed water resource management.
5. Energy-smart agriculture and technology integration.
6. Strategic, sustainable and regenerative agricultural practices.
7. Socioeconomic and policy research.²⁸

This work was funded by USDA's National Institute of Food and Agriculture (NIFA).

APLU's Board on Agriculture Assembly Member Institutions

National

American Indian Higher Education Consortium

Alabama

Alabama A&M University
Auburn University
Tuskegee University

Alaska

University of Alaska Fairbanks

American Samoa

American Samoa Community College

Arizona

University of Arizona

Arkansas

University of Arkansas
University of Arkansas at Pine Bluff

California

California Polytechnic State University, San Luis Obispo
California State University, Fresno
University of California System
University of California, Berkeley
University of California, Davis
University of California, Riverside

Colorado

Colorado State University

Connecticut

University of Connecticut

Delaware

Delaware State University
University of Delaware

District of Columbia

University of the District of Columbia

Federated States of Micronesia

College of Micronesia – FSM

Florida

Florida A&M University
University of Florida

Georgia

Fort Valley State University
University of Georgia

Guam

University of Guam

Hawai'i

University of Hawai'i at Mānoa

Idaho

University of Idaho

Illinois

Illinois State University
Southern Illinois University at Carbondale
University of Illinois at Urbana-Champaign

Indiana

Purdue University

Iowa

Iowa State University

Kansas

Kansas State University

Kentucky

Kentucky State University
University of Kentucky

Louisiana

Louisiana State University
Southern University and A&M College, Baton Rouge

Maine

The University of Maine

Maryland

University of Maryland
University of Maryland Eastern Shore

Massachusetts

University of Massachusetts Amherst

Michigan

Michigan State University

Minnesota

University of Minnesota

Mississippi

Alcorn State University
Mississippi State University

Missouri

Lincoln University
University of Missouri-Columbia

Montana

Montana State University

Nebraska

University of Nebraska-Lincoln

Nevada

University of Nevada, Reno

New Hampshire

University of New Hampshire

New Jersey

Rutgers, The State University of New Jersey

New Mexico

New Mexico State University

New York

Cornell University

North Carolina

North Carolina A&T State University
North Carolina State University

North Dakota

North Dakota State University

Northern Mariana Islands

Northern Marianas College

Ohio

Central State University
The Ohio State University

Oklahoma

Langston University
Oklahoma State University

Oregon

Oregon State University

Pennsylvania

The Pennsylvania State University

Puerto Rico

University of Puerto Rico at Mayagüez

Rhode Island

The University of Rhode Island

South Carolina

Clemson University
South Carolina State University

South Dakota

South Dakota State University

Tennessee

Tennessee State University
The University of Tennessee, Knoxville

Texas

Prairie View A&M University
Tarleton State University
Texas A&M University
Texas Tech University

Utah

Utah State University

Vermont

The University of Vermont

Virgin Islands

University of the Virgin Islands

Virginia

Virginia Polytechnic Institute & State University (Virginia Tech)
Virginia State University

Washington

Washington State University

West Virginia

West Virginia State University
West Virginia University

Wisconsin

University of Wisconsin-Madison

Wyoming

University of Wyoming

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Assembly manages the database. Please visit landgrantimpacts.org.

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