

TEXAS A&M AGRILIFE RESEARCH

---

# RESEARCH GOALS AND IMPACTS

Annual Report | 2015



TEXAS A&M  
**AGRILIFE**  
RESEARCH



# Contents

## ► ANNUAL REPORT | 2015

Introduction	5
AgriLife Research Selected Accomplishments 2015	6
Strategic Goals FY10–15 with Current Research Impacts	9
<i>Eastern Region</i>	11
<i>Far West Texas Region</i>	59
<i>Lower Rio Grande Valley</i>	65
<i>Panhandle-Plains Region</i>	71
<i>Winter Garden and South Central Region</i>	97
Conclusion	109



## MISSION

Our mission is scientific discovery that benefits consumers and expands agricultural sustainability, profitability, and environmental stewardship.

## VISION

We will maintain our position as the leader among peer organizations — both nationally and internationally — in the discovery and application of research in agricultural and life sciences. Our discoveries, development, and transfer of innovative technologies will produce economic, environmental, and health benefits that are key to Texas's success and vital to the lives of its citizens.

# INTRODUCTION

In this report, you will find the Texas A&M AgriLife Research 18 major research goals for Fiscal Years 2010–2015 and the impacts we have made as progress toward these goals. The goals and impacts are organized by the five agricultural regions of Texas: Eastern, Lower Rio Grande Valley, Winter Garden and South Central, Panhandle-Plains, and Far West Texas. Broadly, these goals address prominent agricultural and life sciences issues such as improving agricultural production, protecting water quality and making irrigation more efficient, using land wisely, preserving biodiversity and ecosystems, ensuring food safety, and mitigating insect-borne diseases. But they also include drug discovery, adding value to agricultural products and expanding market channels, developing healthy and affordable foods, providing scientific data about carbon sequestration, and creating alternative energy through biofuels.

This report includes our Top 10 impacts for 2015. For example, citrus greening, a bacterial disease transmitted by the citrus psyllid, has devastated Florida's citrus industry since it began infecting trees in 2005, cutting the citrus harvest by more than half. The disease has now spread to Rio Grande Valley citrus groves, even though fruit loss has so far been minimal. An AgriLife Research scientist working in the Valley has found that by introducing a natural plant defensin (a protein that helps plants resist bacteria, fungi, and viruses) from spinach into citrus tree varieties, they become resistant to the bacterium that causes greening. These varieties are nearly ready to be released. Long awaited by growers, they could help save the citrus industry.

In the conclusion to this report, we look forward to the coming five years, FY2016–2020, with four broad research goals as agriculture moves toward a more precision-driven, high-tech future. Like other scientists around the world, we understand that agriculture will meet new challenges as we endeavor to feed a projected 9 billion world population by 2050 while also coping with unfavorable conditions brought about by climate change and diminishing natural resources. We believe that scientific research and technological innovation will make agriculture more adaptive and resilient as we move forward into this future.

---

## About Texas A&M AgriLife Research

Established in 1888, we are the state's premier research and technology development agency in agriculture, natural resources, and the life sciences, with over 550 doctoral-level scientists. With headquarters at Texas A&M University in College Station, AgriLife Research has scientists and research staff in the College of Agriculture and Life Sciences, the College of Veterinary Medicine and Biomedical Sciences, and at nine centers and institutes on campus. We also have a statewide presence, with research faculty and staff on other Texas A&M University System campuses and at 13 regional Texas A&M AgriLife Research and Extension Centers. The National Science Foundation has ranked AgriLife Research number one in agricultural sciences expenditures, accounting for over \$179 million of the more than \$3.35 billion spent on agricultural research by more than 200 U.S. universities.

---

# 2015

## SELECTED ACCOMPLISHMENTS



### Combating Drug Resistance

The Sacchetti Lab is extending research in drug resistance by using novel rifamycins (a group of antibiotics that are particularly effective in treating tuberculosis and leprosy) to restore the effectiveness of existing therapeutic drug regimens for Non-Hodgkin's lymphoma, ovarian cancer in humans, and drug-resistant canine cancer. This method will also restore the efficacy of two of the drugs most commonly used to treat parasites in sheep and goats.



### Reversing Quail Decline

AgriLife Research published the first genome assembly for the northern bobwhite quail (*Colinus virginianus*). This seminal work should prove to be invaluable to researchers working to identify the cause of the decline in native Texas quail populations and to reverse this decline.



### Testing Wildlife Genes

Genetic testing by scientists at the Uvalde Center, in partnership with the College of Veterinary Medicine and Biomedical Sciences, revealed that deer cannot transmit tick fever to cattle. This finding protects the \$1.7 billion hunting industry in Texas by eliminating the requirements to impose quarantine restrictions on Texas cattle and to fund a costly tick-control program in wildlife.



### Saving Water through Hydroponics

AgriLife Research developed hydroponic cropping systems that increased lettuce yields by more than 40% while achieving water savings of more than 90% when compared to lettuce grown under conventional irrigation systems.

## Increasing Feed Efficiency

AgriLife Research made a preliminary identification of a gene variant that could result in a 20%–30% difference in feed efficiency in growing and finishing cattle. Capitalizing on this discovery could be worth \$112 per head, or more than \$2 billion annually, for U.S. cattle feeders.



## Improving Air Quality in Feedlots

Our air quality research team showed that ground-level particulate matter (dust) concentration could be reduced by 54%–84% by achieving optimal animal density in large cattle feedyards. This team has saved concentrated animal feeding operations more than \$20 million annually in potential fines and remediation.



## Controlling Invasive Insects

AgriLife Research and Extension worked with the Texas Department of Agriculture to obtain a Section 18 exemption from the Environmental Protection Agency for an unlabeled but effective insecticide to respond to an invasion of sugarcane aphids. Producer groups estimated savings of at least \$160 million in 2014 alone.



## Designing Disease-Resistant Citrus

Our scientists introduced a natural plant defensin (a protein that helps the plant fend off viruses, bacteria, and fungi) from spinach into citrus varieties to control citrus greening, an insect-transmitted disease that threatens to wipe out the \$13 billion citrus industry.



## Developing Drought-Resistant Wheat

TAM 111, TAM 112, and TAM 113 wheat are among the most drought-resistant varieties ever developed for the High Plains. Growers realized an almost \$5 million increase in yields when planting wheat varieties developed by Texas A&M AgriLife Research.



## Reducing Cotton Irrigation

Researchers found that cutting early cotton irrigations reduced total water use by 20% while reducing lint yield by only 5%. A 25% adoption rate of this irrigation method could reduce annual water requirements by more than 1 million acre-inches, or 27 trillion gallons. This potential water savings could meet the municipal water needs of Lubbock for 20 months.





---

**TEXAS A&M AGRILIFE RESEARCH**

**Strategic Goals  
Fiscal Years 2010–2015  
with Current Research Impacts**



# EASTERN REGION

*Texas A&M AgriLife Research and Extension  
Center at Beaumont*

*Texas A&M AgriLife Research and Extension  
Center at Corpus Christi*

*Texas A&M AgriLife Research and Extension  
Center at Dallas*

*Texas A&M AgriLife Research and Extension  
Center at Overton*

*Texas A&M AgriLife Research and Extension  
Center at Temple*

*College of Agriculture and Life Sciences,  
Texas A&M University*

*College of Veterinary Medicine and  
Biomedical Sciences, Texas A&M University*

*Norman Borlaug Institute for International  
Agriculture*

*Texas A&M AgriLife Genomics and  
Bioinformatics Service Facility*

*Institute for Infectious Animal Diseases*

*Office of the Texas State Chemist*



# GOAL

Protect water quality and increase the amount of water available for urban and rural use through new technologies and approaches.



## PROGRESS

### *Testing, improving, and protecting water quality*

- The Dallas Center, in collaboration with the Temple Center and the Spatial Sciences Laboratory in the College of Agriculture and Life Sciences (Department of Ecosystem Science and Management), conducted a basinwide assessment for 12 major reservoirs in the Trinity River Basin for sediment and nutrient delivery.
  - *This resulted in a calibrated model for the Dallas–Fort Worth Metroplex that allows governments, municipalities, water districts, agencies, planners, and developers to make better decisions on how to manage land resources to protect and improve water quality.*
- Soil and Crop Sciences Department research in 2015 determined that the alluvial aquifer below the city of Austin was not contaminated by fecal matter and other pathogens following the release of water from the Colorado River dam.
- The Soil and Water Assessment Tool (SWAT) hydrologic model, developed at the Temple Center and in the Department of Ecosystem Science and Management in cooperation with the USDA Agricultural Research Service, is the standard across all federal agencies to evaluate the hydrologic and nutrient impacts of growing crops for biofuels.

### *Developing irrigation strategies to save water*

- Overton Center researchers are estimating the water requirements of landscape plants and evaluating management of lawn sprinkler systems with equipment controllers that account for potential evapotranspiration conditions.
  - *They initiated a study with Kilgore College to estimate irrigation water requirements of Coastal and Tifton 85 Bermuda grass and of selected vegetable crops.*
  - *Researchers demonstrated the potential for developing salt-tolerant ryegrass cultivars for lawns and golf courses that can be irrigated with marginal water.*
- Collaborating with researchers in several southern states, Overton Center scientists screened plant pathogens commonly found in recycled irrigation water for fungicide resistance.

## Conserving water on farms and in urban environments



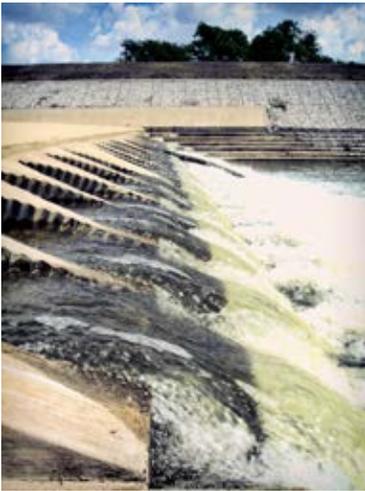
*During 2014, the Dallas Center's Urban Water Team trained 3,700 individuals and constructed 4,800 rain barrels, which collect 7.6 million gallons of water annually, eliminate 7,000 pounds of non-point source pollution, and save their owners \$60,000 a year on water bills.*



- The nation's first EPA-certified WaterSense retrofit home, at the Dallas Center, serves as an urban water education center. It promotes residential water conservation by providing hands-on learning opportunities in such areas as on-demand hot water systems, water-efficient faucets, water-efficient landscaping and irrigation systems, rainwater harvesting, and rain garden design. A WaterSense home saves 50,000 gallons of water and \$600 in utility costs each year.
- During 2014, the Dallas Center's Urban Water Team trained 3,700 individuals and constructed 4,800 rain barrels, which collect 7.6 million gallons of water annually, eliminate 7,000 pounds of non-point source pollution, and save their owners \$60,000 a year on water bills.
  - *The team also serves on government and private boards, including the Texas Water Development Board's Water Conservation Advisory Council and the Fort Worth Water Department's Water Conservation Advisory Council. In 2014 the team was recognized with numerous awards, including the WaterSense Award from the U.S. Environmental Protection Agency.*
- Capping eroded urban landscapes having marginal permeability with a thin layer of more permeable material such as sand can help capture more rainwater, reducing the need for supplemental irrigation. Soil and Crop Sciences researchers are developing fundamental data to show the appropriate hydraulic properties and depth of capping materials for particular landscapes.
- Wildlife and Fisheries scientists conducted research on the Brazos and Trinity Rivers that provided information for state agencies and regional stakeholder groups to evaluate current environmental flow standards. These standards have been established by the Texas Commission on Environmental Quality and are used to evaluate applications for new water rights.
  - *Surface water is a limiting factor for residential, industrial, and agricultural growth in many regions of Texas, and balancing direct human water needs with ecosystem services of the state's rivers, streams, and estuaries requires scientific studies to determine ecological responses to flow variation.*
- Beaumont Center researchers have developed the Rice Water Conservation Analyzer to estimate the effects of on-farm water conservation methods such as laser leveling, on-site reservoirs, buried laterals, and water-conserving rice varieties.
  - *It also leads development of water- and fertilizer-efficient rice production systems and promotes optimization of cutting heights to increase ratoon crop production.*
  - *New proposals are being developed with scientists from Texas, Mississippi, and California addressing the optimization of rice water management using both field experimentation and crop modeling to analyze how regional differences in soil, rainfall, climate, and cropping practices affect the degree with which different on-farm conservation measures can reduce rice water use.*

# GOAL

**Sustain and support efficient use of land resources and ensure air quality in the production of food and non-food crops.**



*Overton Center researchers have completed three years of a trial using legumes as nitrogen source crops in rotation with grain sorghum. Results indicate warm-season legumes contribute at least 100 pounds of nitrogen per acre per year to cropping systems.*



## PROGRESS

### *Developing best practices for remediating soil contamination and conserving land and water*

- The Conservation Effects Assessment Program (CEAP) Modeling Team at the Blackland (Temple) Center plays a pivotal role in the development of national resources conservation policy leading to the development and application of federal farm programs. The team helps state, federal, and nonprofit environmental organizations address high-priority concerns, including water quality, agricultural runoff, and soil erosion.
  - The team completed priority assessments of water quality for Chesapeake Bay, Delaware River, Lake Erie, Des Moines River, St. Francis River, and the California–San Francisco Bay tributaries for the USDA Natural Resources Conservation Service chief's congressional testimony on efforts to improve water quality in critical areas.
  - The team completed and published 12 reports for the 2003–2006 CEAP Cropland Assessment. The research showed that the nation has made significant strides overall in reducing the loss of sediment, nutrients, and pesticides from cropland by adopting conservation practices. There is still a need for comprehensive conservation planning related to high fertilizer losses in many areas.
- A Soil and Crop Sciences professor developed a team to provide leadership in reducing soil contamination problems associated with oil leaks internationally. This work has expanded to offering workshops and advanced training on soil remediation.
- A Soil and Crop Sciences researcher developed methods resulting in a reclamation strategy that has successfully revegetated the largest U.S. EPA Superfund site, a 150-year-old mining and copper ore–smelting site near Butte, Montana. The reclamation reduces further risks of heavy-metals pollution at the site.

### *Identifying cropping strategies for better land use and air quality*

- Overton Center researchers have completed three years of a trial using legumes as nitrogen source crops in rotation with grain sorghum. Results indicate warm-season legumes contribute at least 100 pounds of nitrogen per acre per year to cropping systems.
- Overton researchers are in year 2 of trials designed to develop cropping systems using rotations of cowpea and forage rye to reduce nitrogen fertilizer inputs in forage and cowpea seed production systems for East Texas.



*The pilot of the Temple Center's index-based insurance grazingland risk management product for the USDA's Risk Management Agency has been well received, with livestock producers enrolling more than 52 million acres across 29 states. Research is underway to extend its capabilities to include national drought monitor information so producers can receive daily actionable information for adaptive drought management and livestock optimization.*

- The Overton Center has identified optimum stocking rates and strategies to maximize land-use efficiency in producing beef cattle weight gains on pasture.
  - *Overton researchers are developing stocking strategies and pasture systems for grass-fed natural beef.*
- Soil and Crop scientists have selected an extensive collection of drought-tolerant, cold-tolerant, resource-use-efficient forage crops that can also be used for biofuels, developed through the Perennial Grass Breeding Program. The researchers recommend using these crops on abandoned, degraded, and underutilized grassland resources throughout Texas.
- Research at the Corpus Christi Center into the use of warm-season legumes adapted to South Texas has discovered the potential for their use as pulse/grain, hay, grazing, and bioenergy crops.
  - *Legumes increase resource-use efficiency by providing nitrogen and soil stabilization to perennial warm-season grasses grown for bioenergy or livestock grazing.*
  - *A project evaluating germplasm of black-eyed peas, which are less susceptible to iron chlorosis, is in its fourth year. This crop will produce pulse for domestic and international markets and provide fodder for livestock production or crop residue, which is nitrogen rich.*

### **Designing tools for production and conservation**

- After 15 years, the Crop-Weather Program for South Texas (CWP), launched at the Corpus Christi Center, continues to be a robust, reliable, and expandable Web-based tool for researchers and crop managers, due to its innovative and efficient architecture.
  - *As of 2015, the network of 32 weather stations extends from Fort Bend County to the Rio Grande Valley, with approximately 2,050 registered users.*
- The pilot of the Temple Center's index-based insurance grazingland risk management product for the USDA's Risk Management Agency has been well received, with livestock producers enrolling more than 52 million acres across 29 states. Research is underway to extend its capabilities to include national drought monitor information so producers can receive daily actionable information for adaptive drought management and livestock optimization.
  - *An outgrowth of the PHYGROW and Livestock Early Warning System developed by AgriLife Research and USAID in East Africa, this product has become an important safety net for U.S. livestock producers.*



*The USDA Natural Resources Conservation Service established regional modeling centers for APEX at Temple and in Alabama, Massachusetts, and California. Researchers will address regional conservation and water quality concerns. The AgriLife Research APEX modeling team is supporting these efforts by developing regional databases and adjusting model parameters to better serve the needs of landowners and managers in each region.*

- Soil and Crop Sciences developed methods for applying poultry litter to prevent problems associated with *E. coli* runoff following land application. They are adding a new poultry bacterial source tracking model (with greater than 99% effectiveness against tested isolates) to the Texas Bacterial Source Tracking Toolbox to monitor sources of water contamination.
- The demand for the Soil and Water Assessment Tool (SWAT), Agricultural Policy/Environmental eXtender (APEX), and Environmental Policy Integrated Climate (EPIC) models, developed at the Temple Center, continues to grow in the United States and around the world. In 2014, 435 people participated in training for these models at workshops held in the United States, Brazil, Italy, Ethiopia, Uzbekistan, Kazakhstan, Poland, India, Vietnam, Jordan, and Tunisia.
  - *The USDA Natural Resources Conservation Service established regional modeling centers for APEX at Temple and in Alabama, Massachusetts, and California. Researchers will address regional conservation and water quality concerns. The AgriLife Research APEX modeling team is supporting these efforts by developing regional databases and adjusting model parameters to better serve the needs of landowners and managers in each region.*
  - *Interest in the application of these models is very strong in Africa, with 120 students and scientists trained in Ethiopia alone.*

## GOAL

**Conduct basic and translational research to minimize the unfavorable effects of agricultural production and urban communities on the environment.**

## PROGRESS

### *Minimizing the impacts of industry on the environment*

- A novel Hybrid Zero Valent Iron treatment for wastewater was developed in the Department of Biological and Agricultural Engineering. This treatment can remove more than 95% of heavy metal contaminants generated by electric power plants, mining, and other industries.
  - *Siemens Water Technologies and Texas A&M AgriLife Research have an exclusive license agreement and a research and development agreement to continue to develop and commercialize this technology.*

### *Reducing greenhouse gas emissions in animal agriculture through nutrition models*

- An *in vitro* gas-production technique has been developed by Animal Science faculty to assess biological values of feeds based on their pattern of accumulated gas (including methane, a potent greenhouse gas) during incubation with rumen fluid under anaerobic conditions. This information is used to formulate and balance rations for ruminants to reduce greenhouse gas emissions in animal-feeding operations.



*Soil and Crop Sciences researchers studied the effects of fertilization timing and source on resulting runoff losses of nitrogen and phosphorus during establishment of St. Augustine grass sod. They found that regardless of nitrogen source or timing, only 0.6%–4% of the total applied nitrogen fertilizer was lost to runoff and that nearly 33% of the nitrogen was dissolved organic nitrogen, suggesting that it was from natural sources rather than fertilizer. The data suggests that in healthy, properly irrigated and fertilized sod, environmental losses of nitrogen and phosphorus should be minimal.*



## Identifying best practices for Texas landscapes

- Research on pest-resistant rose varieties at the Overton Center aims to minimize the use of pesticides by rose producers and by consumers planting roses in home and commercial landscapes.
  - *Annual bedding plant varieties are being tested for adaptation, which will allow producers and consumers to make ornamental plant selections that will increase the sustainability of commercial and home landscapes, reducing costs from shrinkage, pesticides, and water use.*
- Overton Center research has contributed to the growth of horticulture in East Texas to an over \$1.2 billion industry.
  - *Bedding plant trials, plant management research, and disease studies continue to provide technology to aid producers and homeowners.*
- Soil and Crop Sciences researchers studied the effects of fertilization timing and source on resulting runoff losses of nitrogen and phosphorus during establishment of St. Augustine grass sod. They found that regardless of nitrogen source or timing, only 0.6%–4% of the total applied nitrogen fertilizer was lost to runoff and that nearly 33% of the nitrogen was dissolved organic nitrogen, suggesting that it was from natural sources rather than fertilizer. The data suggests that in healthy, properly irrigated and fertilized sod, environmental losses of nitrogen and phosphorus should be minimal.
- Research by a Recreation, Park and Tourism Sciences professor and graduate students have helped College Station, Texas, reduce water use by nearly 200 million gallons over a four-year period by providing 5,500 homeowners with targeted landscape water budgets. Based on these budgets, homeowners adjusted their outdoor water use and reduced lawn overwatering. The Brazos Valley WaterSmart website ([bvwatersmart.tamu.edu](http://bvwatersmart.tamu.edu)) helps homeowners reduce further overwatering.
- The Texas Coastal Watershed Program (TCWP), working with researchers in the Department of Recreation, Park and Tourism Sciences, has taken a lead role in developing Green Stormwater Infrastructure (GSI), also known as low-impact development, for the greater Houston region. Using the WaterSmart landscape program, they collaborated on development of the Ghirardi WaterSmart Park, a first-of-its-kind park in Texas and one of few in the United States demonstrating a number of GSI techniques. These demonstrations are also used for water quality monitoring.
- Consulting with professionals in Recreation, Park and Tourism Sciences, the Texas Coastal Watershed Program has installed several high-profile stormwater wetlands in the Houston region, including two in the Texas Medical Center.

- The TCWP laid the groundwork for one of the very first stakeholder-based watershed protection plans in Texas, the Armand Bayou Watershed Protection Plan, and is currently concentrating on watershed protection plans in Galveston County.

### **Researching forage and soils for optimum use of nutrients**

- Forage and soils data from long-term experiments at the Overton Center document the impact of stocking rates and fertility regimens on soil nutrient status at multiple depths.
  - *Nutrient cycling returns key nutrients to pastures via excreta and plant decomposition, providing a way to grow forage without nitrogen fertilizer.*
- Overton researchers developed recommendations for nitrogen supplementation to poultry litter applications to maximize the efficient use of nutrients for plant growth.

### **Designing cost-effective, sustainable, pest- and disease-management solutions**

- Scientists at Beaumont developed a web-based postharvest grain management program for insects in on-farm storage bins and in rice mills. Included is a feature that evaluates the effects of organic pesticides on postharvest insect control.
- The Beaumont Center is a leader in the development of cost-effective and sustainable rice integrated pest management (IPM) production systems. Development of IPM programs for rice water weevil, rice stinkbug, and stem borers have reduced yield loss to rice by about 5% annually, resulting in a savings of \$8.1 million per year for producers.
  - *Revised treatment thresholds for rice stinkbug and registration of new residual insecticides have decreased the number of insecticide applications from 4 to 2, saving \$2.8 million per year in application costs alone.*
  - *Development of an IPM program for the red-banded stinkbug in soybeans is expected to save growers \$2.5 million per year.*
  - *The center's entomology research program led to the development of a microbial seed treatment, BioEnsure, for use in rice and other field crops. This treatment represents a new type of research that enables growers to manage plant disease, drought, salt, and temperature stresses.*

*The Beaumont Center is a leader in the development of cost-effective and sustainable rice integrated pest management (IPM) production systems. Development of IPM programs for rice water weevil, rice stinkbug, and stem borers have reduced yield loss to rice by about 5% annually, resulting in a savings of \$8.1 million per year for producers.*





*Beaumont research has led to an emergency exemption for a product to control a newly invasive sugarcane aphid; supported the registration of a product to manage sheath blight, which threatens rice production; and supported the registration of fungicides for rice seedling disease control, now used to treat more than 60% of rice seed in the United States.*

- The Beaumont Center's plant pathology research program is a national leader in developing innovative blight-management options that use beneficial growth-promoting bacteria, bio-fumigation cover crops, and rate-reduced fungicides. Development of a resistant rice cultivar-based sheath blight management program has reduced damage and reduced the use of fungicide by 50%, with an estimated economic advantage of \$4.1 million per year.
  - *Beaumont research has led to an emergency exemption for a product to control a newly invasive sugarcane aphid; supported the registration of a product to manage sheath blight, which threatens rice production; and supported the registration of fungicides for rice seedling disease control, now used to treat more than 60% of rice seed in the United States.*
- A researcher in the Department of Plant Pathology and Microbiology demonstrated that mutants deleted in each of four genes encoding a particular type of protein in the fungal biocontrol agent *Trichoderma virens* enhanced induced systemic resistance in maize and tomato, reducing the defense levels in the plant. *T. virens* produced volatile compounds to stimulate the growth of cotton seedlings and had a negative effect on growth of the cotton pathogen *Fusarium oxysporium*.
- A Plant Pathology scientist developed next-generation plant virus-based gene expression vectors to modulate gene expression in plants. These can be used to isolate high levels of proteins of interest in plants grown for biofuel and pharmaceutical purposes.
- A scientist in Plant Pathology and Microbiology was recognized for her contributions to the field of plant-microbe interactions and plant immune signaling. Another distinguished researcher won recognition for his paradigm-breaking research on the role of programmed cell death in plant pathogen interactions.
- A plant pathologist published the first analyses of innate immune responses of the model species *Brachypodium distachyon* (C3 grass) and *Setaria viridis* (C4 grass) to infection by seven plant viruses that are known to cause significant economic damage to small grains and forage grasses.
- A scientist in Plant Pathology showed that the genes involved in mating of maize and sorghum isolates of the head smut pathogen are compatible and developed DNA markers that will allow them to determine whether crosses will occur in nature or the laboratory. The ability to cross would allow new combinations of virulence alleles and perhaps account for the ability to overcome host resistance.



*A plant pathologist has conducted experimental trials to control cotton root rot in wine grapes with the fungicide flutriafol and found it to be successful in suppressing disease development and saving vines. This information will be used to obtain emergency registration for a commercial product to help Texas grape growers control the disease.*



- A Plant Pathology researcher developed a computation algorithm to define key genetic elements involved in mycotoxin biosynthesis in corn toxigenic fungi. This researcher is also developing a device to improve functional genomics research in plant pathogenic fungi; it could innovate and streamline fungal genomics with much greater efficiency and cost savings. A third project involves a research collaboration to better understand cellulolysis and amylolysis at the molecular level in fungi, which would provide a conceptual blueprint for microbial metabolic engineering via synthetic biology.
- A plant pathologist has conducted experimental trials to control cotton root rot in wine grapes with the fungicide flutriafol and found it to be successful in suppressing disease development and saving vines. This information will be used to obtain emergency registration for a commercial product to help Texas grape growers control the disease.
- A Plant Pathology scientist has confirmed that silver nanoparticles are effective for managing plant-parasitic nematodes in golf courses.
- A Plant Pathology and Microbiology researcher has developed and licensed to a pharmaceutical company a bacteriophage-based treatment for Pierce's disease of grapes. Phage therapy is an attractive disease-control method because it is pathogen-specific and has no negative effects on beneficial bacteria.
  - *This work is gaining interest by the olive tree community because olive scorch disease, which has affected millions of olive trees in Italy, is also caused by the bacterium that causes Pierce's disease (Xylella fastidiosa). The process will also be useful for treating Xylella-caused diseases in coffee and citrus.*
- By implementing the School Integrated Pest Management (IPM) System, developed by researchers in the Department of Entomology, the Spring (Texas) Independent School District (serving 36,000 students) now uses 100% "Green" category pesticides, the lowest-risk pesticides.
  - *No sprays are applied to the interior of buildings.*
  - *The amount of chemicals used has been reduced by 70%.*
  - *Before the adoption of IPM, 55% of pesticides used in Spring ISD were classified by the EPA as highly toxic.*

# GOAL

Conduct basic and translational research into the factors affecting biological diversity and ecosystem structure and functioning, including the role of human activity.



*Researchers in Wildlife and Fisheries Sciences are studying the impacts of persistent organic pollutants on migrant birds, the impacts of harmful algal blooms on aquatic birds, and the impacts of neonicotinoid insecticides on bobwhite quail in Texas. They are also evaluating the impacts of the red imported fire ant on northern bobwhite populations.*

# PROGRESS

## *Finding solutions when human activity might affect endangered species*

- Researchers at the Temple Center and in the Department of Ecosystem Science and Management have provided unbiased data on habitat requirements and ecological interactions of endangered species, such as the golden-cheeked warbler and the black-capped vireo. Wildlife and Fisheries Sciences researchers have substantially advanced the understanding of the status of these and many other endangered species in Texas. Using advanced methods and study designs, Wildlife and Fisheries has provided management agencies with the information they need to alter existing guidance for conserving these species.
  - *This data has helped government leaders, agricultural producers, and the U.S. Department of Defense arrive at workable solutions to human-wildlife interactions in the Fort Hood region of Central Texas.*
- Researchers in Wildlife and Fisheries Sciences are studying the impacts of persistent organic pollutants on migrant birds, the impacts of harmful algal blooms on aquatic birds, and the impacts of neonicotinoid insecticides on bobwhite quail in Texas. They are also evaluating the impacts of the red imported fire ant on northern bobwhite populations.
- Wildlife and Fisheries researchers are collaborating with Texan Exotic Wildlife Ranchers and the International Conservation community to determine the social behavior and habitat requirements of dama gazelles. They hope to help repopulate these animals in their native African lands, where they are highly endangered.
- A Recreation, Park and Tourism Sciences researcher is studying the attitudes and behaviors regarding the natural environment that U.S. citizens bring to developing nations through amenity migration. Some improve local ecosystems, whereas others are questioned or rejected by local populations. Rural areas rich in natural resources seem to be benefiting from a large pool of environmental attitudes and behaviors that are emerging in countries experiencing amenity migration, brought both by larger macro-societal movements and U.S. citizens.
- Recreation, Park and Tourism Sciences is also studying changing rural communities that are encroaching into natural ecosystems or protected areas. While most people wish to protect these environments, many are unwittingly causing damage by building homes and consuming natural resources in the areas.

*The direct economic contribution from Lower Rio Grande Valley nature tourism led to a total county-level economic output of \$463 million and more than 6,600 full- and part-time jobs annually. This total contribution includes a \$266.6 million contribution to gross regional product and a \$163 million contribution to labor income across the region. This information was provided to local destination-marketing organizations to help them plan for sustainable tourism throughout the region.*



- A Recreation, Park and Tourism Sciences professor led the development of a national Socioeconomic Monitoring Program for the National Park Service to inventory the social, cultural, and behavioral stressors affecting the ecological and social systems that parks occupy. He conducted a yearlong national needs assessment to identify vital social indicators whose long-term monitoring would improve the planning and management of parks. The report is guiding the development and pilot testing of a national monitoring program in 20 National Park System units, with the long-term goal of expanding the program to represent all 407 units of the park system.

### **Studying the economic impacts of sustainable nature tourism and Texas state parks**

- A team of researchers from the Departments of Recreation, Park and Tourism Sciences and Agricultural Economics assessed the economic impact of nature tourism throughout the four-county region of the Lower Rio Grande Valley, estimating the direct, indirect, and induced effects of spending among nature tourists. The results of the study showed that the direct economic contribution from Lower Rio Grande Valley nature tourism led to a total county-level economic output of \$463 million and more than 6,600 full- and part-time jobs annually. This total contribution includes a \$266.6 million contribution to gross regional product and a \$163 million contribution to labor income across the region. This information was provided to local destination-marketing organizations to help them plan for sustainable tourism throughout the region.
- A Recreation, Park and Tourism Sciences professor was commissioned by the Texas Parks and Wildlife Foundation in a study that collected data from over 51,000 park visitors in 2014. The sample was used to estimate the economic impact of each of the 89 state parks on its host community. In fall 2015, these results were cited in major media and were used by leaders of conservation organizations to inform individual legislators of the economic impact of Texas state parks. As a result, the 2015 legislature increased the state parks' budget by about \$100 million for 2016–17. In addition, a sporting goods sales tax will now be a designated fund that can be allocated only to state parks, guaranteeing that 94% of the \$130 million from the tax will go to state parks in future years.

### **Providing resources for biodiversity research**

- The Texas A&M University Insect Collection (TAMUIC), in the Department of Entomology, currently holds nearly 3 million total curated specimens. This is the largest insect collection in Texas, and it provides a resource for scientists and others who conduct systematic research.
  - *The TAMUIC also participates in the Global Biodiversity Information Facility in Copenhagen, Denmark, which provides the largest biodiversity database on the Internet, collected from dozens of participating countries. Its basic collection data may be accessed electronically.*



The TCWP developed an “ecologic map” for the eight-county Houston Metro region, documenting significant natural habitats of 100 acres or more. The map has been a major factor in the emerging Regional Conservation Plan facilitated by Houston Wilderness and is recognized across the region as the “go-to” map.

- A researcher in Recreation, Park and Tourism Sciences is helping to protect the biodiversity of Texas’s inland and coastal fisheries by studying the human dimensions of fisheries, with the Texas Parks and Wildlife Department as part of its long-term monitoring program. A 2015 survey of licensed Texas anglers will provide information concerning the public’s attitude toward existing resource management plans, current angling behavior, and the angling public’s awareness of threats to fishing, such as introduced and invasive species.
  - A researcher is studying the use of artificial reefs in Texas for fishing and boating and informing the public about the Texas Parks and Wildlife Department’s Artificial Reef Program in the Gulf of Mexico. The results of the study have implications for ecosystem restoration, water quality, fisheries production, recreation, and placement of future reefs.
- Students in the Department of Agricultural Leadership, Education, and Communications developed presentation materials to support the application of the Namib Sand Sea as a UNESCO World Heritage site. They also compiled a photo repository for the Gobabeb Research and Training Centre, located in the Namib Desert, which conducts research and educational training to serve as a catalyst for understanding arid environments.
  - The Sand Sea is a coastal fog desert that is home to a large number of endemic plants and animals that are globally important examples of evolution and life in extreme environments.

### Researching wetlands and preserving ecosystems

- The Texas Coastal Watershed Program (TCWP), developed in coordination with the Department of Recreation, Park and Tourism Sciences, researches the ecohydrology of headwater wetlands in the greater Houston area and maps ecosystem resources and services on the Upper Gulf Coast. The program has developed new information on the loss of so-called isolated wetlands, the relationship of the wetlands to the quality of receiving water bodies, and the documentation of mitigation for wetland loss. This research influenced the direction of the recently adopted Clean Water Act Section 404 wetland rule.
  - The TCWP recently collaborated with the Houston Advanced Research Center (HARC) to evaluate wetland mitigation in the Houston Metro region. This research is just beginning to influence policy discussions on long-term wetland mitigation issues.
- The TCWP developed an “ecologic map” for the eight-county Houston Metro region, documenting significant natural habitats of 100 acres or more. The map has been a major factor in the emerging Regional Conservation Plan facilitated by Houston Wilderness and is recognized across the region as the “go-to” map.

*Agricultural economists estimated that a biological control program for giant reed along the Rio Grande would contribute \$9 million to \$18 million per year to the South Texas economy by 2025 and create an additional 197 to 351 jobs.*

*This has resulted in the implementation of a biological control program for giant reed in the Rio Grande Valley.*

- The TCWP, working with the Texas Parks and Wildlife Department, has pioneered a simple but extremely effective method for restoring coastal prairie pothole wetlands. Known as the Sheldon-Sipocz Method, this tool enables first-class restoration to successfully take place in record time, because the original wetland topsoil is re-exposed using the same tools that leveled these wetlands for rice from the 1960s through the 1990s.
  - *The method is coming into wider use across the area (for example, by the Katy Prairie Conservancy), and more than 100 acres received high-quality restoration at Sheldon State Park in Houston.*

### **Studying the impacts of livestock grazing and animal domestication**

- A 30-year project at Overton revealed the impact of grazing management on Bermuda grass ecotype composition. Current and long-term pasture and plant sampling documented extensive Bermuda grass ecotype diversity in response to beef cattle stocking rate, fertility regimens, and other factors.
- Department of Ecosystem Science and Management researchers demonstrated that soil nematode communities are much more diverse in native grasslands than in invasive woody plant communities, altering the flow of energy and nutrients in belowground food chains.
  - *Because nematodes help regulate ecosystem function, their distribution in grasslands rather than woody clusters could affect the bioavailability of nutrients and limit plant-microbe and plant-plant interactions, altering the future of ecological processes in their ecosystem.*

### **Mitigating the effects of invasive species**

- The Overton Center initiated a collaborative project with the Noble Foundation to define habitat-use patterns of feral hogs to aid in developing control protocols.
- Agricultural economists estimated that a biological control program for giant reed along the Rio Grande would contribute \$9 million to \$18 million per year to the South Texas economy by 2025 and create an additional 197 to 351 jobs.
  - *This has resulted in the implementation of a biological control program for giant reed in the Rio Grande Valley.*

# GOAL

Improve agricultural production and efficiency through advances in animal and plant breeding, management, and health.

*The Texas A&M AgriLife vegetable breeding program, coordinated in the Department of Horticultural Sciences, generated more than 700 new lines and hybrids of pepper, tomato, onion, and melon and is evaluating them for commercial potential. Seven pepper, three melon, and eight tomato hybrids were chosen by private industry collaborators for advanced trials. Disclosures for four onion lines and two tomato lines were submitted to the Office of Technology Commercialization for licensing to two private companies, and for a utility patent.*



# PROGRESS

## *Using genetics and genomics to develop drought- and disease-resistant, herbicide-tolerant, high-yielding plants*

- Studies on crop drought tolerance began at the Corpus Christi Center in 2010 on construction of the Drought Tolerance Laboratory. Cotton drought tolerance studies were conducted in collaboration with AgriLife Research cotton breeders. Other studies included sugarcane transgenic genotypes, which helped identify drought-tolerant genotypes. For example, two cotton genotypes showed higher water-use efficiency as a result of higher biomass partition into seed cotton. Two transgenic sugarcane varieties also showed higher water-use efficiency while maintaining biomass production. Studies conducted in 2015 with sugarcane are still in progress; those with cotton are being analyzed.
- Corpus Christi Center scientists and AgriLife Research peanut breeders have developed new peanut varieties that have a greater potential yield and make better use of irrigation water. Research on newer herbicides, which provide more effective control of problem weeds, has led to a reduction in overall herbicide usage. The use of more effective fungicides, along with varieties with tolerance to foliar and soil-borne diseases, has led to increased control of disease and higher yields.
  - *These developments have resulted in increased net profits for growers. With a yield increase from 3,500–4,000 pounds per acre about 20 years ago to 5,500–6,000 pounds per acre today, the added gain for peanut producers can be \$100–\$150 per acre at today's prices.*
- The Texas A&M AgriLife vegetable breeding program, coordinated in the Department of Horticultural Sciences, generated more than 700 new lines and hybrids of pepper, tomato, onion, and melon and is evaluating them for commercial potential. Seven pepper, three melon, and eight tomato hybrids were chosen by private industry collaborators for advanced trials. Disclosures for four onion lines and two tomato lines were submitted to the Office of Technology Commercialization for licensing to two private companies, and for a utility patent.
- Over the past four years, the AgriLife Research Prunus Breeding and Genetics Program in the Department of Horticultural Sciences has released 20 new peach or nectarine cultivars for the low- to medium-chill zones with improved flesh colors, flavors, shapes, and nutritional content.
  - *These releases represent a major advancement in the types of stone fruit available to growers in the southern regions of the country, advancing the commercial harvest by 2–3 weeks and potentially adding 10% in production capacity. This could have a potential value of up to \$50 million annually in the United States.*

*Analyses of a collection of corn mutant lines that are nearly genetically identical except for the LOX family of genes revealed new functions for this gene family, which can produce plants with the ability to grow in zinc- and iron-deficient soils, drought tolerance, resistance to insects and pathogens, and resistance to aflatoxin contamination of seed.*



- The AgriLife Research wheat-breeding team, including a wheat breeder in the Department of Soil and Crop Sciences, has been recognized for its varieties, which continue to dominate wheat production in the Great Plains and are estimated to add more than \$200 million annually to the U.S. economy. The recently released TAM 204 is a grazing-type wheat, and TAM 114 is a new drought-tolerant wheat that makes a stronger dough. In 2015, Texas A&M wheat varieties topped the Republic of Georgia trials, and they average three times the yield of previously grown cultivars.
- The AgriLife Research potato-breeding program has developed 15 potato varieties, and several of these are licensed to seed producers nationwide. The latest addition is the recently patented variety 'Sierra Rose'. Our potato breeder is a member of the USDA Zebra Chip Team, which was recognized by the USDA as a recipient of the 2014 Partnership Award for service to the national and international potato industry.
- Plant Pathology and Microbiology researchers have identified five genes that either positively or negatively affect drought tolerance in maize. Analyses of the genomes of 60 diverse maize lines identified four lines in which the genes required for drought tolerance are duplicated. Efforts are underway to breed these beneficial duplicated alleles into AgriLife Research maize elite germplasm.
  - *Analyses of a collection of corn mutant lines that are nearly genetically identical except for the LOX family of genes revealed new functions for this gene family, which can produce plants with the ability to grow in zinc- and iron-deficient soils, drought tolerance, resistance to insects and pathogens, and resistance to aflatoxin contamination of seed.*
- The sorghum-breeding program in Soil and Crop Sciences has developed the lines that are the bases for most bioenergy sorghum work, but breeders have also developed parental lines for food and forage. Significant among those are lines that produce photoperiod-sensitive forage hybrids. This system of impacting maturity, and thus forage quality, was developed and released by the Texas A&M AgriLife sorghum team and is now used worldwide for forage hybrid production. The long-term program in breeding grain sorghum has led to hybrids that are noted for their healthy characteristics and are currently being evaluated for the food industry.
- A researcher in Soil and Crop Sciences has developed advanced lines of corn for improved resistance to biotic and abiotic stresses; improved quality and processing properties for food, feed, and industrial products; and improved agronomics for Texas production. Trials indicated that this is one of best germplasms across the southern United States, and multiple agreements are underway to investigate potential market opportunities.

Dallas Center scientists developed the first sequence-tagged high-density genetic maps of two commercial, warm-season turfgrasses, *Zoysia japonica* and *Zoysia matrella*. The zoysiagrass map, which was accepted for publication in *Plant Journal*, provides an essential genomic tool for gene tagging and marker-assisted selection for accelerated development of significantly improved varieties. It is also the foundation for sequencing the zoysiagrass genome and for conducting comparative genomics analyses among grasses. This research will speed the development of more water-efficient, heat- and cold-tolerant, and disease-resistant turfgrass varieties. The grasses will also be more tolerant to the use of effluent or brackish water for irrigation, preserving freshwater for human consumption and food crop production.



- Corpus Christi Center research on the fungus that causes sorghum downy mildew in wild Johnson grass across the upper and lower Coastal Bend of Texas has led to discovery of the best resistance genes for hybrid grain sorghum grown in the region. The research also indicates that seed treatment fungicides once thought lost may again be effective in sorghum grown here.
- A new drought- and cold-tolerant St. Augustine grass developed at the Dallas Center and released in 2013 (DALSA 0605) is being licensed to more than a dozen turfgrass producers in Texas and is currently in pre-licensing evaluation by producers in Georgia and Australia. A new hybrid bluegrass for southern climates (DALBG 1201) is in pre-licensing evaluation by a major turf producer in Georgia. New cold-tolerant zoysiagrass lines co-developed by the Dallas Center and Kansas State University (KSUZ 1201, KSUZ 0802) underwent pre-licensing evaluation by 11 companies in 7 different states during 2015. KSUZ 1201 has already been released, and KSUZ 0802 was scheduled for release in 2015.
- Dallas Center scientists developed the first sequence-tagged high-density genetic maps of two commercial, warm-season turfgrasses, *Zoysia japonica* and *Zoysia matrella*. The zoysiagrass map, which was accepted for publication in *Plant Journal*, provides an essential genomic tool for gene tagging and marker-assisted selection for accelerated development of significantly improved varieties. It is also the foundation for sequencing the zoysiagrass genome and for conducting comparative genomics analyses among grasses. This research will speed the development of more water-efficient, heat- and cold-tolerant, and disease-resistant turfgrass varieties. The grasses will also be more tolerant to the use of effluent or brackish water for irrigation, preserving freshwater for human consumption and food crop production.
  - *Using genotyping by sequencing for diversity analysis of zoysiagrass varieties, the scientists also discovered that several current commercial zoysiagrasses, thought to be different varieties, are actually identical genotypes. This new approach demonstrates a novel scheme for protecting intellectual property of new plant varieties.*
- Soil and Crop Sciences researchers co-developed Palisades zoysiagrass, a staple in the product line of turfgrass sod producers in Texas and throughout the southern United States. Palisades greatly contributes to the sustainability of urban-suburban agroecosystems. Researchers also developed more efficient irrigation strategies for landscapes and reduced potable water consumption by 25% or more for consumers adopting these strategies.
- The Overton Center initiated cooperative research to develop roses broadly adapted for heat tolerance and disease resistance.
  - *These roses would increase the sales of the national flower and provide landscape plants that would reduce the need for pesticides and have reliable ornamental value for home and commercial landscapes.*



Beaumont Center researchers developed Texas A&M AgriLife Research's first rice cultivars, 'Colorado' and 'Antonio', released in 2012. They are available for large-scale commercial production for 2015. If a 15% adoption rate is achieved over the next five years, the 5% yield advantage over currently grown inbred rice varieties will increase statewide rice production revenue by \$1.22 million per year.



- Cotton-breeding programs in the Department of Soil and Crop Sciences have several new elite strains that exhibit high-yield potential, high-fiber quality, or both. AgriLife Research has developed and released germplasm lines with extraordinary fiber length and strength, with length equaling that of pima cotton and fiber bundle strength that is 25% stronger than current upland cultivars grown in Texas. The material is under testing agreements with various companies to identify market opportunities.
- The Basye Endowed Rose Breeding Program in the Department of Horticultural Sciences is working to develop disease-resistant and heat-tolerant rose varieties to expand the market for roses and reduce the amount of chemicals needed to maintain the plants in the landscape. This work is complemented by genome-mapping studies that will lead to a better understanding of the rose genome and better methods to create disease-resistant varieties.
  - This program will be enhanced by the recent awarding of a U.S. Department of Agriculture Specialty Crop Research Initiative grant of almost \$4.6 million to a team of researchers led by AgriLife Research scientists to study the rose rosette disease.
- Developing a hybrid rice-breeding program is a top priority for the Beaumont Center. Scientists integrate model-assisted selection to allow rapid identification of sets of primary phenotypic traits having the greatest likelihood of producing superior performing hybrids. They also initiate advanced marker development for key phenotypic traits to allow rapid incorporation into breeding lines. A primary goal is to develop locally adapted, high-yielding, superior grain quality, and disease-resistant hybrids.
- Beaumont Center researchers developed Texas A&M AgriLife Research's first rice cultivars, 'Colorado' and 'Antonio', released in 2012. They are available for large-scale commercial production for 2015. If a 15% adoption rate is achieved over the next five years, the 5% yield advantage over currently grown inbred rice varieties will increase statewide rice production revenue by \$1.22 million per year.
  - They are the first cultivars of any crop species developed using marker- and model-assisted selection.
  - 'Antonio' provides a 9% increase in yield over existing inbred rice genotypes, while 'Colorado' averages a 7% increase in yield and has extremely high milling quality.



*In a multi-year collaboration with AgroFresh, Beaumont Center scientists have identified antioxidants that can mitigate the effects of reactive oxidative species by preventing damage to cell membranes, thereby reducing crop sensitivity to heat stress, maintaining foliage health. Experiments have shown a 5.7% increase in yield, which if applied to the entire Texas rice production area would have a value of \$9.26 million per year at an expected cost of less than \$1.45 million per year.*

- In a multi-year collaboration with AgroFresh, Beaumont Center scientists have identified antioxidants that can mitigate the effects of reactive oxidative species by preventing damage to cell membranes, thereby reducing crop sensitivity to heat stress, maintaining foliage health. Experiments have shown a 5.7% increase in yield, which if applied to the entire Texas rice production area would have a value of \$9.26 million per year at an expected cost of less than \$1.45 million per year.
  - *An added benefit of this research has been the development of methods for screening large numbers of rice cultivars as a means of identifying sections of DNA corresponding to heat tolerance in rice.*

### **Boosting state income from forage, pasture, livestock, and forestry industries**

- Overton Center research has a current annual economic impact of \$150 million on the \$1.5 billion forage, pasture, and livestock industries of East Texas.
  - *Technologies developed by Overton researchers such as use of fine lime, sod seeding of winter annuals, grazing management, and new forage varieties continue to contribute to increased productivity.*
- The Overton Center released five new cultivars: ‘Neches’ white clover, ‘Blackhawk’ arrowleaf clover, ‘Sabine’ crimson clover, and ‘TAM TBO’ and ‘Nelson’ ryegrass.
  - *The early and profuse flowering traits of ‘Neches’ clover will save stakeholders approximately \$1 million each reseeded year, assuming ‘Neches’ is only 5% of total white clover use.*
  - *‘Blackhawk’ arrowleaf clover was developed with multiple disease resistance to improve reliability of annual clovers in forage-animal systems.*
  - *‘Sabine’ clover was developed to improve the reliability of long-season forage production as a component of ryegrass-clover mixtures.*
  - *The two new tetraploid ryegrass varieties have improved vigor and productivity over previous varieties.*
- Clovers affect the forage production system by (1) capturing nitrogen from the atmosphere to yield forage for grazing and (2) increasing soil nitrogen for future plant growth through animal waste recycling and the decay of residual forage material. Nutrient cycling research at Overton provides a protocol for growing forage and producing beef weight gains on pasture without applying nitrogen fertilizer.
  - *Management and grazing strategies have been developed to maximize efficiency of nutrient use on pastures maintained with no applied nitrogen fertilizer as well as with conventional production practices.*

- Overton research has provided management guidelines for Tifton 85 bermudagrass to ensure that producers realize best returns from this excellent cultivar released from Tifton, Georgia.

### **Grazing stocker cattle in East Texas**

- Overton Center research has shown that cool-season annual pastures (sod-seeded rye and ryegrass) and warm-season perennial grass pastures (Tifton 85 bermudagrass) are complementary and could support increased post-weaning grazing of stocker cattle in East Texas.
  - *Research has determined potential individual animal gains of 2.5 to 3.0 pounds per day, or 1,000 pounds per acre, on cool-season pastures and 2.25 pounds per day, or 1,500 pounds per acre, on Tifton 85 for the respective grazing seasons.*
  - *Gains can be increased significantly by providing low levels of supplemental feed to the grazing animals if feed costs and cattle values warrant this practice.*

*Concerns currently exist about the use of antimicrobial products in cattle production. Overton scientists are researching systems to measure cellular immune response and antibody-mediated immune response in beef cattle. Selection of cattle with high immune responses would result in a reduced need for antimicrobials as well as improved performance due to reduced disease and treatment costs.*



### **Breeding better beef cattle**

- Overton Center research has increased understanding of the effects of early puberty, temperament, and stress on the growth, reproduction, and health of tropically adapted beef cattle.
  - *Research on stress response shows that cattle temperament affects production efficiency, immune response, and product quality.*
  - *The center has developed an early-calving line of tropically adapted Brahman cattle to increase beef production efficiency in Texas and in tropical regions throughout the world.*
- Residual feed intake (RFI) research on cattle at the Overton Center indicates there is low correlation between RFI of a weaned calf and RFI of the same animal as an adult. This implies that selection for RFI post weaning will not impair adult performance.
- Concerns currently exist about the use of antimicrobial products in cattle production. Overton scientists are researching systems to measure cellular immune response and antibody-mediated immune response in beef cattle. Selection of cattle with high immune responses would result in a reduced need for antimicrobials as well as improved performance due to reduced disease and treatment costs.

---

## Epigenetic effects in beef cattle

- Overton researchers have discovered that transportation — a common management practice — produces stress in pregnant cows, which alters the performance of their subsequent calves. Offspring from cows that are stressed are more temperamental, have decreased immune function, and have an increased response to insulin, with implications for growth and fat deposition. These results imply that common management practices applied differentially can alter the effectiveness of genetic evaluation programs.

## Protecting and improving livestock

- Investigators in the Department of Large Animal Clinical Sciences in the College of Veterinary Medicine and Biomedical Sciences have discovered a cure for *Trichomonas* in bulls. This will greatly affect the disease-control program that currently calls for the slaughter of approximately 1,000 bulls that test positively each year in Texas. Successful treatment of infected bulls can also prevent the millions of dollars of lost production due to herd infertility.
- Investigators in the Department of Large Animal Clinical Sciences have demonstrated that a metal-based drug (gallium maltolate) can replace traditional antibiotics. This has reduced the use of standard antimicrobials at farms in central Kentucky, thereby reducing pressure for antimicrobial resistance, which is a major problem for livestock industries, including horse production. Although quantifying lives saved or number of doses of antimicrobials reduced is difficult, this finding will likely be influential in coming years as use grows.
- Investigators in the Department of Large Animal Clinical Sciences Comparative Orthopedics and Regenerative Medicine Laboratory investigate musculoskeletal disease and healing in the horse and regenerative medicine techniques to enhance musculoskeletal healing. They have demonstrated that the joint flare seen after stem cell injection is due to laboratory preparation technique. The result of this project had a major impact to the veterinary regenerative medicine world.
  - *They continue to work on concepts that have the potential to shift the paradigm in regenerative medicine, including the development of methods to determine the mechanism of action of stem cell therapies, including methods to longitudinally track stem cells in vivo.*
- Researchers in the Department of Animal Science have discovered that gestating, growing, and lactating swine require arginine and glutamine — previously classified as “dispensable” amino acids — to achieve maximum production performance.
  - *They found evidence that led to the recognition by the American Society of Animal Science of arginine and glutamine as conditionally essential amino acids for both pregnant sows and neonatal pigs.*

*Investigators in the Department of Large Animal Clinical Sciences in the College of Veterinary Medicine and Biomedical Sciences have discovered a cure for *Trichomonas* in bulls. This will greatly affect the disease-control program that currently calls for the slaughter of approximately 1,000 bulls that test positively each year in Texas. Successful treatment of infected bulls can also prevent the millions of dollars of lost production due to herd infertility.*



*Improving calf crops from 63% to 85% in beef and dairy cows, and piglets weaned per sow from 17.5 to 22, will increase animal protein to help feed our world and add values of \$4.5 billion and \$2.7 billion to the beef and swine industries, respectively.*

- *They played a role in the commercial development of feed-grade glutamine as a nutritional supplement to prevent intestinal atrophy, improve feed efficiency, and enhance growth in pigs worldwide.*
  - *They also identified arginine deficiency in piglets and demonstrated that dietary supplement with arginine improved skeletal muscle growth in pigs.*
  - *They led the commercial development of feed-grade arginine as a nutritional supplement to increase litter size and neonatal survival in pigs.*
  - *Improving nutrition and milk production reduces piglet mortality from about 13% to less than 6%, which has an economic value of over \$2 billion to the swine industry.*
  - *Innovative research on metabolism and physiological functions of amino acids led to a paradigm shift in understanding of protein nutrition that changed the course of research in this discipline, to help improve human and animal health worldwide.*
- Animal Science researchers following the One Health Initiative Systems Biology Approach to Foods for Health and Prevention of Disease integrate scholarship between disciplines in human and veterinary medicine, agriculture and life sciences, biomedical engineering, computational sciences, genomics, and environmental sciences to ensure a safe, abundant, and affordable supply of high-quality animal protein.
    - *Improving calf crops from 63% to 85% in beef and dairy cows, and piglets weaned per sow from 17.5 to 22, will increase animal protein to help feed our world and add values of \$4.5 billion and \$2.7 billion to the beef and swine industries, respectively.*
  - Current One Health Initiative projects in Animal Science also focus on bacteriophages (viruses that infect bacteria) as antimicrobials against several common human and animal pathogens, including *Salmonella*, methicillin-resistant *Staphylococcus aureus* (MRSA), *Klebsiella pneumoniae*, and *E. coli*. The use of phages in animal agriculture may be able to reduce the use of chemical antibiotics, increasing agricultural efficiency and reducing the burden of antibiotic resistance in both humans and animals. Reducing pathogenic bacteria in animal agriculture can also protect human health by reducing the risk of foodborne illness and zoonosis.



*Bee Synch I enables breeders to use the top artificial insemination sires, which can increase individual beef carcass values of progeny by more than \$400.*

- The impacts of translational research in Animal Science highlight links between nutrition and reproduction and metabolic diseases such as obesity and type 2 diabetes.
  - *Interferon tau, the pregnancy-recognition hormone for ruminants, has been used in studies that show it can reduce accretion of white fat, increase accretion of brown fat, reduce oxidative stress, and prolong insulin sensitivity in a mouse model of diabetes. This research could reduce the more than \$100 billion spent on healthcare to treat adult-onset metabolic syndrome and inflammatory diseases.*
- Investigators in the Department of Large Animal Clinical Sciences have helped to improve the productivity of goat farms by recommending targeted culling to reduce losses from intestinal parasitism. Resistance of intestinal parasites to anthelmintic agents (i.e., dewormers) is a global problem that is widely recognized in the United States.
  - *The investigators plan to extend this work by using genome-wide approaches available through Texas A&M AgriLife resources to identify genetic (and eventually epigenetic) markers of susceptibility to endoparasitism in goats. This approach could lead to selective breeding programs and also might help identify biological pathways and processes that drive susceptibility and are possible targets for novel therapeutics and/or preventatives to control endoparasites.*
- Animal Science faculty focusing on animal nutrition have designed and developed the Large Ruminant Nutrition System and the Small Ruminant Nutrition System to help producers, consultants, researchers, and students learn about issues related to animal nutrition; help feedlot managers achieve maximum profit; provide advanced modeling techniques; and deliver a complete system for assessing the quality of feeds for ruminants.
  - *The nutrition models website ([nutritionmodels.tamu.edu](http://nutritionmodels.tamu.edu)) and the department's computer models are accessed and used by universities in Australia, Italy, and Brazil and by many commercial users.*
- At the Animal Reproduction Laboratory in Beeville (part of the Corpus Christi Center), researchers study the reproductive biology of beef cattle, meat goats, and horses to develop procedures that enhance reproductive efficiency. Their protocol Bee Synch I was named in 2014 and 2015 in the National Beef Sire Directory as the method of choice for synchronization of ovulation in fixed-time artificial insemination of *Bos indicus* (Brahman) influenced cattle.
  - *Bee Synch I enables breeders to use the top artificial insemination sires, which can increase individual beef carcass values of progeny by more than \$400.*
- Beeville researchers have now developed Bee Synch II, which in early trials appears to produce results similar to Bee Synch I but with fewer injections and a \$5 reduction in drug costs per head. With the cost of developing replacement heifers approaching \$1,500 per heifer, being able to time puberty and first pregnancy is one of the most critical components of efficient beef production.



Research at Corpus Christi and Texas A&M University-Kingsville is evaluating applied reproductive management, accelerated lambing, age at puberty, and reproductive seasonality of Dorper sheep. This breed experiences a spring reproductive season that must be managed appropriately for greatest flexibility in lambing season. The feasibility of producing three Dorper lamb crops every two years in South Texas is encouraging and can add \$150 per ewe per year income without substantial inputs. Future efforts will concentrate on stimulation of reproductive activity in April and May.

- A forage scientist at Beeville has developed systems for sustainable use of natural resources and has defined ways to improve seasonal forage production for livestock and wildlife. Research includes the following:
  - *Discovery of novel brain mechanisms that affect sexual maturation in beef heifers as influenced by early calthood nutrition. This research also has implications in human diet as it relates to female puberty.*
  - *Development of a pharmacological method for controlling seasonal breeding in mares that accelerates time of pregnancy by up to 60 days. The center has collaborated with industry to develop a subcutaneous treatment that could have a \$20 million to \$30 million impact on the industry with a 15% market penetration.*
  - *Identification of forage crops with potential in South Texas and a fibrolytic enzyme to improve silage storage.*
- Investigators in the Department of Large Animal Clinical Sciences have developed improved methods for enhancing the quality of ejaculates and for insemination of mares. These developments are being used successfully in commercial breeding operations worldwide.
  - *This group has also discovered a unique form of subfertility (impaired sperm acrosome reaction) primarily affecting Thoroughbred stallions. Collaborative research with a genomics scientist in Department of Veterinary Integrative Biosciences has led to identification of a susceptibility locus for this phenotype, thereby demonstrating a genetic predilection.*
  - *A test for this locus (FKBP6) is now available and is being utilized by stallion owners, veterinarians, and equine insurance companies worldwide.*
- Research at Corpus Christi and Texas A&M University-Kingsville is evaluating applied reproductive management, accelerated lambing, age at puberty, and reproductive seasonality of Dorper sheep. This breed experiences a spring reproductive season that must be managed appropriately for greatest flexibility in lambing season. The feasibility of producing three Dorper lamb crops every two years in South Texas is encouraging and can add \$150 per ewe per year income without substantial inputs. Future efforts will concentrate on stimulation of reproductive activity in April and May.
- Conservation tillage and legume integration is new in South Texas and will help conserve soil and water and enhance soil structure. Two projects at the Corpus Christi Center are in years 4 and 5, with the first set of data to be released via peer-reviewed publications. Water savings from conservation tillage increases cotton and sorghum yields in drought years, and legume cover crops grown for livestock grazing diversify income and provide \$75 per acre in nitrogen fertilizer equivalent annually.

---

## Helping other nations protect and expand livestock production and farming

### Ukulima Farm, South Africa



Texas A&M AgriLife Research, through the Norman Borlaug Institute for International Agriculture, is working with the Howard G. Buffett Foundation to promote African agricultural research, extension, and education at the 9,200-acre Ukulima Farm Research Station in the Limpopo Province of South Africa.

- Texas A&M AgriLife Research, through the Norman Borlaug Institute for International Agriculture, is working with the Howard G. Buffett Foundation to promote African agricultural research, extension, and education at the 9,200-acre Ukulima Farm Research Station in the Limpopo Province of South Africa.
  - *Its mission is to support science to increase African agricultural production, enhance rural livelihoods, and conserve natural resources through new models addressing the diverse needs of agriculture in Africa.*
  - *The Ukulima concept is grounded in the principle that technology must be developed and tested in Africa so that researchers can adequately address the many unique issues facing African agriculture.*
  - *The program is addressing the themes of smallholder agricultural systems, wildlife and ecosystem conservation, and conservation agriculture technology, including dryland systems.*

### Other nations

- A researcher in the Department of Soil and Crop Sciences has developed more than 35 cowpea varieties for release in Africa and more than 45 countries globally. His current research in India is helping to solve that nation's problem with food and protein insecurity. Four new varieties of a heat-tolerant, photoperiod-insensitive, 60-day cowpea have been released. This new crop could be grown on up to 10 million hectares of wheat and rice lands in northern India.
  - *The researcher is also adapting the short-season, drought-tolerant, disease- and insect-resistant cowpeas to Texas.*
- The Department of Agricultural Leadership, Education, and Communications focuses on the diversity of human resources in agriculture, emphasizing working in a multicultural society and developing sensitivity toward different cultures. It also explores the interrelationships between the contributions of diverse individuals, the state, and the nation as they relate to the global success of agriculture. It is also broadening students' awareness of agricultural infrastructure in the United States and in Namibia.



Department of Entomology researchers have identified receptors in the cattle fever tick and the black-legged tick involved in fluid balance. These new receptors may represent novel targets for new acaricides that would be nontoxic to other organisms.

- As part of an effort to learn more about global food systems and support agriculture and world peace, the Department of Agricultural Leadership, Education, and Communications has involved more than 90 farm families in its Texas-Poland young farmer exchange program, which involves more than 20 universities in Poland and Texas. In addition, government, business, and agricultural leaders; university faculty; and students have participated in an exchange program to visit farms and ranches in Poland and Texas. They study farming practices such as no-till maize production and the science behind GMOs.
  - *The past decade has been labeled Ten Years of Economic Success for Poland, as the size of farms has seen 14.2% growth per year and acreage planted in corn has increased by 84% since 2012.*
- Agricultural Leadership, Education, and Communications faculty are working with non-profit organizations in Haiti to develop educational, demonstration, and outreach programs to relieve food insecurity in the region and train graduate students to acquire complex competencies needed to address global food security and malnutrition. They have introduced goat milk as a potential source of protein to help decrease malnutrition.
  - *According to the USDA, one cup of goat milk yields about one-quarter of the required protein daily nutritional needs. A milking herd of 10 does can provide protein for about 10 people.*

### Using ecosystem science to manage pests

- Increasing occurrence of fever ticks on South Texas ranches has raised concerns about the ability to continue to control these insects and keep them in the quarantine zone.
  - *Agricultural economists estimated the total yearly cost to control fever ticks to a smaller, limited outbreak in Texas would be \$123 million.*
  - *Department of Entomology researchers have identified receptors in the cattle fever tick and the black-legged tick involved in fluid balance. These new receptors may represent novel targets for new acaricides that would be nontoxic to other organisms.*
- Research at the Corpus Christi Center comparing the effectiveness of insecticide sprays to manage sugarcane aphids on sorghum helped develop a threshold of 50 to 125 aphids per leaf, before flowering-head emergence. If growers sprayed when aphid counts were at threshold, they were able to reduce aphid populations to manageable levels, while only slightly reducing predator populations.
  - *In South Texas, research and outreach efforts helped control the sugarcane aphid in sorghum at a cost of about \$5 million, with a benefit of \$30 million to \$60 million from protecting the harvest in 2014.*
  - *Savings were at least doubled in 2015, based on prevented losses using targeted insecticide use with assistance from early rainfall and beneficial insects.*

- The destructive potential of a combination of six sucking bugs and the boll rot disease they introduce was studied at the Corpus Christi Center from 2011 to 2014. Based on these studies, growers have been able to improve pest detection in their fields and use insecticides to control them only where and when needed.
  - *The Entomology Project at the Corpus Christi Center has worked with consultants to transfer this knowledge out to the cotton field.*

### Keeping growers up-to-date on best practices

- Beaumont researchers produce the *Texas Rice Production Guidelines*. Thousands of copies of these guidelines are downloaded each year.
  - *They also produce the Texas Rice Newsletter, providing cutting-edge information on rice research in Texas, the United States, and around the world.*
- Overton research on the effects of heat delay on breeding lines of poinsettia is helping producers learn how to mitigate these effects and will facilitate future varietal selections to reduce this problem for Texas producers.
- Annual bedding plant adaptability research at Overton is providing information for producers and landscapers to help them choose the ornamental plant crops that will enhance sustainability of their businesses.

## GOAL

**Add value to raw agricultural products and expand market channels through new product development and enhancements to existing commodities.**

*Agricultural Economics researchers evaluated the economic impacts of the U.S. milk promotion check-off program funded by dairy farmers, milk processors, and importers. Results indicated that for each \$1.00 spent on promoting dairy products, dairy producers gain another \$5.78 in income.*

## PROGRESS

- Agricultural Economics researchers evaluated the economic impacts of the U.S. milk promotion check-off program funded by dairy farmers, milk processors, and importers. Results indicated that for each \$1.00 spent on promoting dairy products, dairy producers gain another \$5.78 in income.
  - *The total economic impact of promotion programs for the U.S. dairy industry was estimated to be \$2.4 billion. These reports were provided to the industry and to the U.S. Congress.*
- Department of Animal Science researchers determined that as fatty tissue differentiates, monounsaturated fats increase, primarily due to oleic acid that increases the healthfulness of beef. Their research has led to production and marketing of leaner beef, labeled as "Select" beef.
  - *Historical research on nutrient composition of beef improved beef products for healthier consumers and provided the beef industry with economic incentives to produce leaner beef.*
  - *They also found that ground beef from grass-fed and grain-fed cattle have equal nutrient values and consumer acceptability and that electrical stimulation of beef carcasses early postmortem increases tenderness.*

- Overton researchers released 'Rio Verde' lablab, a new crop for the Texas seed and forage industries.
  - *New lablab cultivars with improved Texas seed production are currently in breeding trials.*

## PROGRESS

### *Focusing on ways to market agricultural products*

- The Overton Center's Texas Superstar® Program continues to grow, founded on research trials conducted to evaluate Texas-hardy plant varieties. The program features major plant promotions for the public.
  - *Each promotion increases sales and promotes the use of ornamental plants that are well adapted statewide.*
  - *Texas Department of Agriculture cooperative efforts included television ads to promote the program and funding to update brochures describing the plants.*
- Overton Center researchers initiated a collaborative project with Kilgore College to train students in producing and marketing organically produced vegetable crops.
- Overton Center field days, tours, and industry event presentations improve marketing efforts, product performance, and sustainability of the Texas bedding plant industry.
- The Cattle Value Discovery System (CVDS), for both beef and dairy cows, was developed by Animal Science faculty to maximize production efficiency in the feedyard by marketing cattle individually to reduce excess fat produced, increase consistency and quality of products, enhance productivity, and increase economic returns. This technology has been used by prominent Texas companies, including Cactus Feeders, to manage cattle individually.
- Department of Agricultural Economics researchers estimated that widespread adoption of existing technologies to eliminate *E. coli* in the U.S. beef supply chain would increase income by \$277 million annually and add 3,026 jobs as a result of eliminating the effects of *E. coli* in beef nationwide.

# GOAL

## Enhance sales and trade of agricultural products through consumer-guided marketing and economic strategies.

*Department of Agricultural Economics researchers estimated that widespread adoption of existing technologies to eliminate E. coli in the U.S. beef supply chain would increase income by \$277 million annually and add 3,026 jobs as a result of eliminating the effects of E. coli in beef nationwide.*

# GOAL

Minimize the impacts of foodborne hazards and biosecurity threat agents.



Scientists from the Department of Veterinary Integrative Biosciences, Veterinary Pathobiology, and Texas A&M AgriLife Research are conducting an intervention trial to reduce fecal shedding of *E. coli* O157:H7 in finishing cattle through better management of cattle drinking water.

# PROGRESS

## *Developing procedures to ensure the safety of food and consumer products*

- Scientists from the Department of Veterinary Integrative Biosciences and Texas A&M AgriLife Extension published epidemiological studies of the interacting effect of weather, farm management, and local environment on the probability and level of pre-harvest contamination of produce with generic *E. coli* as an indicator of fecal foodborne pathogens.
  - *These findings will aid in the development of new and improved strategies to enhance microbial safety of fresh produce.*
- Scientists from the Department of Veterinary Integrative Biosciences, Veterinary Pathobiology, and Texas A&M AgriLife Research are conducting an intervention trial to reduce fecal shedding of *E. coli* O157:H7 in finishing cattle through better management of cattle drinking water.
  - *Preliminary findings support that water management may serve as a novel, simple, and inexpensive strategy to control *E. coli* O157:H7 in finishing cattle and protect public health.*
- A researcher in Veterinary Integrative Biosciences is conducting epidemiological studies to identify novel methods for reducing contamination of produce with foodborne pathogens at the pre-harvest level.
  - *These findings will be disseminated to produce growers, government officials, and researchers in classroom, workshop, and conference settings and through peer-reviewed publications.*
- A Plant Pathology and Microbiology researcher confirmed the antifungal activity of nonthermal plasma and showed its potential as an effective disinfection technique to reduce seedborne pathogens in food crops.
- Department of Nutrition and Food Science researchers are developing new techniques to ensure the safety of foods. Among them are:
  - *Applying strain-specific molecular diagnostics to detect and quantify food safety cultures in consumer products and assess the inhibition of bacterial pathogens.*
  - *Determined the effect of low-dose irradiation on whole fresh peaches and provided this information to the USDA Animal and Plant Health Inspection Service for consideration of increasing the use of this technology.*
  - *Determining the role of surface factors on the contamination and survival of pathogens in fresh produce grown in Texas and Mexico.*

- Department of Biological and Agricultural Engineering scientists have made many advancements in food safety, including the following:
  - *Developed a technology that ensures microbiological safety of fresh and fresh-cut fruits and vegetables.*
  - *Developed a method for accurate dosimetry calculation using 3D visualization and computer simulation techniques.*
  - *Standardized a method to calculate absorbed dose when irradiating fresh produce.*
  - *Developed a method to reduce the amount of ionizing required to decontaminate pathogens in fresh produce.*
  - *Developed a method to decontaminate Salmonella in pecans using irradiation and food-packaging technologies.*
  - *Established the appropriate procedure for treatment of fresh eggs using irradiation technology.*
  - *Developed a risk assessment tool to predict the potential of a foodborne outbreak while handling and processing fresh baby spinach.*
- A scientist in the Department of Veterinary Integrative Biosciences has developed and is characterizing new enterosorbent strategies and therapies to mitigate dietary risk factors for disease in humans and animals.
  - *Based on this work, Texas A&M University has launched two companies: Texas Enterosorbents, Inc. (Bastrop) and Salient Pharmaceuticals, Inc. (Houston).*

### **Monitoring and ensuring the safety of animal feeds**

- The Office of the Texas State Chemist provides regulatory oversight of the manufacture and distribution of over 18 million tons of animal feed in Texas by approximately 3,000 establishments.
- The Texas State Chemist's Office developed new methods for detecting biological and chemical hazards, including:
  - *Listeria monocytogenes in raw milk that may be used in animal feed*
  - *Heavy metals in animal feed matrices (mineral mix, minerals, and fish meal products)*
  - *Polycyclic aromatic hydrocarbons in fish meal*

- The Texas State Chemist’s Office successfully managed the disposition of high-aflatoxin corn from annual corn harvests and approved blending plans that ensured corn used for feed met safety standards.
- The office introduced a new rule approving the use of aflatoxin binders and approved products for use by seven companies.
  - *This was the first such action in the United States toward mitigating the impact of this Group I carcinogen and toxin in customer-formula animal feed.*
- The State Chemist’s Office trains individuals from seven countries in the application of Hazard Analysis and Critical Control Point (HACCP) principles to improve food safety.

### **Detecting and responding to animal and human disease outbreaks and biosecurity threats**

- Agricultural economists have analyzed the interrelationship between climate change and animal disease, showing that climate change has increased the probability of avian influenza outbreaks.
- The Institute for Infectious Animal Diseases (IIAD) develops agricultural screening tools that aid in early detection and response to high-consequence diseases such as foot and mouth disease, classical swine fever, African swine fever, and other naturally occurring endemic livestock diseases.
  - *IIAD is working with the USDA and the Department of Homeland Security to implement a system that can be used in business continuity, emergency response, and recovery from a major disease outbreak.*

*AgriLife Research and Extension scientists in the Department of Entomology developed a mobile phone application, The TickApp, to identify ticks as vectors of Lyme disease and greatly reduce the cost of diagnosis and treatment.*

## **GOAL**

**Prevent transmission of human disease agents through development of improved methods of vector control.**

## **PROGRESS**

- AgriLife Research and Extension scientists in the Department of Entomology developed a mobile phone application, The TickApp, to identify ticks as vectors of Lyme disease and greatly reduce the cost of diagnosis and treatment.
  - *Each case of Lyme disease costs \$100,000 to diagnose and treat.*
  - *Annually, 20,000 new cases of Lyme disease are diagnosed in the United States, with 70–130 cases in Texas.*
- A scientist in the Department of Veterinary Integrative Biosciences is conducting epidemiological studies to identify novel methods for preventing Lyme disease.
- Researchers in Entomology discovered that silver nanobeads can penetrate the cuticle of the yellow fever mosquito to deliver insecticides without harming the environment.

# GOAL

**Develop wholesome, healthful, and affordable foods through scientific discovery, novel technologies, and new processes.**

*Soil and Crop Sciences researchers have developed specialty wheat lines with traits that eliminate the need for current additives in tortilla flour. The project could have a \$150 million annual impact on the tortilla industry by providing additive-free flour with a more consistent quality.*



## PROGRESS

### *Developing new food products and processes*

- The Texas A&M AgriLife Vegetable and Fruit Improvement Center (VFIC), in the Department of Horticultural Sciences, conducts research to develop healthy and flavorful vegetables and fruits. VFIC scientists demonstrated that high-pressure processing extends the shelf life and minimally alters the levels of health-promoting compounds in grapefruit. In addition, methods were developed to separate coumarins and polymethoxyflavonoids in citrus using flash chromatography.
- Soil and Crop Sciences researchers have developed specialty wheat lines with traits that eliminate the need for current additives in tortilla flour. The project could have a \$150 million annual impact on the tortilla industry by providing additive-free flour with a more consistent quality.
- Refinements in diet formulations and feeding practices of red drum, hybrid striped bass, and channel catfish in the Department of Wildlife and Fisheries Sciences have saved money by reducing the costs of production, increasing the efficiency of diet utilization, limiting potential negative environmental consequences, and improving the nutritional value of resulting products.
  - *Fish diet costs make up over 50% of production costs for farmed fish. To reduce costs, the department has evaluated protein concentrates from algae, barley, corn, and soybean as alternatives to fishmeal, which is one of the most expensive feedstuffs used in fish feeds.*
  - *Wildlife and Fisheries Sciences nutrition and physiology research has also benefited the red drum stock enhancement program operated by the Texas Parks and Wildlife Department. This program, in which hatchery-produced red drum are released into Texas bays to enhance recreational fishing, contributes an estimated \$1.3 billion annually to the Texas economy.*
- Wildlife and Fisheries biologists have determined that shrimp abundance is associated with tidal height and river discharge, suggesting the importance of coastal wetlands for shrimp production. They have also investigated the interactions between shrimp and recreationally important fish species and found that shrimp are important forage species for these fish.
- Forage management and stocking strategy research at Overton has enhanced the efficiency of producing natural forage-fed beef.
- Nutrition and Food Science research in processing led to the commercialization of açai oil.

- Biological and Agricultural Engineering scientists developed an effective vacuum-frying technology to produce lower-fat-content fruit and vegetable fried snacks, including mangoes, potatoes, sweet potatoes, and apples. Other innovations include:
  - *Developed an edible coating that can extend the shelf life of fresh-cut fruits and vegetables such as cantaloupe, watermelon, papaya, and pineapple by 7–10 days.*
  - *Demonstrated that nanoparticles made of PLGA polymer can be used as effective carriers of natural antimicrobial components when incorporated into edible coatings.*
  - *Evaluated biological materials to function as inexpensive and green polymeric matrices for delivery of antimicrobials, antioxidants, and nutritional compounds to a wide variety of foods.*
  - *Enhanced the nutritional quality of Meals-Ready-to-Eat rations using intelligent packaging and reformulation with healthier ingredients.*

## GOAL

**Promote healthy lifestyles and nutrition to prevent acute and chronic illness.**

*Scientists in the Department of Nutrition and Food Science have identified innovative and plant-derived compounds that elicit a protective effect against gastrointestinal diseases.*

## PROGRESS

### ***Assessing and promoting the disease-preventing properties of foods***

- Scientists in the Department of Nutrition and Food Science have identified innovative and plant-derived compounds that elicit a protective effect against gastrointestinal diseases.
  - *They have also discovered new mechanisms by which plant phytoestrogens suppress the formation of colon cancer.*
  - *They are exploring the ability of plant-derived compounds to alter the development and growth of colonic stem cells.*
  - *Nutrition and food scientists have worked with colleagues to identify a complex interaction between specific diet-derived compounds, microorganisms in the gastrointestinal tracts, and the normal intestinal physiology of the host animal.*
- Nutrition and Food Science researchers are currently identifying the mechanisms by which diets modulate metabolic genes and/or inflammatory genes to create pathogenic conditions such as type 2 diabetes, steatohepatitis, and atherosclerosis.
  - *They are providing basic information for developing effective preventative or therapeutic approaches to resolve metabolic disease.*

- Nutrition and Food Science researchers are assessing many foods to determine how they can protect against environmental contaminants and disease. Their work includes:
  - *Investigating the chemoprotective effects of natural products to understand how stem cells respond to factors such as diet, chronic inflammation, and carcinogens.*
  - *Characterizing the regulation of choline transport in brain cells to mediate oxidative stress induced by cadmium exposure and the protective effects of zinc supplementation to explain how zinc disrupts stress-induced intracellular signaling and exchange of molecules across cellular barriers.*
  - *Assessments of phytochemicals and polyphenolic extracts from grapes, green tea, curcuminoids, plums, mangoes, peaches, cowpeas, and wines have shown that many of these compounds reduce cellular inflammation in both colon and breast cancer models.*
  - *Testing phytochemicals derived from açai and mango in human clinical trials to determine their protective effect against colon cellular inflammation and carcinogenesis.*

### **Researching the relationship between diet and disease**

- AgriLife Research scientists in the Department of Horticultural Science and the Vegetable and Fruit Improvement Center have shown that stone fruit phenolics (especially in plums) are an excellent source of antioxidants, inhibit the oxidation of low-density lipoprotein, inhibit platelet aggregation, selectively inhibit the proliferation of breast cancer cells over normal breast cells in the laboratory, and suppress the oxidative and inflammatory processes involved in the pathogenesis of vascular diseases. They have also shown that peach and plum juice consumption protected obese rats against obesity-induced metabolic disorders.
- Nutrition and Food Science researchers are studying various aspects of tumor formation, growth, detection, and prevention, including:
  - *Determining mechanisms by which omega-3 polyunsaturated fatty acids modulate tumor formation and cell death, including the suppression of colonic inflammation-induced tumor progression.*
  - *Classifying dietary effects on genetic signatures during colon cancer initiation and progression.*
  - *Using messenger RNA populations to characterize transcriptional and posttranscriptional changes to monitor responses to diets that reduce chronic inflammation and carcinogenesis.*
  - *Developing a noninvasive molecular biomarker to detect colon cancer using sloughed colon cells in stool samples.*

---

## Providing training in other nations for animal and human health

- A Recreation, Park and Tourism Sciences professor led a 2014 One Health Immersion study-abroad course in Senegal and Gambia that focused on the impact of water, animal, and environmental health on foodborne diseases, nutrition, health-professional training, public health, and family and youth programming.

## Using structural biology and bioinformatics to discover new drug treatments

- Researchers in the Department of Biochemistry and Biophysics study the three-dimensional structure of proteins and nucleic acids to find structural vulnerabilities that can be targeted with new drugs to help treat diseases.
  - *The labs use X-ray crystallography to view the structure of molecules that cannot be seen with a microscope.*
  - *This allows researchers to study the interaction between proteins and potential drug compounds in the search for novel drugs to treat Alzheimer's disease, malaria, tuberculosis, non-Hodgkins lymphoma, and other cancers as well as other diseases that are difficult to treat, often fatal, and can become resistant to current drugs.*
  - *The Junjie Zhang Lab has solved the structure of the tuberculosis ribosome using electron microscopy.*
  - *The Meek Lab synthesized and characterized a novel inhibitor of both falcipain and cruzain, two cysteine proteases that are drug targets for malaria and Chagas's disease.*
  - *Through structure-guided medicinal chemistry, the Sacchettini Lab has led to development of leads that target two enzymes that generate important components of the mycobacterial cell wall. Pharmacology and toxicity studies have been promising, and mouse studies are being carried out. These projects are funded by the Bill and Melinda Gates Foundation and the National Institutes of Health.*
  - *The Sacchettini Lab has screened over 50,000 drug-like compounds to test effectiveness against an enzyme that causes drug resistance in gram-negative bacteria like Klebsiella and are poised to begin trials of their best compounds in a mouse model.*
  - *The Sacchettini Lab has completed several of the required preclinical studies on their cancer drug for clinical trials in drug-resistant ovarian cancer. They are in negotiation to conduct phase I clinical trials.*

*The Meek Lab synthesized and characterized a novel inhibitor of both falcipain and cruzain, two cysteine proteases that are drug targets for malaria and Chagas's disease.*

*Working with the Texas A&M Institute for Genomic Medicine (TIGM), the Center for Structural Biology in the Department of Biochemistry and Biophysics is developing first-in-class high-throughput screening procedures for mouse stem cells involving state-of-the-art robotic equipment and pioneering screening procedures.*

- *The Pellois Lab has developed a technology that allows the efficient introduction of proteins into live human cells. This unique technology relies on a simple co-incubation protocol with a membrane-active peptide they have discovered, named dfTAT. This technology can be used in cell biology applications that involve cultured live human cells, and it serves as a promising foundation for the future design of agents for delivering therapeutics in vivo. Several companies have expressed interest in licensing this technology.*
- *The Polymenis Lab and collaborators published a paper describing enhanced longevity by ibuprofen that has generated considerable notice, with over 20,000 views in the first month, a highlight in Science, and features on mass media television outlets. Just 24 hours after online publication, the story received 1.2 billion views from 89 million unique visitors from around the globe.*
- *The Gohil Lab has filed a patent application for a novel use of the existing investigational anti-cancer drug elesclomol in the treatment of rare mitochondrial disorders.*
- *The team is also working to find nontoxic “smart drugs” that can be delivered directly to sites of disease in the body through the use of nanoparticles as carriers. These drugs fight only diseased cells rather than also targeting healthy cells, as some conventional drugs do.*
- *As part of a long-standing collaboration with the Dwight Look College of Engineering’s Department of Computer Science and Engineering, the center combines structural biology with bioinformatics to rapidly discover new potential drug candidates by screening thousands of compounds at a time and solving the structures of protein inhibitor complexes.*
- Working with the Texas A&M Institute for Genomic Medicine (TIGM), the Center for Structural Biology in the Department of Biochemistry and Biophysics is developing first-in-class high-throughput screening procedures for mouse stem cells involving state-of-the-art robotic equipment and pioneering screening procedures.
  - *Once proven in animals, new drugs can be designed for human use that would block the infection or toxin’s access to particular human genes.*

### **Utilizing clinical trials to develop novel drugs and therapies to benefit both animals and humans**

- The oncology group in Small Animal Clinical Sciences in the College of Veterinary Medicine and Biomedical Sciences has a robust portfolio of canine-based cancer clinical trials. They have published studies on new investigational drugs that have impact in lymphoma and bone cancer as well immunotherapeutic approaches. As companion animals are physiologically similar to humans and share the same environment, these prototypical One Health research projects contribute to knowledge about drugs, devices, and diagnostics of mutual benefit to animal and human health.

---

*The gastrointestinal (GI) laboratory is internationally recognized for contributions in the area of small domestic species gastrointestinal health and disease. This year, high-impact contributions included publication of studies characterizing the GI microbiome in dogs and cats as well as validation of markers for mast cell and eosinophilic inflammation in the intestinal tract of dogs.*

- The neurology group in Small Animal Clinical Sciences is heavily focused on studies that define the basic biology of canine spinal cord injury and evaluation of therapies for injury that hold promise in humans.
  - *During the past year, the group had key publications on the release of cytokines and chemokines into the cerebrospinal fluid after injury; definition of MRI-based markers of injury and recovery; and evaluation of neuroprotective therapies for injury.*
  - *Neurology clinician-scientists have expanded collaborations with The University of Texas MD Anderson Cancer Center to explore natural disease models of glioma.*
- The clinical cardiology group in Small Animal Clinical Sciences continues to participate in multi-center clinical trials. One particularly important study, on the effect of pimobendan on dogs with chronic heart valve disease, was just completed. Studies on biomarkers of canine and feline heart disease continue to be published by this group.
- The gastrointestinal (GI) laboratory is internationally recognized for contributions in the area of small domestic species gastrointestinal health and disease. This year, high-impact contributions included publication of studies characterizing the GI microbiome in dogs and cats as well as validation of markers for mast cell and eosinophilic inflammation in the intestinal tract of dogs.

## GOAL

**Provide policy makers, producers, and consumers with scientifically sound data regarding carbon cycling and sequestration.**

## PROGRESS

- A Soil and Crop Sciences researcher has provided national and international leadership in developing methods of using VisNIR spectroscopy to quantify soil constituents such as organic carbon. Collaborations based on this research led the USDA's Natural Resources Conservation Service to use the technology in its rapid carbon assessment project.
- Soil and Crop researchers have determined that removing brush on the Edwards Plateau (long recommended by state and federal agencies and water authorities) does not improve water recharge in the Edwards aquifer. In addition, brush overgrowth improves carbon sequestration in the area. Therefore, the researchers do not recommend brush removal on the plateau, other than for its positive impact on livestock production.
- A Soil and Crop Sciences study on carbon dynamics in the Southern Cotton Belt found that biomass sorghum, perennial grasses, and dryland cotton are carbon sink ecosystems compared to intensively managed irrigated cotton in the region. A separate study found evidence to support bioenergy sorghum as a net carbon-sequestering crop. These results support bioenergy sorghum as a good choice in meeting the U.S. renewable fuel standards and will have long-term implications on Texas and U.S. cropping systems.



*A researcher in Recreation, Park and Tourism Sciences has studied the human dimensions of natural resources in the context of hurricanes, floods, and wildfires, finding that the major factor in conservation and protection of natural resources is the human factor — the way individuals and communities can form partnerships to protect people, communities, and property from disaster while successfully managing natural resources.*

- A Recreation, Park and Tourism Sciences professor is conducting research on the role of ecotourism and interpretation in addressing climate change. Enhancing environmental literacy creates an informed citizenry and increases civic participation in policymaking for climate change mitigation. One research project was at the Great Barrier Reef in Australia.
- A researcher in Recreation, Park and Tourism Sciences has studied the human dimensions of natural resources in the context of hurricanes, floods, and wildfires, finding that the major factor in conservation and protection of natural resources is the human factor — the way individuals and communities can form partnerships to protect people, communities, and property from disaster while successfully managing natural resources.
  - *The role of social media and technology has increased, especially among younger people, when making evacuation decisions during natural disasters.*
- Data from a 30-year project at the Overton Center have shown that carbon sequestration has been enhanced by stocking rate, fertility regimen, and overseeding of ryegrass or clover in Bermudagrass pastures.
  - *The pastures were fertilized with nitrogen or managed with legumes and tested with three levels of grazing pressure.*
  - *Research on soil carbon and nitrogen levels in cropping systems is in its second year of data collection.*
- A Beaumont Center researcher developed a daily version of the DayCent soil carbon and greenhouse-gas emissions model for use in flooded production systems such as rice.
- Beaumont researchers propose to expand the center's modeling of carbon sequestration and greenhouse gas emissions by conducting detailed field validation studies to allow accurate assessment of the environmental impact achieved through a range of existing conservation measures and incorporating the DayCent models into their modeling system.
- Agricultural Economics researchers continue to document impacts of climate change on a global scale through research collaboration with the United Nations Intergovernmental Panel on Climate Change (IPCC).
  - *Carbon dioxide is a major contributing factor to climate change, but researchers found that it also accounts for 40% higher yields in cotton produced in some regions of Texas.*

- Department of Ecosystem Science and Management research has shown that woody plant encroachment into areas that were once grassland results in rates of soil carbon storage of 200–600 kilograms of carbon per hectare, which is comparable to or greater than rates of soil carbon sequestration in most deliberate carbon sequestration schemes.
  - *The researchers also found that the long-term stability of plant carbon stored in soil carbon sequestration schemes depends on the organic chemistry of the plant tissue stored in the soil and on the ability of organic matter to interact with soil to form stable soil aggregates.*

# GOAL

**Create economically feasible, sustainable alternative energy systems through basic and translational research in feedstocks, logistics, and conversion technologies.**

*In their research on the use of sorghum as a feedstock for biofuels, the Mullet Lab in the Department of Biochemistry and Biophysics has described the physiological and genetic basis of stay-green drought tolerance and the molecular mechanism that regulates flowering time in sorghum in response to photoperiod.*



# PROGRESS

## *Developing feedstocks and production systems for cellulosic biofuels*

- Scientists at the Overton Center have completed the third year of evaluating bioenergy feedstocks and sustainable biomass production systems, including soil, water, and wildlife stewardship.
- In their research on the use of sorghum as a feedstock for biofuels, the Mullet Lab in the Department of Biochemistry and Biophysics has described the physiological and genetic basis of stay-green drought tolerance and the molecular mechanism that regulates flowering time in sorghum in response to photoperiod.
- Biological and Agricultural Engineering researchers have studied the thermochemical conversion of biomass using pyrolysis, gasification, and liquefaction. Techniques for gasification of various biomass sources have been identified, and the technology for producing electricity from gasification of municipal solid waste has been licensed and is being commercialized by a Dallas company that is selling gasification units domestically and internationally.
- Beaumont Center scientists developed the Biomass Economic Variability Analyzer, a complete life cycle analysis model for estimating site- and year-specific, cultivar-specific biomass production potential as well as the optimal location for siting cellulosic biorefineries, taking into account transport distance and costs.
  - *They have received a USDA-NIFA grant to develop management practices for sustainable bioenergy sorghum production in the southern United States. This project focuses on determining the effects of tillage, fertilization, biomass incorporation, and crop rotation on sustainability, with regards to the quality and yield of biomass sorghum, carbon sequestration, soil quality, nutrient cycling, and greenhouse gas emissions.*
  - *In collaboration with scientists from Purdue University, the University of Massachusetts-Amherst, and the University of Nebraska-Lincoln, this project team has submitted a research proposal to the Department of Energy's Systems Biology Research to Advance Sustainable Bioenergy Crop Development program.*



*The Devarenne Lab in the Department of Biochemistry and Biophysics, with collaborators at Texas A&M, has developed a microfluidic photobioreactor device to use with oil-producing microalgae as a high-throughput screening system to identify high-oil-producing strains of algae. This information could be directly used for scaling up the growth of microalgae on the industrial scale for biofuel production.*

- AgrLife researchers are cooperating with the Environmental Protection Agency on the design of rules for the amount of greenhouse gas offsets when a stationary source uses agricultural commodities in production, primarily for bioenergy. The rules will be part of future clean air policies that address greenhouse gas emissions.

### **Developing the production of biofuels from algae**

- The microalgae team at Corpus Christi has continued research in conjunction with Sandia National Laboratories and Open Algae on a Department of Energy funded project to advance the use of a low-cost recycled nutrient, struvite, for the production of microalgae biomass. They have demonstrated that microalgae grown using struvite have biomass productivities equal to more expensive, non-recycled nutrients. Optimizing the application of struvite led to a 15% reduction in struvite addition without a decrease in production, thereby further reducing production costs.
  - *Additional nutrient optimization has produced microalgae biomass from mixed algae cultures with protein content near 50%. The high-protein content of this microalgae biomass makes it a strong contender as a sustainable protein substitute for fishmeal, and growth trials will begin soon using the biomass as a fishmeal replacement in marine and freshwater fish diets.*
- Scientists in the Department of Biological and Agricultural Engineering have conducted federally funded research into algae cultivation, harvesting, lipid extraction, catalysis to fatty acid methyl esters, and systems engineering.
  - *They also conducted federally funded research into the development of sensors to enhance algae biomass and lipid production.*
- The Devarenne Lab in the Department of Biochemistry and Biophysics, with collaborators at Texas A&M, has developed a microfluidic photobioreactor device to use with oil-producing microalgae as a high-throughput screening system to identify high-oil-producing strains of algae. This information could be directly used for scaling up the growth of microalgae on the industrial scale for biofuel production.

### **Researching the economics of biofuels**

- Agricultural Economics researchers have developed economic feasibility studies for alternative renewable energy feedstocks, ranging from sweet sorghum to algae.
  - *These studies have been widely cited in the industry and led to requests for further analysis as the technologies near commercialization.*
  - *Recent research estimates that, in a developed cellulosic ethanol industry, energy sorghum could increase Texas agricultural income by \$818 million and the Texas economy by almost \$7 billion annually, accounting for 11,000 new jobs.*

---

# GOAL

Enhance viability of bioenergy systems by developing markets for co-products of cellulosic, algal, and other alternative energy products.

- Biological and agricultural engineers have enhanced the viability of bioenergy systems by researching cost-effective methods and improved logistics for harvesting and delivering energy biomass.
- Department of Ecosystem Science and Management researchers have devised an approach for determining optimal forest biomass removal for energy production when considering profitability, long-term land productivity, and greenhouse gas consequences.
  - *They have also developed a model for analyzing forest biorefinery supply chains, including biomass-use allocation, siting, and size of biomass storage and conversion plants in East Texas.*

## PROGRESS

- Corpus Christi researchers have developed plans to grow and use macroalgae for biofuels, human consumption, terrestrial and aquatic feed ingredients, and bioproducts, and they determined that algal residue has potential as a safe and effective fertilizer.
- Researchers at the Corpus Christi Center's Mariculture Laboratory at Flour Bluff conducted synchronous cultivation of two microalgal species (*Nannochloropsis salina* and *Phaeodactylum tricornutum*) in outdoor raceways. Growing these two species together produced biomass at higher levels than growing them separately, regardless of season.
  - *Biomass production was over 1,800 gallons of lipid per year per acre when grown together, compared to 1,400 and 700 gallons of lipid per year per acre for the *N. salina* and *P. tricornutum*, respectively, when grown separately.*
- Corpus Christi Center USDA-NIFA funded research in collaboration with the University of Louisiana at Lafayette and Texas A&M University-Corpus Christi quantified responses of *N. salina* to light and temperature and integrated these into a simulation model that generates trends of light dynamics, growth, and lipid production. The model indicated that lipid production could be optimized to 4.2 times the current production in outdoor raceways, which would increase the value of a metric ton of biomass from \$347 to \$1,475.
  - *Research currently underway is focused on *N. salina* culture's carbon-use efficiency, biomass conversion efficiency, and nutrition optimization for maximizing biomass production and cost reduction.*
- Researchers in the Department of Plant Pathology and Microbiology used synthetic and systems biology approaches to engineer algae, cyanobacteria, and high-cellulose plants to produce terpene at high titer and efficiency. The new platform enables photosynthetic systems to directly reduce carbon dioxide into energy-dense and high-value products ranging from pharmaceutical and nutraceutical chemicals to jet fuel components. The production has been scaled up, and collaboration with major corporations is under development.

- In other research in Plant Pathology, synthetic microorganisms were developed to convert lignin into valuable products like bioplastics and biofuels, reducing the cost of biomass conversion for biofuel. Overall, the synthetic and systems biology research will enable more affordable renewable energy, provide novel healthcare solutions, mitigate global climate change, and help protect the environment. It will also boost local economic development and promote economic competitiveness in Texas.

## GOAL

Develop novel technologies and systems that enable producers and consumers to improve energy efficiencies.

## PROGRESS

- Overton Center researchers have developed forage production systems that use no applied nitrogen and therefore reduce the global need for fossil fuels to produce nitrogen fertilizer. This could have a large long-term impact on global meat production.

## GOAL

Model and understand the dynamic relationships among biological molecules to genetically improve production, disease resistance, and environmental adaptability of plants and animals used to produce food, fiber, and bioenergy.

## PROGRESS

### *Developing process-based crop models*

- The Beaumont Center is an international leader in the development of process-based crop models, an approach that integrates knowledge across biological scales, from the molecular to organ, plant, and population levels.
  - *Process-based models allow clarification of genotype x environment interactions, which is not possible in models with less physiological detail.*
  - *This effort led to the first implementation of a marker- and model-assisted selection program.*
- Beaumont Center scientists have advanced knowledge of how key primary phenotypic traits impact rice and energycane crop growth, development, and yield. They have also developed possibly the most advanced physiologically based rice model that can rapidly evaluate the putative impact of hundreds of thousands of combinations of key primary phenotypic traits in terms of crop growth, development, yield, and aspects of grain quality. Many of these methods can be translated to other crops.
  - *The crop modeling system can link a crop's genetic makeup to primary physiological traits; it enhances the ability to identify traits that contribute to yield improvement and to predict crop performance under different input conditions and environmental stresses.*

- This model is structured to easily incorporate additional morphological, physiological, and biochemical improvements.
- The center has also developed a strong relationship with the Texas Rice Research Foundation, which is committed to partnering with Texas A&M AgriLife Research in developing a hybrid rice-breeding program.

### **Producing genetically modified livestock for disease resistance**

- Researchers in the Reproductive Sciences Laboratory in the College of Veterinary Medicine and Biomedical Sciences have generated transgenic cell lines that contain a gene coding for RNA that blocks the production of foot and mouth disease virus or vesicular stomatitis virus.
- The Reproductive Sciences Laboratory and partners have produced two transgenic calves, one bull and one heifer, with genetic resistance to *Staphylococcus aureus*, the most frequent cause of mastitis in cattle.
- Using stored DNA samples from cattle identified as either susceptible or resistant to brucellosis, the Reproductive Sciences Laboratory and partners are conducting a genome-wide study to identify genetic polymorphisms that are associated with brucellosis resistance.
  - The goal is to develop a simple DNA-based test that can be used to identify cattle that are naturally resistant to *Brucella*.
  - When combined with other marker-assisted selection technology, the addition of genetic resistance to disease will greatly enhance livestock production in the United States and around the world.

*Using stored DNA samples from cattle identified as either susceptible or resistant to brucellosis, the Reproductive Sciences Laboratory and partners are conducting a genome-wide study to identify genetic polymorphisms that are associated with brucellosis resistance.*

### **Using next-generation sequencing and biotechnology tools for a wide range of research**

- The Texas A&M AgriLife Genomics and Bioinformatics Service Facility (TAGS) addresses the need for access to the latest genomic technologies across The Texas A&M University System.
  - TAGS launched a marker-assisted breeding platform for researchers and has sequenced the genomes of thousands of energy sorghum breeding lines, approximately 800 bacteria, a large number of plant pathogens, and animals ranging from companion animals and birds to livestock.
  - It is also involved in human cancer research.
  - TAGS has supported more than 250 researchers representing over 20 departments, six colleges, the Texas A&M Health Science Center, and many A&M System agencies.
  - It is involved with more than 100 grant applications, representing millions of dollars in possible funding, including launching a highly successful genomic seed grant program with the largest response in Texas A&M AgriLife history.

# GOAL

Capitalize upon data from high-throughput sequencing, proteomics, metabolomics, metagenomics, and other advanced technologies to develop systems biology tools for improving agricultural productivity.

## PROGRESS

- Overton researchers use rumen microbe pyrosequencing to assess relationships between rumen microbes and efficient digestion of starch and/or cellulose to document efficiency in beef cattle performance.
- A Beaumont researcher is determining the genetic basis for heavy metal and nutrient uptake in rice, using proteomics and metabolomics approaches.
- Ecosystem Science and Management researchers have developed individual chromosome isolation approaches using laser capture microscopy and whole genome amplification for resequencing the complete conifer genome for loblolly pine, a major timber and biofuel crop.
- DNA sequencing of soils in Ecosystem Science and Management revealed that invasive mesquite trees support increased soil bacterial and fungal diversity and harbor a distinct fungal community relative to the native grasslands that are being replaced by mesquite woodlands.

### *Exploring genetic selection for enhanced disease resistance in dairy and beef cattle*

- A researcher in the Department of Veterinary Pathobiology is developing genomic prediction and selection protocols that will be used in U.S. breeding programs to reduce the prevalence of bovine respiratory disease complex (BRDC). This researcher has established a leadership role in demonstrating that the multi-pathogen BRDC phenotype, once considered a trait with low heritability and low selection potential, is actually moderately heritable among dairy and beef cattle; it also is well suited for modern genomic prediction and selection protocols. BRDC is a leading economic obstacle for the U.S. beef and dairy industry.

# GOAL

Model and understand dynamic relationships among behavioral and economic factors that influence the development and sustainable adoption of new technologies for the benefit of consumers, producers, and society.

## PROGRESS

- The Pasture and Livestock Management Workshop for Novices developed at the Overton Center encourages new landowners to adopt the newest technologies for efficient and environmentally sustainable production.

- To help Texas communities redevelop downtown areas to better integrate parks and other public spaces, researchers in the Department of Recreation, Park and Tourism Sciences have provided economic development districts and planners with recommendations for trails and wayfinding as well as locations for new parks and enhanced streetscapes.
  - *They are also working with the National Park Service's Rivers, Trails, and Conservation Assistance Program to gather data related to work it conducts with Texas communities. The program helps communities identify park and trail resources that can be planned and developed to support use and conservation of natural resources in urban areas.*
  - *Another project in collaboration with the Brewster County Tourism Council has examined visitor attitudes toward nature-based recreation to help tourism businesses and land managers make decisions about topics ranging from service quality to recreational use zones.*
- Agricultural Economics researchers, with Texas A&M AgriLife Extension and the USDA Farm Service Agency, made a major impact on U.S. Farm Bill implementation by educating producers nationwide. Their research on 2014 farm bill policy options led to the completion of 264 education programs nationally, with more than 19,000 producers attending.
  - *They also conducted 14,000 YouTube sessions and received more than 1,700 calls on the Texas A&M help desk.*
  - *Their Farm Bill Decision Aid guided farmers on program participation decisions and the implementation of farm bill provisions.*
  - *More than 49,000 producers, landowners, and agribusinesses in all 50 states were provided data on and received decision output while viewing nearly 3 million pages in 136,000 sessions of materials developed by this team.*
- The Temple Center's Grazingland Animal Nutrition Laboratory processed over 10,000 forage and fecal samples providing management recommendations to over 2,000 livestock producers across the nation. Since 2010, interest in GANLAB analyses and advisories has grown 25%–40% per year.
- Researchers in the Department of Agricultural Leadership, Education, and Communications' Digital Media Research and Development Laboratory have completed the second year of their heuristic modeling project, which will enable researchers and practitioners to account for, and eventually correct for, errors in data that enable them to understand the human capital characteristics of rural regions.
  - *Without correcting for errors, subject characteristics may vary by more than 50%. The heuristic modeling project may reduce the error to less than 25% and eventually to less than 10%.*

*To help Texas communities redevelop downtown areas to better integrate parks and other public spaces, researchers in the Department of Recreation, Park and Tourism Sciences have provided economic development districts and planners with recommendations for trails and wayfinding as well as locations for new parks and enhanced streetscapes.*

- Researchers in the Digital Media lab have developed three new field-research methods that have increased response effectiveness by up to 60% over traditional data-collection methods. These methods have been tested in people in seven western states and have accounted for more than 12,000 contacts.
- Undergraduate and graduate students in the Digital Media lab have completed two years of the “public engagement with agriculture” modeling project. Results of research conducted in five Western states have increased effectiveness and efficiency of industry partners’ marketing efforts, including economic impacts exceeding \$68 million annually. Nationwide content analyses have led to consumer-choice experiments to test the visual effects of animal-based protein products in print advertisements.
- Through national professional development, service, and educational outreach, Agricultural Leadership, Education, and Communications faculty work with over 4,500 secondary-level agriscience programs. Through student experiential learning projects, these programs developed over \$278 million in economic impacts, a 50% increase from 2014.
- A large international agricultural corporation is implementing the results of Agricultural Leadership, Education, and Communications research on how the trust level between sales representatives and producers has a positive impact on choice to purchase seed.
  - *In an extremely competitive market, investing money into training programs for sales reps and focusing on establishing producer trust will ensure seed corporations keep their current customers and expand their customer base.*
- Through a Texas Department of Agriculture–funded project, Agricultural Leadership, Education, and Communications faculty are measuring demand preferences for the \$100 billion Texas agricultural industry, including such products as shrimp, other food and fiber products, and tourism.
- Student work disseminated through the Agricultural Leadership, Education, and Communications website and social media outlets inform the public about issues affecting voting and purchasing decisions. Students use photography, infographics, and multimedia productions to help consumers become more literate about science and agricultural issues, reaching more than 500 potential consumers daily.
- The Texas A&M Instructional Materials Service *Poultry Science Manual*, 6th edition, helps train students nationwide for employment in the poultry industry; it is used annually by about 20,000 students in 5,000 schools and has also been adapted for school use in Christianville, Haiti. Improving skills related to the poultry industry can help smallholders address niche market opportunities and increase their income from egg sales by about 12%.



# FAR WEST TEXAS REGION

*Texas A&M AgriLife Research and  
Extension Center at El Paso*

*Pecos Station, Texas A&M AgriLife  
Research and Extension Center at  
Lubbock*

Eastern Region

Far West Texas Region

Lower Rio Grande Valley

Panhandle-Plains Region

Winter Garden and South Central Region



# GOAL

Protect water quality and increase the amount of water available for urban and rural use through new technologies and approaches.



## PROGRESS

### *Reducing soil and water salinity*

- Soil and water salinity is a critical issue in Far West Texas, where it threatens the long-term viability of irrigated agriculture.
  - *Researchers at the El Paso Center tested inexpensive soil-moisture sensors to help farmers identify appropriate sensors for elevated salinity conditions.*
  - *Results show that at least one irrigation, or about 3,000 acre-feet of freshwater per year, can be saved using soil moisture-based irrigation scheduling in El Paso County.*
- A Phase I analysis of the economic impacts of salinity in the Upper Rio Grande Basin showed damages exceeding \$10 million per year, with 75% of the damages affecting urban water users in El Paso.
  - *The analysis also estimated that damages could be cut in half with a 200 parts per million reduction in salinity concentration.*
- Scientists at the El Paso Center and colleagues at the Lubbock Center and its Pecos Station are working to find new ways to recycle water to irrigate crops, including pecans and chile peppers.
  - *Results from three years of research on salinity management using an anionic polymer in irrigation water show reductions in both salinity and sodicity in the effective root zone of pecans.*
  - *The annual pecan nut yield in polymer-treated orchards increased by an average of 23%, which translates into an increase in gross revenue of \$2,780 per acre.*

### *Saving water through precision measurements*

- In Far West Texas, the El Paso Center is using an evapotranspiration tower and hydrologic cycle monitoring network to measure carbon dioxide, water vapor, and heat fluxes, using the eddy covariance technique. This helps them to develop improved and timely information for assessment of crop evapotranspiration, irrigation scheduling, and the potential impacts of climate change on hydrological processes and crop production.
  - *This information is available to producers via the Internet and is especially useful to farmers in developing and implementing drought-contingency plans and evaluating alternative sources of water.*



El Paso Center researchers are developing bioenergy crops that can use marginal-quality water sources such as electric utility cooling water, treated urban wastewater, gray water, and saline groundwater.

### *Developing bioenergy crops that thrive on marginal-quality water*

- El Paso Center researchers are developing bioenergy crops that can use marginal-quality water sources such as electric utility cooling water, treated urban wastewater, gray water, and saline groundwater.
  - *Early data indicate that varieties of switchgrass, sorghum, castor, and jatropha can tolerate irrigation water with high salinity levels.*

### *Protecting water resources in the border region*

- The El Paso Center has been a key partner in a bi-national effort (the U.S.-Mexico Transboundary Aquifer Assessment Program) to ensure adequate water resources for Texas, New Mexico, and the Mexico border region.
  - *Researchers have produced hydrologic models and scientific information for state and local decision making about water rights and use.*

### *Monitoring water quality*

- Center researchers provide scientific data on the protozoan water pathogen *Cryptosporidium* to support public health decisions and regulatory monitoring by the U.S. Environmental Protection Agency.

## GOAL

**Create economically feasible, sustainable alternative energy systems through basic and translational research in feedstocks, logistics, and conversion technologies.**

## PROGRESS

### *Algae for fuel*

- Texas A&M AgriLife Research and General Atomics continue a strategic, collaborative alliance to research, develop, and commercialize biofuel production through farming microalgae in Texas and California. In 2012–2013, the Algae for Fuel program at the Pecos Station developed and evaluated flocculation processes for harvesting algae to reduce the cost of algal lipid production by 30%.



## GOAL

**Model and understand dynamic relationships among behavioral and economic factors that influence the development and sustainable adoption of new technologies for the benefit of consumers, producers, and society.**

*The Pecos Algae Research and Development Facility at the Texas A&M AgriLife Research Station at Pecos, a partnership with General Atomics, aims to develop and demonstrate algae growth and harvesting techniques and bio-oil extraction processes that can be commercially scaled and economically replicated in the Southwest desert regions of the United States for industrial production of biofuels.*

- The Pecos Algae Research and Development Facility at the Texas A&M AgriLife Research Station at Pecos, a partnership with General Atomics, aims to develop and demonstrate algae growth and harvesting techniques and bio-oil extraction processes that can be commercially scaled and economically replicated in the Southwest desert regions of the United States for industrial production of biofuels.
  - Revolutionary changes in algae growth efficiency and separation technology could create an algae biofuels industry that is economically competitive with current fuel prices.
  - If a successful system can be demonstrated, 2,000-acre production systems may be a reality for the Permian Basin of Texas and the southwestern United States.
  - For each 2,000-acre unit, Texas A&M economists predict about \$190 million per year in local economic impact.

## PROGRESS

### *Evaluating the costs of State Water Plan management strategy*

- In support of the 50-year State Water Plan, El Paso Center scientists developed expected costs for alternative agricultural water management strategies to identify the most economically efficient strategies and those that save the most water. Strategy costs ranged from \$54 to \$1,632 per acre-foot, with reservoir improvement and control systems having the lowest costs. This information is being used to develop the 2016 regional water plans to meet future water needs.

### *Developing tools to improve water operations and planning*

- El Paso researchers modeled Rio Grande hydrologic conditions and alternative water management operations to help identify those that are the most effective and efficient. The results of this research are helping to develop strategies to sustain economic development and a healthy ecosystem, especially during periods of extreme drought. These strategies will benefit more than 2.5 million people in New Mexico and West Texas and along the U.S.-Mexico border.



# LOWER RIO GRANDE VALLEY

*Texas A&M AgriLife Research and Extension Center at Weslaco*



# GOAL

Protect water quality and increase the amount of water available for urban and rural use through new technologies and approaches.



## PROGRESS

### Improving water quality

- Weslaco Center researchers are identifying the effects of different agricultural management practices on nonpoint source pollution from irrigated farms where effluents are discharged into the Arroyo Colorado.
  - *Two practices with the greatest beneficial impact on nutrient loadings are nutrient management (applying fertilizer according to a soil analysis) and irrigation management (reducing runoff and using non-erosive stream sizes).*

### Increasing irrigation efficiency

- A Weslaco researcher developed and evaluated Internet-based applications and mobile phone and tablet apps to improve crop efficiency, productivity, and profitability per unit of irrigation water applied. Researchers developed and evaluated a web-based program with tools to analyze weather data, estimate crop water requirements, estimate heat and chill units or freeze hours, and develop a water balance equation to manage irrigation. This tool has the potential to conserve at least 15% of the total water applied, with a potential economic impact of \$180 million per year.
  - *Experiments were conducted to increase the potential for conserving water and increasing net returns per unit of water applied to bioenergy crops such as sorghum and energy cane.*
  - *Researchers also developed sensor technology to detect water, insect, and disease stresses and help breeders select traits for crop improvement.*
- Researchers are developing and using a new method for evaluating the performance and longevity of subsurface drip irrigation (SDI) systems.
  - *Performance and longevity are key factors in the profitability of SDI systems when used for lower value commodities, such as fiber and grain crops.*
  - *Weslaco Center recommendations for management and maintenance of SDI systems can greatly affect the efficiency and longevity of these systems.*
  - *Optimal use of SDI systems can maintain production with less water, reducing the environmental impacts of agriculture.*

# GOAL

Improve agricultural production and efficiency through advances in animal and plant breeding, management, and health.



## PROGRESS

### *Enhancing citrus and vegetable production*

- Weslaco Center research — in partnership with the Texas A&M University-Kingsville Citrus Center and the USDA Agricultural Research Service's Kika de la Garza Subtropical Agricultural Research Center — focuses on citrus and vegetable production.
- This partnership also strengthens agribusiness in the Lower Rio Grande Valley through research in
  - *integrated pest management*
  - *biological pest-control techniques*
  - *diseases of honeybee colonies*
  - *the introduction of plant quarantine treatments*
  - *organic farming systems*
  - *postharvest treatment of produce by nonchemical means*
  - *aerial remote sensing to detect agricultural threats*
  - *the selection of pesticide-tolerant vegetable, ornamental, and specialty crops to comply with U.S. labeling and Environmental Protection Agency standards.*

### *Designing healthier foods, bio-factory crops, and bioenergy crops*

- Next-generation crops will improve human health, open larger markets for growers, protect the environment, and help provide new sources of energy. Weslaco Center researchers are using cutting-edge technologies in molecular biology and plant sciences to develop
  - *supernutritious fruits and vegetables*
  - *"biofactory" crops that produce high-value compounds for medical, therapeutic, and industrial uses*
  - *energy crops designed to be used as feedstocks for bioenergy and biofuels production*
- The Texas A&M AgriLife Sugarcane Breeding Program has developed energy cane cultivars with high-biomass yield, in partnership with Chevron Technologies Venture and BP Biofuels. This energy cane, specifically designed for use in biofuels production, can be grown in a wider region of Texas and the United States. By applying next-generation DNA sequencing, this program has identified and isolated genes controlling cold tolerance, which could prevent losses to the \$3.8 billion U.S. sugar industry.



*Weslaco Center research has developed new sugarcane varieties through genetic improvement that are high in sugar, resistant to disease and insects, cold- and drought-tolerant, have desirable harvest and processing characteristics, and are well suited to South Texas growing conditions.*



- AgrilLife Research has signed a commercial license agreement with Syngenta for a novel promoter technology in transgenic sugarcane and energy cane for enhanced biofuel production.
- Weslaco Center research has developed new sugarcane varieties through genetic improvement that are high in sugar, resistant to disease and insects, cold- and drought-tolerant, have desirable harvest and processing characteristics, and are well suited to South Texas growing conditions.

### **Making fruit and vegetable crops resistant to disease**

- Weslaco Center scientists are conducting applied research to incorporate disease-resistance genes into crops important to South Texas agriculture. A Weslaco Center researcher has developed citrus varieties containing natural spinach plant defensin genes, which make them resistant to citrus greening, a widespread and difficult-to-control disease. In May 2015, he received an Experimental Use Permit from the Environmental Protection Agency for these varieties, which have been exhaustively shown to be safe. The next step toward commercialization is to test the trees for any effects on fruit quality or taste. If commercialized, these trees could save the \$13 billion per year U.S. citrus industry from being devastated by citrus greening.
- Other current disease-resistance research projects at Weslaco are in potatoes and sugarcane, including the development of transgenic sugarcane that is resistant to viruses and to a broad spectrum of insects that transmit plant viruses.
- A Weslaco Center tomato breeder crossed heat-tolerant and pest- and disease-resistant germplasm obtained from Texas A&M, USDA's National Plant Germplasm System, and other public breeding programs to develop a base breeding population. Cultivars developed from the program are expected to help revitalize Texas's tomato production to satisfy local demand of more than 2 million pounds of tomatoes per year.
- Spinach breeding at Weslaco has resulted in the identification of 21 lines that are highly resistant to white rust, from the University of Arkansas collection, and 11 USDA lines with desired leaf characteristics that will be used to develop breeding and mapping populations. Molecular markers linked to white rust resistance have been identified and will be used to speed up cultivar development to reduce cost and yield losses resulting from white rust disease.
- Weslaco scientists are researching plant disease vector biology, ecology, and management; epidemiology; and disease resistance as they relate to vegetable integrated pest management practices.
  - *Results of plant disease vector research combined with integrated pest management will reduce both insect pest management costs and growers' losses to plant diseases.*

---

# GOAL

Add value to raw agricultural products and expand market channels through new product development and enhancements to existing commodities.

## PROGRESS

- Collaborating with industry partners, a Weslaco Center researcher developed improved agronomic practices within a stress-physiology program that has resulted in significant yield increases of greater than 30% and improved water- and nitrogen-use efficiencies of alternative crops for value-added products. These advancements translate into significant savings in water, fertilizer, herbicide, and pesticide costs and have improved the prospects of a sustainable and profitable bio-based economy in Texas.
  - *Research on citrus greening (or Huanglongbing), a bacterial disease threatening the U.S. citrus industry, has identified key nutrition management factors that allow growers to sustainably manage and prolong the productive life of infected trees and groves.*

# GOAL

Capitalize upon data from high-throughput sequencing, proteomics, metabolomics, metagenomics, and other advanced technologies to develop systems biology tools for improving agricultural productivity.

## PROGRESS

- At Weslaco, a new high-throughput, microbial hairy-root platform is being developed to culture, propagate, and study plant pathogens such as *Candidatus* spp. This platform will enable transformative studies of multiple devastating plant pathogens that until now have been uncultivable.
- Weslaco scientists have identified several novel spinach defensin genes using genomics and bioinformatics tools. The genes are currently being characterized and will be used to impart resistance to citrus greening and to zebra chip disease in potatoes. Efforts are also underway to identify tomato and potato central stress regulatory networks.
- Using comparative genomics approaches, Weslaco Center researchers identified several new genes that are potentially useful to improve cold tolerance, salinity tolerance, and nitrogen-use efficiency as well as resistance to such diseases as smut and orange rust.

# PANHANDLE- PLAINS REGION

*Texas A&M AgriLife Research and  
Extension Center at Amarillo*

*Texas A&M AgriLife Research and  
Extension Center at Lubbock*

*Texas A&M AgriLife Research and  
Extension Center at Vernon*

*College of Agriculture and Life Sciences,  
Texas A&M University*

*Institute for Infectious Animal Diseases*



# GOAL

Protect water quality and increase the amount of water available for urban and rural use through new technologies and approaches.



## PROGRESS

### *Boosting irrigation efficiency*

- The Texas High Plains is the state's most intensively irrigated region, with 1.38 million irrigated acres accounting for nearly 90% of all water use. Irrigation management has been practiced here since development of irrigated agriculture in the 1950s. Advances in irrigation have been developed and implemented by farmers over time, along with crop genetic improvements. Irrigation engineers and plant scientists have shown that genetics alone, without adequate advanced irrigation system management, are not enough to meet the complex challenges facing today's farmers. AgriLife Research irrigation engineers have teamed with crop genetics faculty to help farmers achieve advanced productivity and higher water-use efficiency than ever before, with significantly less groundwater resources being pumped from the Ogallala Aquifer.
  - *Major irrigation strategies were irrigation scheduling, changing crop type and variety or converting to dryland crops, updating irrigation equipment, conservation tillage, and advances in plant breeding.*
  - *Successes from this research are being proposed for inclusion in developing regional and state water plans, and the tools developed as part of the research have saved producers hundred of millions of dollars by sustaining crop yields with less irrigation water per acre over the past two decades.*
- AgriLife Research economists investigated economic and groundwater use implications of climate change in three heavily irrigated counties (Dallam, Hartley, and Sherman) in the Texas Panhandle's Ogallala Aquifer region, using a new spatially explicit, dynamic, integrated model.
  - *They determined that the average saturated thickness in these counties will decrease by 39.7%, 35.7%, and 42.5%, respectively, by 2050. They predict that total irrigated acres will decline due to aquifer depletion by 43.8%, 13.2%, and 12.7% and dryland acreage will increase by 109%, 116%, and 116%, respectively, by 2050.*
  - *Simulation models showed that adopting a water-conserving crop mix is an effective strategy for farmers in adapting to climate change by increasing 4.3%, 5.8%, and 2.1% of the net returns for producers in these counties, respectively.*
- A field study at the Lubbock Center evaluated water policy based on the economics of bioenergy or food crops grown with limited irrigation in rotation with cotton. The study showed increased overall crop profitability between \$74 and \$93 per acre using sorghum and target irrigation rates of 60% and 80% evapotranspiration with crop rotation. When applying these scenarios to 25% of the irrigated cotton acres (about 500,000 acres) in the High Plains, the overall economic impact would be approximately \$41.8 million.



*By preventing a single unnecessary 2-inch irrigation on a ½-mile center pivot, a farmer could save approximately \$12,000 and 28.6 million gallons of groundwater.*

- Vernon Center researchers have shown that delaying irrigation until critical cotton growth stages, as compared to banking water through pre-season or early season irrigation, can reduce water applications by 41% while reducing lint yields by only 5%. Estimating 148,000 irrigated acres of Rolling Plains cotton, water savings for the region could total 21,323 million gallons and save over \$1.3 million in pumping costs.
- Amarillo researchers created a “service portal” that serves as a public gateway to information available from the Texas High Plains Evapotranspiration (TXHPET) Network, providing Internet access to weather data affecting agriculture, accurate crop water-use estimates, online irrigation scheduling tools, and other educational resources. The crop water-use data are regionally focused in the Texas High Plains (Panhandle and South Plains), where most irrigation water in the state is used, as well as in portions of the Rolling Plains and West Texas. The amount of water savings associated with this Texas Water Development Board–funded project was conservatively projected to be 201,846 acre-feet annually. The four most heavily impacted counties were Dallam, Moore, Hartley, and Sherman, since they are the largest water users. This estimated conservation impact equals only a 4.5% reduction of the regional water use per year by both regions but is significant because of the large crop acreages and irrigation water volumes pumped annually.
  - *Based on a TWDB study cost of \$152,400 to date for the two years, the project cost per acre-foot saved with this ET-based management project was only \$0.38 per acre-foot or \$0.03 per acre-inch, extremely inexpensive in terms of a benefit-to-cost ratio. The low costs justify statewide development and support of the network for future irrigation management and water conservation.*
- A research team at the Amarillo and Lubbock Centers developed new software to accurately and easily compute evapotranspiration, or ET, the loss of water from the soil by evaporation and by transpiration from plants.
- The team also developed web-based irrigation scheduling tools and educational resources to improve the efficiency and efficacy of water management in irrigated crop production. A newly created Bushland Evapotranspiration (BETS) calculator software program has been completed. It serves as a tool for standardized computation of reference ET and is widely used in industry and by researchers around the world. The software program is available for mobile phones as well as personal computers.
  - *This information allows growers to determine the correct amount of irrigation needed for their crops. This method has saved over 50,000 acre-feet (16.2 billion gallons) of groundwater annually for the northern Texas High Plains.*
  - *Results from a recent Borlaug Institute irrigation systems assessment project indicate that irrigation improvements using tools and ET-based scheduling methods developed at Amarillo, Bushland, and Lubbock could make a marked increase in production operations.*



*Preliminary studies at the Lubbock Center on irrigation timing in cotton show potential water savings of 10% with no significant reduction in lint yield compared to traditional irrigation practices.*

- An Amarillo and Lubbock research team has improved the ability to detect plant diseases early in the growing season by using remote-sensing technologies, allowing farmers to eliminate irrigations of diseased wheat.
  - *By preventing a single unnecessary 2-inch irrigation on a ½-mile center pivot, a farmer could save approximately \$12,000 and 28.6 million gallons of groundwater.*
- Preliminary studies at the Lubbock Center on irrigation timing in cotton show potential water savings of 10% with no significant reduction in lint yield compared to traditional irrigation practices.
  - *Subsurface drip irrigation saves more water than other irrigation methods.*
  - *Lubbock researchers also identified new cotton varieties best suited to dryland growing or to varying levels of irrigation when affected by disease or nematode pressure.*
- A recent USDA Agricultural Research Service study supported a four-year Lubbock Center study showing that on a clay loam soil, subsurface drip irrigation cotton yield and quality irrigated at seven-day intervals instead of daily intervals had no negative effect and significantly increased yield by 250 pounds per acre in dry years, using the same quantity of irrigation.
- In an ongoing study at Lubbock in which rain is leveraged with very limited irrigation to optimize rain value, increases in water-use efficiency occurred with each incremental increase in seasonal irrigation. This indicates that concentrating available irrigation, even with significant rain, may be the better irrigation water-use option than irrigating larger areas with less water.

### ***Studying the economics of climate change in the Ogallala Aquifer region***

- Vernon Center researchers studying climate change in the Ogallala Aquifer region found the following:
  - *Three Regional Climate Models predicted an overall decrease in the average rainfall, an increase in the intensity of extreme rainfall events, and an increase in both minimum and maximum temperatures in most counties in the Texas High Plains and the Rolling Plains in the future (2041–2070) when compared to historic periods (1971–2000).*
  - *Optimal crop pattern selection and mix are related to initial water availability and land distribution.*
  - *Irrigated lands in areas facing water scarcity show sharper drops in crop production, while production increases annually in areas with relatively high water levels.*
  - *Deficit irrigation is an effective strategy for agriculture and water sustainability.*
  - *With continuing water depletion, more irrigated land will be replaced by dry land and pastureland, which demand much less irrigation water.*

---

*The Spatially Explicit Load Enrichment Calculation Tool (SELECT) was developed and adopted by state agencies to assess E. coli contamination in more than 20 impaired Texas watersheds.*

## Improving groundwater quality

- High levels of nitrate in groundwater and bacteria in streams are contributing to more Texas waters being listed as impaired. Researchers at the Vernon Center found that the groundwater in the southern Ogallala Aquifer region, where shallow wells are abundant, has substantially higher nitrate, sulfate, and chloride contamination accompanied by high salinization, when compared to the northern Ogallala region. In shallow wells, about 80% and 32% of observations exceeded the EPA's Secondary Maximum Contaminant Level for total dissolved solids (an indicator of salinity) and the Maximum Contaminant Level for nitrates, respectively, from 2000 to 2010, when compared to 22% and 3% of such observations in deep wells.
  - *Agricultural producers could reduce their nitrogen fertilizer applications by 43%–72% when accounting for well water nitrates and crediting them toward crop nitrogen requirements. Vernon Center studies showed that crop yields were maintained with reduced nitrogen inputs, confirming that well-water nitrate is used by irrigated crops.*
  - *The Spatially Explicit Load Enrichment Calculation Tool (SELECT) was developed and adopted by state agencies to assess E. coli contamination in more than 20 impaired Texas watersheds.*

# GOAL

**Sustain and support efficient use of land resources and ensure air quality in the production of food and non-food crops.**

## PROGRESS

### Conducting air quality research

- In addition to impacts on air quality for humans, more than a million cattle die from respiratory illness in the United States each year, causing economic losses in the hundreds of millions of dollars.
- Through the Air Quality: Reducing Feedlot Emissions initiative, the Amarillo Center has developed a sound scientific basis for cost-effective air quality emissions abatement measures for open-lot cattle feedlots and dairies in the Southern Great Plains of Texas and Kansas.
  - *Researchers measure particulate matter, ammonia, hydrogen sulfide, odor, volatile organic compounds, and greenhouse gases to help with emissions control.*
  - *Scientists showed that ground-level particulate matter concentration (dust) was reduced by 54%–84% by increasing animal density in large cattle feedyards.*
  - *Amarillo researchers have successfully demonstrated the use of automated digital imaging followed by image processing and interpretation to visually estimate ground-level feedlot dust concentrations. Based on the outcomes of an earlier 10-year USDA National Institute of Food and Agriculture grant, they are now validating their methods in the field with a prosumer-grade Digital Single-Lens Reflex (dSLR) camera.*

- *The researchers have also successfully demonstrated the design, assembly, and use of a low-cost, wireless network of small optical sensors to generate vertical and horizontal distributions of particulate matter mass concentrations within a feedlot dust plume.*
- *Two national networks, the National Atmospheric Deposition Program (NADP) and the Clean Air Status and Trends NETwork, provide researchers and policymakers with standardized, high-quality, ongoing measurements of airborne nutrients that are deposited onto soils and vegetation by direct contact or by being dissolved or suspended in precipitation. NADP sites in Texas managed by Amarillo Center personnel are included in the NADP annual report of wet-deposition data. Successful participation in an NADP site has provided a valuable reference baseline database and context for discussing feedyard and dairy ammonia concentrations and emissions from other research projects.*
- *Research on mitigating ammonia emissions from animal manure has shown that a technology involving an acid-filled gas-permeable membrane system can effectively remove and capture 50% of the ammonia from liquid dairy manure in less than three weeks.*
- *Amarillo researchers estimated that a Panhandle feedlot with a capacity over 32,000 head could save about \$40,000 per year by adopting dust-abatement practices alone.*
- Nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>), greenhouse gases that are emitted from cattle feedlots, have global-warming potentials (GWP) of 21 and 310 times that of carbon dioxide, respectively, with N<sub>2</sub>O being the greater contributor to global warming. Little research has been conducted into the emissions of these greenhouse gases from beef cattle feedyards, particularly as it applies to climatic conditions, ration formulations used, and management practices of feedlots in the Texas High Plains, even though reporting is required by the U.S. Environmental Protection Agency. An Amarillo researcher measured greenhouse gas emissions in the spring and summer of 2014 in feedyard pens and found that both N<sub>2</sub>O and CH<sub>4</sub> emissions were temperature-dependent and decreased as manure-pack temperatures decreased. Treatments were applied where the dry surface layers were removed and added to adjacent bases, to test temperature differences. With USDA Agricultural Research Service collaborators, this data is being used to develop and improve emissions models.
- Collaborating with colleagues in the College of Agriculture and Life Sciences' Department of Biological and Agricultural Engineering, the researchers installed a second open-path Fourier transform infrared (OP-FTIR) system at a commercial feedyard, providing greenhouse gas measurements for the dominant wind directions on the Texas High Plains.
  - *Biological and Agricultural Engineering teaches a continuing professional development course on global warming and the regulation of greenhouse gases under the federal Clean Air Act.*



## GOAL

**Conduct basic and translational research to minimize the unfavorable effects of agricultural production and urban communities on the environment.**

*Lubbock Center researchers found ways to increase overall crop profitability between \$74 and \$93 per acre using sorghum for crop rotation, with target irrigation rates of 60% and 80% evapotranspiration. If these scenarios apply to 25% of the irrigated cotton acres (about 500,000 acres) in the High Plains, the overall economic impact would be approximately \$41.8 million.*

## Improving crop production

- Lubbock Center researchers found ways to increase overall crop profitability between \$74 and \$93 per acre using sorghum for crop rotation, with target irrigation rates of 60% and 80% evapotranspiration. If these scenarios apply to 25% of the irrigated cotton acres (about 500,000 acres) in the High Plains, the overall economic impact would be approximately \$41.8 million.
- Researchers at the Lubbock Center have found ways to improve cotton production on land infested with root-knot nematode and black root rot by using a combination of disease-resistant cultivars and chemical or seed treatments, resulting in greater yields and reduced variability in cotton growth.
  - *They also conduct ongoing economic evaluation of precision farming technologies.*

## PROGRESS

### Conserving soil and water in crop production

- Environmental soil science research at Vernon has indicated that tillage has no significant effect on sorghum and cotton lint yields. Fitted models indicate that optimum lint yields and net returns can be achieved at irrigation rates of 83% evapotranspiration. Net returns across all irrigation treatments were significantly higher for no-till cotton systems (\$44.54 per acre) compared with bedded conventional till systems. Thus, adoption of conservation tillage systems should not negatively affect lint yield or net returns in deficit-irrigated cotton systems in the Texas Rolling Plains, particularly during the transition from intensively tilled systems to conservation-tilled systems.
- Likewise, three years of tillage and water effects on grain sorghum production indicate that tillage does not impact grain yields. In addition, irrigation at 60% evapotranspiration has produced equal yields as 90% ET. Environmental benefits, such as erosion control and improved soil and water quality, could also increase the overall value of conservation production systems.
  - *Vernon research in the region has shown that no-till results in a 78% reduction in sediment loss, as much as 52% increase in water infiltration, and three times lower losses of nutrients such as phosphorus and ammonium. Enterprise budgets for the Texas Rolling Plains indicate a \$23.47 per acre advantage for no-till wheat production versus conventional wheat production. For the 30,000 no-till acres in Wichita County, a savings of over \$710,000 could be realized.*



- Vernon researchers are taking the lead to determine and develop management practices for successful implementation of cover crops. Soil moisture is the top concern for producers in semi-arid environments and a top hindrance to adoption of cover crops. Research has shown that cover crops can significantly lower stored soil moisture entering the cash-crop growing season (cotton and wheat). However, subsequent cotton yields have not been affected, indicating that soil health may be improving where cover crops are implemented. Producers should realize that a long-term commitment must be made to truly weigh the benefits or consequences of cover crops and or crop rotations.
  - *Vernon scientists are exploring supplemental grazing opportunities that may also provide additional benefits or profits to the producer. Environmental benefits, such as erosion control and improved soil and water quality, could also increase the overall value of conservation production systems.*
- Cropping systems within the Rolling Plains are predominantly monoculture cotton and wheat systems. There are several warm-season crops as options for rotation with cotton, but cool-season alternatives for wheat have been less viable. Over the past few years, winter canola has become a viable alternative for wheat producers. In 2013, an estimated 40,000 acres were planted in North Texas, which is similar to planted acreage in Kansas and Oklahoma. Research has shown that wheat yields have increased by as much as 30% following canola. However, canola production has been more of a challenge for no-till producers. Vernon researchers are leading research to develop optimum management strategies to maintain the expansion of canola acres in Texas. Research includes winter canola variety trials, planting date, tillage systems, seeding rate, row spacing, and grazing. This work has become a viable resource for Texas and southwestern Oklahoma canola producers.
- A cropping system study began in 2014 at Amarillo, in conjunction with the Uvalde Center, to assess the production potential and water use of several types of vegetables with a wheat cover crop as an alternative to classic continuous cereal grains production that have relatively low market value and require high irrigation water use. Preliminary results indicate the region has sufficient heat-unit capacity to integrate cropping systems production with vegetables. However, researchers are concerned that Texas High Plains spring season wind levels may make it difficult to establish vegetable crops.
- AgriLife researchers have identified major soil-related issues challenging the viability of row crop production in the Texas Southern High Plains. Continuous tillage, monoculture cropping systems, and an ever-increasing demand for water resources has led to areas in this semi-arid environment of diminishing soil quality and decreasing water quantity and quality. A three-year cropping systems study was initiated in December 2014 aimed at demonstrating and quantifying the impacts of soil health-promoting practices on soil carbon, soil water holding capacity, nutrient availability, and subsequent yield and production economics for deficit-irrigated cotton production. Demonstrations are being conducted at three locations in Texas (Beeville, Chillicothe, and Lamesa), with each of these sites associated with the Texas A&M University System.



*A multi-year study at the Lubbock Center proved that fertilizing cotton with more than 100 pounds of nitrogen per acre did not significantly increase the lint yield but could delay crop maturity, enhance the severity of cotton aphid infestation, and negatively affect cotton quality.*

## **Reducing fertilizer and pesticide applications in cotton**

- A multi-year study at the Lubbock Center proved that fertilizing cotton with more than 100 pounds of nitrogen per acre did not significantly increase the lint yield but could delay crop maturity, enhance the severity of cotton aphid infestation, and negatively affect cotton quality.
- A study of fruit loss caused by insects in the genus *Lygus* is providing valuable information for cotton producers and is expected to reduce the frequency of insecticide application in cotton production. Lubbock researchers have developed economic threshold and management recommendations for *Lygus* in High Plains cotton. After bolls reached 13 days of age, the insects caused very little seed damage, and any damage did not result in significant lint yield reductions. Once bolls reached more than 28 millimeters in diameter, they were safe from the insects.
- Lubbock researchers also found that under a low water regime (3 inches in season irrigation), cotton lint yield losses from fleahopper damage were more prominent than when 6 inches of water was applied. This indicates that plants under less stress have a greater ability to compensate.

## **Monitoring water usage by dairies**

- Dairy production has expanded rapidly in the High Plains, with the number of milking cows increasing tenfold from 23,000 head in 2000 to 230,000 head in 2012. Given that the rate of withdrawal from the Ogallala Aquifer already far exceeds the rate of its natural recharge, the dairy industry was under pressure from communities and government agencies because dairies were thought to use more water than traditional crops grown on the same land. There was a critical need to have region-specific water-usage estimates for dairies. Amarillo researchers monitored water use at two dairies with differing herd management and manure-handling systems from 2011 through 2013. One is a drylot dairy with 2,660 lactating cows, and the other is freestall dairy with 4,600 lactating cows. Total water usage averaged 11.5 liters and 9.3 liters per liter of milk produced (or 5.6 milliliters per hectare and 8.6 milliliters per hectare of land) at the two dairies, respectively. A workbook model of dairy water usage is being developed from existing models, incorporating the results of this research.

# GOAL

Conduct basic and translational research into the factors affecting biological diversity and ecosystem structure and functioning, including the role of human activity.



Vernon research showed that managing grazing for highest ecosystem health results in earning capacity four times higher than on rangelands with poor ecosystem health.

## PROGRESS

- Research scientists at the Vernon Center have developed nationally and internationally recognized, science-based knowledge documenting natural resource management as a requirement for
  - *healthy, functional ecosystems;*
  - *integrated crop and livestock production systems; and*
  - *sustainable use of natural resources in semi-arid environments.*

### *Researching rotational grazing for ecosystem health*

- Vernon Center researchers determined the ecological and economic consequences of managing grazing on semi-arid savanna rangeland stocked with livestock to
  - *maintain current ecosystem health,*
  - *maximize profit, or*
  - *improve ecosystem health over a 30-year time frame.*
- At the Vernon Center, different configurations of multi-paddock grazing strategies in tallgrass prairie were examined using a simulation model. In agreement with fieldwork conducted in the study area, these simulations indicated that multi-paddock grazing, when adaptively managed, can take advantage of positive biological responses and minimize negative responses to livestock grazing if knowledge of these biological responses is incorporated into timely management decisions. Both ecological and economic goals were superior when using optimal management of adaptive multipaddock grazing.
  - *Use of the model has presented insights into the response of different combinations of management options that would be difficult or impossible to achieve in field experimentation.*
  - *Using both field data and simulation approaches in tandem has allowed more complete analyses of the impacts of different management and facilitates systems-level investigation at the scale of rangeland ecosystems.*
- Vernon research showed that managing grazing for highest ecosystem health results in earning capacity four times higher than on rangelands with poor ecosystem health.
  - *Managing for high ecosystem health is imperative for maintaining ranch livelihoods and the ecosystem services that Texans depend on.*

---

## Promoting prescribed burning and herbicide application for brush treatment

*A Vernon Center researcher has developed unique and innovative techniques for low-cost conversion of mesquite woodland thickets to a savanna rangeland, with a low density of mesquite mixed with grasses.*

- The Vernon Center has provided the most complete published data set in the world related to effects of summer season prescribed burning for mesquite and pricklypear cactus control on rangelands grazed by livestock.
  - *This program has published some of the only replicated studies that contrast summer and winter fire effects on rangeland vegetation and soils, as well as effects on mesquite seedling mortality.*
- A Vernon Center researcher has developed unique and innovative techniques for low-cost conversion of mesquite woodland thickets to a savanna rangeland, with a low density of mesquite mixed with grasses.
  - *These techniques include (1) low-intensity fires that reduce mesquite foliage but do not trigger basal resprouting and (2) low rates of herbicide application to convert mesquite thickets to savanna.*
  - *These treatments cost less than mechanical treatments and provide cover for wildlife and shade for livestock.*
  - *In the only study of its kind that is based on field data, the researcher proved that the treatment life of root-killing mesquite herbicides is over 20 years, compared with top-killing herbicides at less than 10 years.*
  - *Mesquite-grass competition research has found that in average precipitation years in north Texas, mesquite canopy cover must reach 60% before production of cool-season midgrasses and warm-season shortgrasses is cut in half. However, mesquite cover only needs to reach 22% to halve production of warm-season midgrasses, which are the most important grasses for cattle forage. This suggests that the best strategy for treating mesquite may be to treat before cover exceeds 50%, which is the standard practice. This adjustment could result in a two- to fourfold increase in forage production following brush control over the modest increases that are usually experienced.*

## Controlling invasive species through biological methods

- The control of the invasive shrub saltcedar with ground beetles expanded in 2014 following a widespread outbreak in 2012 and additional new discoveries in the Texas Panhandle, where the species is using precious water resources. Data on use of the carabid beetle to control saltcedar along riverbanks and on rangelands is underway, and its primary use will be to determine the ecological success of saltcedar biological control where saltcedar is rapidly being removed from the habitats.

# GOAL

Improve agricultural production and efficiency through advances in animal and plant breeding, management, and health.

## PROGRESS

### Controlling insect pests

- The Zebra Chip program at the Amarillo Center has educated close to a thousand farmers and industry representatives about the disease and recommended management practices. The result is that no devastating epidemic of zebra chip has occurred in the past three years. The most solid evidence of the Zebra Chip SCRI program's value is the increase in potato acres planted in Texas since the program was developed. When zebra chip first entered Texas in 2000, about 20,000 acres of potatoes were planted each year, half in South Texas and half in the Panhandle region. Soon after the zebra chip program verified the potato psyllid as the vector of the bacterium *Candidatus Liberibacter solanacearum* (Lso), which causes the disease, team members developed an insecticide program that was rapidly adopted by Texas growers. By 2014, about 30,000 acres of potatoes had been planted, indicating that growers are confident about managing the disease. Using this information, Texas potato growers can remain a viable and competitive industry, with annual economic contributions to the state economy averaging \$300 million. The program has been the basis for all zebra chip management programs in the United States.
  - *Although by 2013, U.S. potato growers were spending more than \$10 million on insecticides to control psyllids, the incidence of the disease has been maintained at sustainable levels and the potato industry has been saved. The program saves Texas growers an estimated \$23 million to \$32 million per year, primarily in the Lower Rio Grande Valley, but also in all western potato-producing regions.*
- A plant pathology team at the Amarillo Center has determined that late-season infection of potato by the zebra chip pathogen, *Candidatus Liberibacter solanacearum* (Lso), will multiply to detectable levels once potatoes are taken out of cold storage. The disease can be detected if potatoes are left at room temperature for one to two weeks.
  - *This gives U.S. exporters a technique to provide confidence when certifying potatoes for export as disease-free.*
  - *The implications of this study are highly significant for seed production and for growers who frequently experience late-season psyllid infestations and place approximately 85% of their crop in cold storage.*
- An Amarillo researcher is trapping Southwestern corn borer and Western bean cutworm adults to develop an emergence model. Corn pest model development continued in 2014, and sufficient data are now available to produce a usable model. Once developed, these models will allow precise prediction of pest emergence and forewarn producers of potential problems. The data could be used for more robust predictions in the future.

---

## Improving wheat

*Growers saw a \$4.8 million annual increase in yields when planting new wheat varieties developed at the Amarillo Center.*

- Major projects are under way at Amarillo to develop superior wheat germplasm lines that can tolerate multiple stresses, using conventional and molecular breeding. Modern cultivars generally have a higher yield and more efficiently use available natural resources. They also have greater resistance to insects and to pathogens such as wheat streak mosaic virus, thus reducing the need for chemical applications. The goal of the TAM wheat breeding program in Texas A&M AgriLife Research is to design small grain cultivars focused on hard winter wheat for specific adaptation areas and management programs in Texas. These cultivars have greater resistance to pathogens and insects, thus reducing the need for chemical applications. Investments in plant breeding have consistently produced between 30% and 60% annual rate of return on plant breeding investments.
- Two new wheat varieties, TAM 204 and TAM 114, were released in 2014. TAM 204 has outstanding potential as a grain, dual-purpose, and graze-out wheat variety with high forage and grain yield, resistance to disease and to greenbug, wheat curl mite, and Hessian fly. With good regrowth after grazing, it could become the dominant grazing wheat grown in Texas. TAM 114 has excellent milling and baking quality, along with high grain yield and disease resistance, and high yield potential in both irrigated and dryland environments. With this and other varieties, Amarillo researchers envision that the High Plains of Texas will be known for high milling and baking quality wheat.
- For the first time ever, researchers are tying disease severity over time to final yield. An Amarillo Center team demonstrated that wheat streak mosaic virus develops across fields during the season so that producers have trouble determining whether additional irrigation and fertilizer will be economically beneficial.
  - *This team uses hyperspectral radiometry to help predict how disease severity will relate to final yield, helping growers understand the cost-benefit potential for further inputs.*
- TAM 111, TAM 112, and TAM 113 wheat are among the most drought resistant varieties ever developed for the High Plains. A 2012 survey showed that TAM 111 and TAM 112 are still the most popular varieties in Texas, Kansas, Nebraska, and the Oklahoma Panhandle. Growers saw a \$4.8 million annual increase in yields when planting new wheat varieties developed at the Amarillo Center.
- These varieties are resistant to wheat streak mosaic virus, which can cause over \$10 million in economic losses in the Texas High Plains.
  - *Studies at the Amarillo Center showed that this wheat is highly resistant to the virus's natural vector, the wheat curl mite; therefore TAM 112 is expected to be resistant to all mite-vectored viruses.*
  - *This finding provides important information to geneticists and breeders in their efforts to identify and deploy genetic resistance to wheat streak mosaic virus and other mite-vectored viruses.*

- Drought is the most important constraint limiting wheat yields in the Southern High Plains, but the past four years of exceptional drought have provided a tremendous opportunity for research and genetic improvements. Researchers in Amarillo have determined traits within the TAM cultivars that provide drought tolerance. Multiple-year field studies indicated that biomass at flowering is important to maintaining high yield under drought. Selecting cultivars with higher biomass and greater early vigor may be beneficial to wheat management. They further found that newer cultivars such as TAM 111 and TAM 112 use soil water more efficiently than a relative older cultivar, TAM 105, suggesting that breeding advancements have improved plant water use in dry conditions.
  - For field phenotyping evaluation, the researchers found that cooler canopy contributed to higher yield in new drought-tolerant cultivars. A crop that is cooler than the air temperature signifies a healthy crop and is associated with increased photosynthesis. Experiments showed that the cooler the canopy, the higher the grain yields. TAM 111 and TAM 112 had up to 5°F lower canopy temperature and 31% more grain yield than other genotypes, suggesting that cooler daytime canopy might be the reason for higher yield in the two drought-tolerant cultivars under drought conditions.
  - In greenhouse studies, whole-plant data indicated that TAM 112 produced more biomass and grain yield than TAM 111 under water-deficit conditions during grain filling. Researchers found that many genes associated with metabolic processes and dehydration responses were uniquely regulated between cultivars. TAM 112 had three times more unique responsive genes than TAM 111, which could be a reason that TAM 112 performed better under longer periods of drought stress.



*Lubbock scientists assisted Bayer CropScience, Americot, Phytogen, and All-Texas Seed in their efforts to breed cultivars that are resistant to root-knot nematode and bacterial blight.*

## Improving cotton

- Researchers at the Lubbock Center have enhanced genetic diversity available to cotton breeders through phenotypic screening of cotton collections.
  - Discoveries include genes from a wild Hawaiian cotton that improve fiber quality and yield potential for cotton crops.
- They also developed novel screening strategies for disease-resistance breeding in cotton, including resistance to verticillium wilt and root-knot nematode.
- Lubbock scientists assisted Bayer CropScience, Americot, Phytogen, and All-Texas Seed in their efforts to breed cultivars that are resistant to root-knot nematode and bacterial blight.
  - This work is critical due to the loss of Temik 15G for nematode control.
- Lubbock researchers tested a new partially resistant reniform nematode cultivar in a Cotton Incorporated project (jointly tested in four states).
  - As a result, GB713 was released for commercial use and should make a significant difference in management of reniform nematode in the future.



- Research at Lubbock developed weed management systems to address emerging herbicide-resistant weed populations.
  - *Palmer amaranth* biotypes resistant to glyphosate were first identified in 2011 and were found in an increasing number of cotton fields in 2014. Weed-management studies evaluating residual herbicides as part of a total management system were identified. A combination of a pre-plant incorporated herbicide followed by a pre-emergence herbicide at planting and a residual herbicide at post-emergence with glyphosate can effectively reduce resistant weeds by using different modes of action.
  - These systems have been communicated at grower meetings, in popular press articles, videos, and other reports.
- Lubbock cotton breeders evaluated new transgenic technologies in cotton, including Bollgard II XtendFlex (glyphosate/dicamba/glufosinate tolerant) and Enlist (2,4-D tolerant), for crop tolerance and weed efficacy. These represent promising tools for managing problem weeds as well as glyphosate-resistant Palmer amaranth. Improved control of many problem annual and perennial weeds was achieved in these systems compared to with glyphosate alone. These technologies are expected to be available to growers in 2016.
- Lubbock researchers used interdisciplinary cropping system research to reduce overall insecticide-use frequency in High Plains cotton.

### ***Improving ruminant health and animal agriculture***

- Through the Ruminant Health project, Amarillo Center researchers have concluded studies that will facilitate development of health, management, and nutritional strategies to improve animal production, animal health and well-being, and food quality and safety in beef and dairy enterprises — while reducing environmental risk factors and conserving natural resources.
  - Included were an analysis of the effect of genotype on uterine health after calving in Holstein cows; a study on the dynamics of culling risk for cows in large multi-breed dairy herds; investigation of the influence of drinking water turnover rate on fecal shedding of *E. coli* O157:H7 in finishing cattle; a study on the genomic variation in immunity and susceptibility to mastitis in Holstein cows; studies on the use of a botanical treatment for mastitis in organic dairies; a study on bovine respiratory disease risk in newborn beef calves; and a project analyzing the use of an algae by-product for cattle feeding.
  - Given the limited resources for treating disease in organic dairies, researchers are evaluating the effect of natural products on health, survival, and fertility of cows affected by uterine disorders. As organic dairies continue to grow in the United States, they will continue to explore this research.

*Through the Ruminant Health project, Amarillo Center researchers have concluded studies that will facilitate development of health, management, and nutritional strategies to improve animal production, animal health and well-being, and food quality and safety in beef and dairy enterprises — while reducing environmental risk factors and conserving natural resources.*

- Scientists from the Department of Animal Science, the Vernon Center, and the Institute for Infectious Animal Diseases (IIAD) are collaborating to develop a behavioral-based monitoring system using radio frequency identification (RFID) technology for preclinical detection and mitigation of bovine respiratory disease (BRD) in beef cattle. This disease is the most common cause of antimicrobial use and morbidity and mortality in the beef cattle industry, costing over \$1 billion annually. Commercial feedlot adoption of active RFID-based morbidity detection for BRD mitigation would also provide enhanced real-time monitoring and surveillance for zoonotic disease outbreaks.
  - *Preliminary results have shown that predictive algorithms developed by AgriLife Research to monitor deviations in feeding behavior metrics can accurately detect BRD cases two to three days before clinical symptoms are observed.*
  - *Ongoing efforts by the research team include further validation of the behavior-monitoring technology, refinement of predictive algorithms, and development of managerial decision-support systems.*
- AgriLife Research and USDA's Agricultural Research Service have collaborated to develop a non-GMO novel probiotic bacteria that can hyperutilize ruminal nitrate and nitrite that markedly reduces the risk of nitrate poisoning in cattle consuming toxic levels of nitrate through feed or water. Increasing drought will lead to increased threat of high-nitrate forages being grazed or fed as hay. The new probiotic has been effective both in the lab and in living animals in rapidly reducing nitrate and nitrite toxicity.
  - *Additional benefits attributed to the probiotic are reductions in rumen methane production and antimicrobial activity against some food pathogens.*
  - *The probiotics are currently under patent evaluation and commercialization review.*
- In Vernon Center research, the rumen metagenomes of Angus and Brahman cattle fed very poor quality hay and supplemented with different protein sources were found to differ in rumen bacterial community composition and functionality. Observed differences point to genetic and environment interaction that supports pursuing further research into the host-microbiome interrelationships to enhance production efficiency in the two most important biologic types of beef cattle in Texas and throughout the South.

---

## Developing new drought-tolerant, cold-tolerant, disease-resistant hybrids

*In the north Texas Panhandle, saving irrigation just 1 inch per acre per year on all the regional corn acreage would result in a total water savings of nearly 40,000 acre-feet, or 13 billion gallons.*



- Adoption of drought-tolerant wheat cultivars is an important practice for producers in the Texas High Plains.
  - *Amarillo researchers found that two newly released wheat cultivars are consistently more drought tolerant as compared to some older, drought-susceptible cultivars.*
  - *These findings help researchers to identify some important physiological traits and molecular markers conferring drought tolerance and use these traits in breeding wheat cultivars for improved drought tolerance, yield, and water-use efficiency.*
- Corn is the major irrigated crop in the North Texas High Plains, and corn irrigation uses 53% of the entire water budget annually in the region. Amarillo researchers have evaluated new drought-tolerant corn hybrids at three irrigation levels in the region. Multi-year field studies indicated that it is possible to maintain 200 bushels per acre of yield at an irrigation level of 75% of evapotranspiration (ET) requirement with some new hybrids. This irrigation level can allow water savings over 20%. Water-use efficiency is generally maximized as well. In the north Texas Panhandle, saving irrigation just 1 inch per acre per year on all the regional corn acreage would result in a total water savings of nearly 40,000 acre-feet, or 13 billion gallons. The overall economic return will be easily multiplied by adding the savings in pumping and other production costs.
- In 2014, Amarillo researchers found that a new drought-tolerant corn hybrid has the ability to use more water in the deeper soil profile, which can boost effective use of soil water under drought. This is an important trait for crops to combat drought stress in semi-arid environments. In another study, they evaluated corn hybrids with differing maturity dates on different planting dates, with a goal to maintain yield and maximize water-use efficiency. The two-year results indicated that proper late planting (early to mid-June versus early May) with short-season hybrids (96-day corn) may provide some benefits for corn production, such as saving irrigation water because of better chance of rain, possible re-planting after hail damage, and other flexible field operations.
- New multiple-stress-tolerant corn germplasm from the Lubbock Center's corn breeding program can broaden genetic diversity; reduce the risks of yield and quality loss due to drought, high temperatures, and insects; reduce aflatoxin contamination; and save water. The lines are being used to produce commercial hybrids in Texas and also in Turkey. Licensing agreements have been signed with both U.S. and international seed companies for evaluations.

*AgriLife researchers have conducted multi-year field studies and evaluated different methods to quantify canopy temperature depression as a good indicator of drought tolerance.*

- A Lubbock corn breeder coordinated the nationwide project for breeding aflatoxin-resistant corn. Other investigators in the project include scientists from Texas A&M University and from USDA's Agricultural Research Service in Mississippi, Georgia, and North Carolina. They have identified new sources of aflatoxin-resistance germplasm.
- Pre-nucleus seed of an early-maturing ryegrass line and a hybrid orchardgrass line was produced at the Vernon Center in 2014. The early-maturing selection needs improvement in persistence, and further selection and evaluation are planned.
- Thirty-eight unique hibiscus lines were identified at the Vernon Center in 2014, and a successful method to propagate hibiscus from stem cuttings was developed to enable production of many copies in a relatively short time for evaluation by commercial partners. Five new evaluation agreements were initiated with private industry partners. About 1,000 new hibiscus hybrids were made during 2014; approximately 30% of them will be evaluated in 2015.
- AgriLife researchers have conducted multi-year field studies and evaluated different methods to quantify canopy temperature depression as a good indicator of drought tolerance.
  - *These methods include continuous infrared thermal meter (IRT), hand-held IRT, and thermal imaging.*
  - *Continuous IRT and thermal imaging appear most promising in quantifying the differences in canopy temperature depression among wheat lines.*
  - *Researchers also developed software to precisely calculate the plant canopy temperature by filtering soil background.*
  - *These tools can be used to evaluate plant response to other stresses such as heat, plant disease, and weed competition.*
  - *They also can be used in other crops such as corn, sorghum, and cotton for screening biotic and abiotic stress tolerance.*

## GOAL

**Add value to raw agricultural products and expand market channels through new product development and enhancements to existing commodities.**

## PROGRESS

### *Feeding cattle with distillers grains*

- One-third of all U.S. beef cattle are finished within a 150-mile radius of Amarillo. The goal of the Texas A&M AgriLife Research Beef Cattle Nutrition Program at the Amarillo Center is to improve beef production efficiency and animal health while
  - *reducing nutrient losses to the environment,*
  - *conserving natural resources, and*
  - *improving the quality of beef delivered to the consumer.*

*In Vernon research, feeding steers dry-rolled corn, steam-flaked corn, and wet distillers grains plus solubles supported markedly different composition in the rumen microbiome. Notably, differences in rumen microbiome composition correlated well with differences in animal performance on these diets. These results point to the need to explore development of targeted probiotic supplementation for feeders receiving markedly different finishing diets.*



- Use of distillers grains in finishing systems is a major focus of the program.
  - Including distillers grains at 20% of dietary dry matter increases the crude protein and phosphorus content of feed.
  - In diets containing distillers grains, a portion of steam-flaked corn can be replaced by dry-rolled corn or finely ground sorghum.
  - Combining two grain sources results in improved average daily weight gain.
- Amarillo researchers continue to study the digestibility and feedlot-performance effects of feeding cattle sorghum wet distillers grains treated with enzymes mixed into a finishing diet of steam-flaked corn. Recent results indicated few differences in digestibility, ruminal pH, performance, and carcass measurements between the group fed with the distillers grains with enzymes versus the control group. Treating the distillers grains with a buffered enzyme complex had positive effects on digestibility, but no corresponding improvements in performance were detected. Further research with increased cattle numbers is warranted.
- In Vernon research, feeding steers dry-rolled corn, steam-flaked corn, and wet distillers grains plus solubles supported markedly different composition in the rumen microbiome. Notably, differences in rumen microbiome composition correlated well with differences in animal performance on these diets. These results point to the need to explore development of targeted probiotic supplementation for feeders receiving markedly different finishing diets.

### ***Enhancing specialty crop production***

- Lubbock Center researchers have enhanced small-acreage specialty crop production by increasing use of high-tunnel plasticulture in Texas.
  - *This technology provides season extension and adverse-climate protection.*
- Lubbock scientists improved and protected specialty crops from invasive weeds and potential herbicide drift through development of weed-management strategies.

# GOAL

Provide policy makers, producers, and consumers with scientifically sound data regarding carbon cycling and sequestration.

*Prescribed burning of agricultural lands is under scrutiny because of carbon dioxide emission on combustion. A Vernon Center researcher has studied the effects of prescribed burning for brush control on carbon loss and carbon sequestration.*

## PROGRESS

### *Studying the impact of land-use changes on greenhouse gases and carbon*

- Vernon researchers are investigating the impact of land-use change on energy, water, carbon, and greenhouse gas fluxes associated with changes from conventional, continuous cotton systems to second-generation biofuel feedstocks (biomass sorghum and perennial grasses) in the Southern Cotton Belt region. Results indicate significant differences in carbon exchange, evapotranspiration, and energy fluxes of cotton compared to biomass sorghum and Old World bluestem grasses. Surface energy balance closure was approximately 90% in biomass sorghum and perennial grassland sites. In the cotton field, the closure was approximately 100%. In the cotton field, most of the available energy (net radiation) was used for evapotranspiration. In the biomass sorghum field, 50%–80% of available energy was used for evapotranspiration. In the perennial grassland, this ranged between 20% and 50%, depending on the soil-moisture conditions.

### *Researching prescribed burning and ecosystem carbon balance*

- Prescribed burning of agricultural lands is under scrutiny because of carbon dioxide emission on combustion. A Vernon Center researcher has studied the effects of prescribed burning for brush control on carbon loss and carbon sequestration.
  - *Repeated fires, either in summer or winter, were not found to reduce total soil carbon but were found to increase it in some treatments.*
  - *Using carbon dioxide flux towers, the researcher found that the amount of carbon lost to the atmosphere from combustion during a winter fire was recovered through increased photosynthesis by vegetation during the first growing season post-fire in both a wet and a drought year.*
  - *Prescribed burning of rangeland for brush control in Texas will likely not contribute to global atmospheric carbon dioxide concentrations and may actually increase carbon sequestration.*

### *Developing data on mesquite water use and carbon sequestration*

- A Vernon researcher has conducted some of the earliest research that quantified mesquite water-use patterns, including water uptake by roots and leaves and root growth responses to drought.
  - *These data sets have helped scientists understand the true impact of rangeland shrubs on the landscape regarding water use, competition, and carbon sequestration.*

---

# GOAL

Create economically feasible, sustainable alternative energy systems through basic and translational research in feedstocks, logistics, and conversion technologies.

*Researchers found that it would be three times more profitable to harvest only aboveground growth of mesquite and allow regrowth to be reharvested every 10–12 years as an optimum to facilitate both bioenergy and livestock forage needs.*

## PROGRESS

### *Developing bioenergy from lignocellulosic plants*

- High-biomass and photoperiod-sensitive sorghum (PSS) has been identified as a potential bioenergy crop. Amarillo researchers have conducted multiple-year field studies and evaluated the feasibility of high-biomass sorghum hybrids under different soil-water regimes. Although high-biomass yield required full irrigation, the biomass sorghum still could achieve high yields (up to 8 tons per acre) under limited irrigation in the Texas High Plains. It may yield up to 6 tons per acre under dryland conditions with about 8 inches of seasonal rainfall.
  - *Although PSS can be grown under both limited irrigation and dryland conditions, limited irrigation may be more attractive for sustaining higher biomass yields, given the large variation of seasonal rainfall in the High Plains.*
- Vernon and Amarillo Center scientists have pioneered research on the potential of invasive rangeland woody plants such as mesquite and juniper for bioenergy uses. Lubbock research found that greenhouse gas emissions (carbon emitted per acre) for harvesting and delivery of mesquite to the farm gate was 11 times lower than for irrigated sorghum and four times lower than dryland sorghum and dryland switchgrass. Dollar cost per biomass harvested and delivered was twice as high in both sorghum systems compared to either switchgrass or mesquite systems. However, due to a 10-year reharvest schedule, as opposed to annual harvesting in the other feedstocks, mesquite production potential was eight times less than irrigated sorghum, five times less than switchgrass, and three times less than dryland sorghum. Thus, while mesquite appears to be environmentally friendly as an energy feedstock, its significantly lower production potential will limit this feedstock to that of a complementary source rather than a primary source.
  - *Researchers found that it would be three times more profitable to harvest only aboveground growth of mesquite and allow regrowth to be reharvested every 10–12 years as an optimum to facilitate both bioenergy and livestock forage needs.*
  - *Compared to conventional coal, mesquite biomass was found to be a more expensive energy source for electricity production, but a possible carbon emission tax would make mesquite biomass competitive with conventional coal.*

# GOAL

Model and understand the dynamic relationships among biological molecules to genetically improve production, disease resistance, and environmental adaptability of plants and animals used to produce food, fiber, and bioenergy.

## PROGRESS

- Lubbock Center researchers created population mapping for developing thrip-resistant cotton using a resistant line discovered in a screening project. Acres treated for thrips from 2008 to 2012 ranged from more than 69,000 to more than 860,000, at a cost of \$2 to \$9 per acre. Cost of treatment has soared, and efficacy has declined with the loss of aldicarb and resistance to seed-applied neonicotinoids. Proposed germplasm releases show a 30% decrease in visual thrips damage; these lower treatment thresholds will save up to \$2 million per year in treatment costs.
- Plant Release Committee approved CA 3003 and CA 3004 germplasm lines from Lubbock research that produce 9.4% and 7.6% less waste than currently grown cotton, respectively, resulting in approximately a \$3 value increase per bale unit and a 54%–69% improvement in yarn quality.

# GOAL

Capitalize upon data from high-throughput sequencing, proteomics, metabolomics, metagenomics, and other advanced technologies to develop systems biology tools for improving agricultural productivity.

## PROGRESS

### *Studying rumen bacteria in relation to cattle diets*

- Researchers at Vernon, Amarillo, and Lubbock quantified and described for the first time, in studies using a single set of cattle, the response of rumen bacteria to diet shifts from warm-season perennial Bermudagrass hay to cool-season grazing on wheat. Using the 16S rDNA gene marker, they identified genera and operational taxonomic units of bacteria in the rumen of cattle on these diets.
  - *Using these molecular DNA tools will allow scientists to identify the bacterial species or species groups associated with the onset of metabolic disease and develop interventions to decrease the more than \$500 million annual cost of bloat and acidosis in cattle.*

### *Exploring genetic selection for disease resistance in cattle*

- Commercial platforms to perform genomewide association analyses have become available and more affordable in the past few years. This technology provides the opportunity to explore vast areas of the genome, complementing traditional breeding strategies for animal improvement.

- Amarillo scientists have conducted candidate gene analyses exploring genetic variation associated with resistance to disease in cattle populations. They have determined genotypes significantly associated with high-impact health disorders, including reproductive diseases and mastitis. Developing applied animal selection practices in disease control is a sustainable approach with significant potential for improving the overall health, welfare, and profitability of food animal producing systems.
  - *Progress is being made in the use of new technologies in disease detection, including (1) analysis of the association between animal behavior, tympanic temperature, and hematologic parameters with clinical bovine respiratory disease and growth performance; (2) changes in behavior, activity, and milk yield during the initial phases of disease; and (3) determination of cutoff levels for early intervention.*

### **Using genetic selection for improved livestock fertility**

*Researchers at Amarillo are evaluating direct measures of fertility in livestock and performing genomewide association studies using high-density DNA analysis platforms. This research is expected to improve the methods used for genetic selection of dairy cattle and reverse the antagonistic trends of reduced fertility in dairy cows without impairing genetic progress for milk yield.*

- Researchers at Amarillo are evaluating direct measures of fertility in livestock and performing genomewide association studies using high-density DNA analysis platforms. This research is expected to improve the methods used for genetic selection of dairy cattle and reverse the antagonistic trends of reduced fertility in dairy cows without impairing genetic progress for milk yield.
- At the beginning of the third year of a multistate, integrated five-year project investigating the potential of genomic selection for improved fertility of dairy cattle, Amarillo researchers had collected reproductive and health phenotypes for 12,000 dairy cows in Texas and six other states (California, Florida, Minnesota, Kansas, Ohio, and Wisconsin), with at least two participating farms per state. Extreme high- and low-fertility cows have now been submitted for genotyping, and association analyses will follow.
  - *The \$2.9 million grant for this project was funded as part of the Translational Genomics for Improved Fertility of Animals program (USDA-NIFA/AFRI program).*

### **Using marker-assisted selection in wheat breeding**

- Wheat genetic research has combined available molecular techniques, knowledge, and tools with traditional methods to identify tightly linked molecular markers for marker-assisted breeding to increase selection efficiency. High-throughput, single nucleotide polymorphic markers (KASP SNP) were developed for a greenbug resistance gene, a wheat curl mite resistance gene in TAM 112, and a wheat streak mosaic virus resistance gene. These markers have been validated and are being used in AgriLife Research breeding programs and many other breeding programs in the High Plains. Private companies from the United States, Australia, and Brazil are requesting these KASP SNP markers.

- The goal of the wheat genetic research at Amarillo is to identify new sources and novel genes associated with resistance or tolerance to drought, rusts, mosaic viruses, and insects. For the past two years researchers have been working to finely tag a gene conferring resistance to wheat streak mosaic virus, with the goal of improving yield and genetic gain through markers for rapid testing of genotypes for resistance to this virus. After genotyping research in 2013 and 2014, molecular markers divided genotypes into two distinct groups corresponding to resistance and susceptibility to the disease. A journal paper covering this work has been prepared and will be published soon.
- Another important wheat genetics study focuses primarily on improving yield by introducing drought tolerance into stem rust resistant lines from Kenya. Phenotyping was conducted under both drought and well-watered environments to obtain data for mapping and select drought-tolerant wheat lines that have no yield penalty when environmental conditions are favorable. Data were collected from seven environments during 2013 and 2014, and genes have been mapped. Crosses between TAM 111 and three spring wheat cultivars from Kenya possessing wheat stem rust resistance have also been made. The crosses are important for potential improvement in yield as well as genetic diversity. They are now being tested in Kenya and the United States under both stress and non-stress environments.

### ***Conducting peanut-breeding programs focused on genetic resistance or insect and disease tolerance***

- The Texas A&M AgriLife Peanut Breeding and Genetics program based partly at the Lubbock Center released transcriptome sequences from leaf, pod, and root tissue of a progenitor species of the cultivated peanut. This was publicized as part of the International Peanut Genome Initiative (IPGI), which involves scientists from Texas A&M AgriLife Research, the University of Georgia, North Carolina State University, University of California, and other institutions. A manuscript on the transcriptome sequence is in press.
  - *The draft genomic sequence of the same diploid species was released in November by IPGI. Lubbock researchers' transcriptome sequences were provided to help with determining which genomic sequences are expressed genes.*
  - *Pending the release of the sequence of the cultivated tetraploid peanut, the diploid wild species progenitor genome and transcriptome sequences are already being used for developing SNP (single nucleotide polymorphism)-based markers in diploid and cultivated peanut.*
- Lubbock Center researchers used transcriptome-based SNPs to develop a genetic map of a diploid wild species cross, using the Roche Lightcycler at the Lubbock Center and the Fluidigm Biomark in College Station that was purchased by AgriLife Research and the Texas A&M College of Veterinary Medicine and Biomedical Sciences. This demonstrates that the new gene-sequencing technology can be used to make marker analysis far more efficient.



### ***Breeding better-tasting peanuts***

- Seed multiplication of Tamrun OL12 and Schubert peanut cultivars is progressing at the Lubbock Center. Tamrun OL12 is an early maturing, high-oleic runner peanut that was developed because of concern about off-flavors caused by drying of immature runner peanuts under warm daytime temperatures. It has reduced potential for developing fruity-fermented off-flavors. Schubert is a second-generation high-oleic runner peanut, intended to replace the OLin variety. Schubert matures one week earlier than OLin, but yielded 520 pounds per acre more in tests over four years, and shelled two percentage points higher. As do OLin and Tamspar 90, Schubert has some resistance to *Sclerotinia* blight.

### ***Using remote-sensing and other new technologies to improve agriculture***

- Using a remote-sensing technique called spectral reflectance, Amarillo Center scientists can accurately estimate early season forage production in a few seconds. Currently this is a ground-based system, but high-resolution aerial systems will soon be available. They have used this system across their entire wheat-breeding program and will now be able to make rapid progress breeding for increased forage yield in wheat. Continued improvement in forage yields and quality will benefit both stocker cattle operators and wheat producers.

## **GOAL**

**Model and understand dynamic relationships among behavioral and economic factors that influence the development and sustainable adoption of new technologies for the benefit of consumers, producers, and society.**

## **PROGRESS**

### ***Keeping growers up-to-date on best practices***

- Research conducted by the Cotton Improvement Program at the Lubbock Center resulted in recommendation to modify the USDA's *Cotton Loss Adjustment Standards Handbook* to remove "stripper" and "picker" variety designations for the Southwest region. This will streamline the adjustment protocol and allow farmers to freely choose the variety they want to plant.
- Lubbock researchers placed information on their website and distributed it at producer meetings that lists rating of the performance of most commercial cotton varieties to verticillium wilt. This heavily used information helps growers make cotton variety decisions if they encounter this disease.
- Lubbock researchers are helping Southern High Plains cotton producers manage nematodes by choosing resistant varieties. Management has become much more difficult with the loss of Temik 15G from the marketplace. Assessment of nematode-resistant varieties with respect to nematode reproduction and yield is important to the producers, and this information is in great demand from both producers and seed distributors.

# WINTER GARDEN AND SOUTH CENTRAL REGION

*Texas A&M AgriLife Research and Extension  
Center at San Angelo*

*Texas A&M AgriLife Research and Extension  
Center at Stephenville*

*Texas A&M AgriLife Research and Extension  
Center at Uvalde*

*College of Agriculture and Life Sciences, Texas  
A&M University*



# GOAL

Protect water quality and increase the amount of water available for urban and rural use through new technologies and approaches.



## PROGRESS

### *Protecting watersheds*

- Stephenville Center researchers have developed new methods of screening water and soil samples for coliform bacteria that will allow better assessment of efforts to mitigate bacterial contamination of watersheds.

### *Enhancing irrigation and cropping systems*

- Uvalde research on water conservation for leafy greens continues to show impressive results for the recirculating hydroponic system, with more than 90% water savings compared to those grown under field conditions. The hydroponic project reached over 350 people through educational programs and attracted a multimillion-dollar investment in a hydroponic system to be placed in a Central Texas location.
- Deficit irrigation applied with subsurface drip systems is an important strategy for sustaining specialty melon productivity in water-limited regions of Texas. Uvalde Center researchers demonstrated a 36% water savings in Tuscan-type and cantaloupe melons.
- A two-year research project in Uvalde showed that integrating strip tillage into a cropping system increased watermelon yield efficiency (biomass per inch of water applied) by 12%–18%. Integrating deficit-irrigation strategies with specific crop coefficients can improve pepper water-use efficiency up to 25% in water-limited regions of Texas.
- The Uvalde Center's findings on plant growth regulators aimed to alleviate transplant shock and reduce crop losses in stressful environments; this can result in significant savings or more profits for high-value crops such as tomato and pepper.
- Uvalde Center researchers collaborated with corn breeders at the Lubbock Center to test the effect of irrigation timing on corn growth and yield. Delivering water through nighttime drip irrigation appeared to significantly reduce root zone temperature, which translates into a 10% increase in yield.
- Texas land available for green industry activities such as nurseries, greenhouses, landscaping, and urban forestry is estimated at 1.5 million to 2 million acres. These activities use up to 6 million acre-feet of water annually, rapidly approaching the usage by irrigated agriculture in the state. The ornamental plant program at the Uvalde Center is helping green industries improve water-use efficiency by implementing new research publicized in books and journals and at conferences.

---

## *Reducing urban water consumption through graywater reuse*

- Efforts are under way at the Uvalde Center to launch a statewide initiative on reusing graywater for irrigating home landscapes and ornamental plants in urban areas. Research has shown that many ornamental plants can grow just as well when irrigated/watered with graywater from bleach-free household laundry. Irrigating with graywater could save 400,000 acre-feet of potable water per year within the state, or about 8% of annual potable urban water use.

# GOAL

**Sustain and support efficient use of land resources and ensure air quality in the production of food and non-food crops.**

## PROGRESS

- A cropping system project at the Uvalde Center determined that the use of cover crops reduces wind erosion, thereby improving air quality. It also allows for more efficient use of land. In response to regional growers' requests, researchers are expanding this project by adding drought-tolerant crops into the rotation systems. Center researchers are collaborating with Sesaco Co. to test sesame growth and yields with different irrigation regimes in southwestern Texas.
- Uvalde researchers studied the use of starch-based, biodegradable plasticulture mulch and found that these mulches degrade almost 100% after 12 months in the field. Biodegradable plastic mulch requires minimal or no labor costs to remove and dispose of after harvest and can mitigate soil environmental pollution better than polyethylene plastic.
- Uvalde research on screening efficient sources of organic fertilizers (fish meal, chicken manure, plant meal, and blood meal) can potentially enhance soil microbial activities, soil physical and chemical properties, and plant performance. This study will help Texas organic growers maximize their profitability.

# GOAL

**Conduct basic and translational research to minimize the unfavorable effects of agricultural production and urban communities on the environment.**

## PROGRESS

### *Improving environmental sustainability of meat and milk production*

- Dairies in North Central Texas have more manure phosphorus than they can safely apply as effluent or compost to their croplands without raising soil phosphorus to levels that threaten surface-water runoff into the Bosque and Leon Rivers. Stephenville Center researchers developed strategies to increase waste-management efficiency by 45% through on-dairy phosphorus recycling using year-round forage cultivation and reduced phosphorus excretion in diets. This saves dairy producers \$900 million in land purchase or lease costs and reduces phosphorus pollution.



Researchers at the Stephenville Center found that secondary compounds from plants native to the southern United States could prevent housefly (*Musca domestica*) larva from developing in dairy cattle manure. This natural control strategy could reduce both the environmental and economic costs of fly control on dairy farms.

- Researchers at the Stephenville Center found that secondary compounds from plants native to the southern United States could prevent housefly (*Musca domestica*) larva from developing in dairy cattle manure. This natural control strategy could reduce both the environmental and economic costs of fly control on dairy farms.

### ***Designing cost-effective, sustainable, pest- and disease-management solutions***

- Red imported fire ants are a chronic pest in much of Texas. These ants present medical, animal health, and agricultural issues in both urban and rural areas. Chemical controls are the most consistent method of management in spite of the fact that fire ants are infected by naturally occurring pathogens. Stephenville scientists are studying two of the most common naturally occurring pathogens, microsporidia and viruses. These pathogens have co-evolved with ants, and it may be possible to upset the evolutionary equilibrium through mechanisms of hormonal interaction, allowing the natural pathogens to dominate the population. Sponsored by the Texas Invasive Ants program, field research into hormonal and or biological control of red imported fire ants is under way to safely reduce ant populations in sensitive areas such as schools, parks, or wildlife-management zones. The protocol will provide a non-toxic means of ant management for citizens living in infested areas.

### ***Improving plant nitrogen use to prevent runoff***

- The nitrogen-use efficiency (NUE) of plants that are given conventional synthetic fertilizers averages only 50% because of losses that occur when soluble nitrogen fertilizers are applied to soils. The vegetable and soil programs at the Uvalde Center jointly submitted a National Science Foundation proposal to evaluate improvements of NUE through advances in nanotechnology.

### ***Returning farmed exotic animals to native countries***

- Uvalde researchers are collaborating with the international conservation community to aid successful repopulation of endangered African ungulates bred on Texas ranches back to their native lands.

# GOAL

**Conduct basic and translational research into the factors affecting biological diversity and ecosystem structure and functioning, including the role of human activity.**



*Wildlife is a valuable resource in Texas, bringing in over \$6.2 billion annually. Researchers at Uvalde work with private landowners to increase the quantity, quality, and diversity of wildlife in Texas. This wildlife provides healthy outdoor recreational opportunities for 6.3 million people who hunt, fish, or watch wildlife in Texas each year, and in doing so supports many jobs in the wildlife-related service and retail industries.*

## PROGRESS

- Genetic testing by Uvalde scientists revealed that deer cannot transmit tick fever to cattle. This finding saves the Texas deer-hunting industry \$2 billion per year by eliminating the requirement to impose quarantine restrictions and fund a costly wildlife-control program.
- Texas A&M AgriLife Research and AgriLife Extension are conducting multiple, diverse studies to help solve the chronic decline in wild quail populations and restore healthy populations of this iconic game bird.
- Wildlife is a valuable resource in Texas, bringing in over \$6.2 billion annually. Researchers at Uvalde work with private landowners to increase the quantity, quality, and diversity of wildlife in Texas. This wildlife provides healthy outdoor recreational opportunities for 6.3 million people who hunt, fish, or watch wildlife in Texas each year, and in doing so supports many jobs in the wildlife-related service and retail industries.
- Juniper infests over 10 million acres of Texas rangelands, reducing forage production and livestock carrying capacity by 10%–50%. It also increases the potential for wildfire and adversely affects the hydrologic cycle, soil health, and biodiversity. Researchers at the Sonora Research Station, part of the San Angelo Center, have developed innovative management strategies using prescribed fire and goat browsing to reduce the cost of juniper control over sevenfold compared to mechanical methods, for a savings of over \$100 per acre for brush control.
  - *Selective breeding was used to develop goats that consume about 15% more juniper than average goats. On the millions of acres of juniper-infested rangeland, that can translate to an increased carrying capacity of about 10%. This could result in an additional net income of \$600 for a herd of 100 goats, while increasing the efficiency of goats as a biological control agent for juniper.*
  - *Research has demonstrated that juniper can be used as a roughage source in ruminant diets. If this technology is adopted by one 500,000-head feedlot, it could reduce feed cost about \$1.5 million while providing a net profit to the juniper harvester of about \$1 million and clearing over 20,000 acres of juniper-infested rangeland at no cost to the landowner.*

# GOAL

Improve agricultural production and efficiency through advances in animal and plant breeding, management, and health.

*The Uvalde vegetable physiology team assisted a College of Agriculture and Life Sciences plant breeder in the development of a new tomato cultivar 'TAM Hot-Ty', which provides excellent quality, is heat and virus resistant, and produces high yields on a small, compact plant, saving both space and water. This cultivar has attracted the attention of Texas growers and retailers.*



## PROGRESS

### *Protecting and improving livestock*

- Because of goat breeding cycles, there is typically an excess of fresh goat meat in late summer and early fall, resulting in lower prices. At the San Angelo Center, researchers are selecting goats that ovulate earlier in the spring to enhance the production of year-round goat meat and allow producers to benefit from the approximately 20% higher prices that exist during the low-volume winter months.
- Scientists at Stephenville developed an *in vitro* embryo production and transfer system to improve summer fertility in commercial dairy cows, saving the industry \$40 million annually.
- The Texas Beef Improvement project at the Uvalde Center resulted in selection of "efficient" animals that gain the same as their "inefficient" herd mates while consuming 15%–20% less feed. Researchers also found that differences in efficiency are related to differences in digestibility and rumen microbiota.

### *Developing new cultivars with superior traits*

- The Uvalde vegetable physiology team assisted a College of Agriculture and Life Sciences plant breeder in the development of a new tomato cultivar 'TAM Hot-Ty', which provides excellent quality, is heat and virus resistant, and produces high yields on a small, compact plant, saving both space and water. This cultivar has attracted the attention of Texas growers and retailers.
- The Uvalde vegetable team conducted five field trials of 75 elite TAMU pepper hybrids to evaluate yield, fruit quality, and resistance to viruses and bacterial leaf spot. This led to identification of three hybrids for commercial license by a seed company and 10 others for further testing with commercial growers.
- The vegetable team also produced trials of 34 experimental TAMU hybrids, 29 elite inbred lines, and 21 commercial cultivars of specialty cantaloupe melons. This led to identification of 5 candidate hybrids for larger commercial trials; these have high sugars, large fruit, and resistance to powdery mildew.

### *Using native plant germplasm to restore grassland ecosystems*

- Landowners in the Cross Timbers region are more interested in restoring farmland to its original diverse, native vegetation than they are in gaining economic returns from the land. Stephenville researchers are developing native plant germplasm for inclusion in commercial seed mixes for woodlands, prairies, rangeland reseeding, roadside revegetation, wildlife plantings, and cultivated pastures.



- *The researchers collect germplasm from remnant native vegetation sites, evaluate it for potential uses, and then develop it into releases that are made available to commercial seed companies.*
- *Two cultivars have been released through the North Texas Ecotype Project, established at Tarleton State University to facilitate prairie restoration.*
- Stephenville Center researchers collect, evaluate, and release commercial ecotypic germplasm that will replace exotic invasive monocultures of annual ryegrass, bermudagrass, and speargrass. Their work, funded largely by the Texas Department of Transportation and the Texas Parks and Wildlife Department, is providing sustainable alternatives for roadside revegetation and grassland restoration. As a result, TxDOT now requires more native seed in roadside revegetation mixes. The increasing demand for native plant species from Texas seed companies will create millions of dollars of additional income within the state.

### ***Conducting peanut-breeding programs focused on genetic resistance, drought tolerance, or insect and disease tolerance***

- Researchers at the Stephenville Center identified and transferred wild peanut genes that control rootknot nematodes and improve drought tolerance and transferred these genes into cultivated varieties, saving producers \$30 million annually in pesticide applications and \$40 million in irrigation and water-pumping costs.
- Stephenville peanut breeders have released the first nematode-resistant variety in the world with high oleic acid content. This release could increase Texas peanut producers' income by \$15 million to \$25 million annually while reducing pesticide requirements and maintaining heart-healthy characteristics in peanut products.
- Drought tolerance has become a focal point of the Stephenville Center's wild species introgression program. A wild peanut species native to desert climates in northeast Brazil has been found and recently hybridized in Texas. Transference of drought-resistance genes to commercial peanut varieties could reduce irrigation water requirements by 10%–20% or more. A 10% reduction in water use would be in line with the 2080 projections needed in the High Plains Water District Management Plan.



- The Stephenville Center's greenhouses contain the largest collection of exotic species of South American peanuts of any university in the world. Some of the plants are over 25 years old, and many contain genes that will sustain peanut production in Texas, both economically and environmentally.
- Texas scientists have been working for several years on transferring genes from wild peanut into cultivated varieties. Stephenville researchers found wild species from Brazil that have genes for higher oil content. While domestic peanut varieties contain 48%–51% oil, some wild species contain up to 64% oil. Globally, many countries encompassing an estimated 3.0 billion people grow peanuts for their cooking oil. Stephenville breeding efforts have produced a hybrid that contains 64% oil (equal to that of the wild parent), and this hybrid is cross-compatible with cultivated peanut. Variety releases will soon be available, and these new varieties will greatly enhance international development efforts to feed the hungry.
- Stephenville researchers, with scientists in Lubbock and College Station, released the new peanut variety 'Tamrun OL11'. This new cultivar has a high oleic and low linoleic acid ratio and is resistant to sclerotinia and tomato spotted-wilt virus. It has the potential to increase Texas peanut farmers' annual income by \$20 million to \$30 million.

## GOAL

**Add value to raw agricultural products and expand market channels through new product development and enhancements to existing commodities.**

*Uvalde Center researchers developed integrated crop strategies — from transplanting to harvest — for artichoke, a specialty crop for Texas. Research on improving stand establishment of artichoke showed that using a low level of nitrogen fertilization can improve transplant quality and the plants' ability to withstand drought and heat shock in the field. These results will also improve profitability by reducing fertilizer costs for growers.*

## PROGRESS

### *Developing and promoting specialty crops*

- Uvalde Center researchers developed integrated crop strategies — from transplanting to harvest — for artichoke, a specialty crop for Texas. Research on improving stand establishment of artichoke showed that using a low level of nitrogen fertilization can improve transplant quality and the plants' ability to withstand drought and heat shock in the field. These results will also improve profitability by reducing fertilizer costs for growers.
- The breeding and physiology pepper programs at the Uvalde Center jointly released 15 disclosures of jalapeño pepper inbred lines and three habanero pepper lines.
- Uvalde research and extension faculty are researching the adaptation of specialty crops for growth in southwest Texas. They are studying stress management, nitrogen fertilization, and irrigation practices (drip, center pivot, hydroponics) on a variety of new crops, such as globe artichokes, diverse melon types, bibb and romaine lettuce, kale and other leafy greens, determinate tomatoes, olives, and grapes.

---

# GOAL

Minimize the impacts of foodborne hazards and biosecurity threat agents.

## *Improving wool marketing*

- The value of wool is determined primarily by mean fiber diameter (MFD) and clean wool yield of greasy wool. In the United States, wool from different growers is often combined into a single lot before being sold to improve marketing efficiency and provide larger, uniform lots of wool. Each bale in these lots must meet American Society for Testing and Materials standards. Because of the large sample size and high price for obtaining results from official methods, marketers use visual appraisal to determine which bales to combine to make a sale lot. Low-cost, rapid near-infrared spectroscopy techniques are being developed at the San Angelo Center that will improve the efficiency of interlotting to assure buyers of a uniform lot and add value to wool for growers.

## *Studying the economics of high-value crops*

- Researchers in the College of Agriculture and Life Sciences, Department of Agricultural Economics, analyzed the economic impacts of agriculture and recreation on the Winter Garden region. Agriculture is vital for the prosperity of southwest Texas and the Winter Garden, with a farm gate value estimated at \$564 million for 2013. Researchers expect that within 10 years, a 10% expansion of high-value crops will have an additional economic impact of \$84 million.

## PROGRESS

### *Developing procedures to ensure the safety of food and consumer products*

- Climate conditions during the past few years have led to the development of mold on crops such as corn. When these molds develop, they produce mycotoxins, which have negative effects on animal production and human health. Aflatoxin is a mycotoxin of special concern because it has been associated with cancer in humans. Milk can contain aflatoxin from feeding contaminated grain to dairy cattle. Scientists at the Stephenville Center determined that an aflatoxin binder was effective at reducing the transfer of the toxin into milk. This helps to ensure production of safe and wholesome milk for consumers.

# GOAL

**Model and understand the dynamic relationships among biological molecules to genetically improve production, disease resistance, and environmental adaptability of plants and animals used to produce food, fiber, and bioenergy.**

# GOAL

**Capitalize upon data from high-throughput sequencing, proteomics, metabolomics, metagenomics, and other advanced technologies to develop systems biology tools for improving agricultural productivity.**

## PROGRESS

- Researchers at the Stephenville Center have developed the ability to rapidly differentiate small amounts of plant pathogenic bacteria in the bodies of insect vectors through multi-locus melt typing assay. The first of its kind, this technique can determine bacterial subspecies, discover new mutant strains, determine which insects are important to a disease epidemic, and help track the source of alternative wild host plants that may harbor the bacterium.
- Stephenville Center researchers developed and published a rapid genotyping method for identifying strains of the bacterium that causes Pierce's disease in grapevines and other perennial species. This method will help entomologists better understand the impacts of insect vectors on disease epidemiology.
- The Uvalde Agronomy program is using computing tools for physiologists and breeders to collect large amounts of plant and soil data. This will have implications for adoption in both high- and low-input systems.
- Uvalde researchers collaborated with USDA scientists to build a multisensory cart for rapid phenotyping and crop-traits monitoring. This innovative tool will facilitate screening and selection of improved genotypes with drought and heat-stress tolerance and high productivity.



TEXAS A&M AGRILIFE  
RESEARCH  
STRATEGIC PRIORITIES,  
FY2016–2020

1. Achieve resilience in food, fiber, and ecological systems through adaptive strategies.
2. Detect, monitor, and mitigate insect vector-borne diseases and invasive species.
3. Enhance agricultural information systems and expand their use through innovative applications.
4. Integrate basic and applied research at the nexus of food and health.



## CONCLUSION

As we look back on the past five years of progress toward our FY2010–2015 goals, we pledge to continue our historical land-grant mission but to also meet the emerging challenges of today and tomorrow. To remain sustainable, agriculture must be a good steward of the environment and our declining natural resources. It must be resilient and able to adapt to climate variability (whatever the cause), a growing population, market disruption, and geopolitical instability. Adaptive agricultural systems can meet our needs not only for food and fiber, but also for clean air and water, functional landscapes, better health, and the availability of natural resources for generations to come. Adaptive systems must also be understood and accepted by the public — and they must be economically viable. Therefore, achieving resilience in the food and fiber system has been a major driver as we established four strategic priorities for Texas A&M AgriLife Research for the coming five years:

1. Achieve resilience in food, fiber, and ecological systems through adaptive strategies.
2. Detect, monitor, and mitigate insect vector-borne diseases and invasive species.
3. Enhance agricultural information systems and expand their use through innovative applications.
4. Integrate basic and applied research at the nexus of food and health.

We have set targeted goals within each of these four objectives, for a total of 17 goals, and we defined milestones and deliverables for each priority. In addition, we developed a risk-assessment table to understand the factors that could prevent us from reaching our milestones. We expect this structure to be dynamic. As progress is made and new discoveries are achieved, some actions may be removed and others may be added. To view or download a copy of our *Strategic Priorities, FY16–20*, please visit [AgriLifeResearch.tamu.edu](http://AgriLifeResearch.tamu.edu).

### Agriculture and the Future

Change is occurring throughout the world that will affect agriculture in the coming decades. As world population continues to grow, food production will need to increase by 70% by 2050, according to the United Nations Food and Agriculture Organization (FAO). The demand for meat, milk, and eggs is expected to increase as more people enter the middle class. Meeting this demand will require scientific and technological innovations and best practices that increase production while protecting natural resources.

By 2050, nearly 80% of the world's people are expected to live in urban centers, and urban agriculture will be important for food security and to save on transportation costs and energy use. But as the discussion on urban farming continues, the FAO is also providing digital sources of farming information and working to build favorable public policies for small family farms.



Genetically modified (GM) crops have been part of the U.S. and global food system for two decades and were carefully reviewed before they became part of the food system. Since then, there has been no credible research finding that they pose any health risks to humans or animals. GM foods are and will be a critical component of increasing food production to feed our world.

Reducing food waste will help feed more people in the future. Today, 30%–40% of all food is wasted, either through pest damage, inadequate storage, spillage in processing, or low crop prices, or, in developed nations, by being discarded even when it is still usable. When food is wasted, so is the water it took to grow that food.

The new UN Sustainable Development Goals, adopted by the international community in September 2015, aims to cut food waste per capita by half by 2030. Many governments, businesses, schools, and universities — including Texas A&M University — are making reducing food waste a key goal for the coming years. In AgriLife Research, the National Center for Electron Beam Research has technology for safely irradiating all foods, from spices to fresh produce, and research is exploring ways to increase the shelf life of processed foods to up to five years.

Climate change could produce an increase in the frequency and severity of extreme weather events, including megadroughts and torrential flooding. These could affect not only developing nations — worldwide at least 10 million of the poorest people are facing food insecurity because of extreme weather — but also some of the most important farming regions of the United States. The cost of adapting to climate change could put some small farmers out of business, leaving local and regional customers dependent on large food-distribution systems that are themselves vulnerable to disruption during extreme weather. Growers of all types and sizes must thrive if our food system is to remain resilient.

Technological innovation is the future of farming. Farmers everywhere are using data from many sources as they adopt precision agriculture. Using inexpensive sensors placed in the ground, they can measure water and fertilizer use, even by individual plants. This can save up to 25% of irrigation water, according to some estimates. Even small farmers can now receive, via cell phone, information on local weather, soil conditions, and the up-to-date market for their crops. Cloud-based software and applications can be downloaded to mobile devices, and this technology is advancing as more companies get on board.

The use of unmanned aircraft systems (UAS), or drones, has been approved by the Federal Aviation Administration for registered, certified pilots under 200-foot elevations in unpopulated areas. UAS are inexpensive to operate and can stay in the air for hours, gathering high-quality thermal and multispectral images that are processed by computer into photos and maps of entire fields. Farmers can use these to tell which crops need more or less water, fertilizer, pesticides, or herbicides. In much less time than it takes to walk or ride through fields, he or she can provide the precise treatment needed, saving plants and resources and increasing yields and income.

In a changing world that is fast embracing new technologies, farmers will still face long-standing problems, such as insect pests and plant and animal diseases. Texas A&M AgriLife Research has for more than 125 years found solutions to these problems and will continue to do so in the coming decades. We will need all the resources available to us to make progress toward our new strategic goals, and we trust that our stakeholders will realize the importance of investing in agricultural science for a secure future — for our nation and the world.



