STRATEGIC PLAN

Texas A&M AgriLife Research and Extension Center at Vernon

Texas A&M AgriLife Research

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STRATEGIC PLAN

Background Introduction

The Vernon Center is home to research programs in environmental systems management, water quality, food, feed, fiber, and biofuel production, animal nutrition and health, rangeland restoration, agricultural resource economics, and natural resource conservation and protection

Vernon Center Vision

Be a leading center for the discovery, development, and delivery of agricultural solutions. Become a Center of Excellence for crop and rangeland resilient agricultural research and climate smart ag.

Vernon Mission

To create economic opportunities for farmers and ranchers by improving their environment and resource base and providing healthy solutions to all Texans.

Priorities of Texas A&M AgriLife Research

Strategic priorities are areas that Texas A&M AgriLife Research will emphasize over the coming years to make measurable progress toward enhancing the resilience of agricultural systems and ensuring an abundant supply of high-quality, nutritious foods for our citizens. These are described in detail in the agency strategic plan.

Strategic Priority One: Leading-Edge Research and Innovations

Discover new innovations, technologies, and science-based solutions to enhance agricultural and ecological systems and the life sciences.

Strategic Priority Two: Sustainable Production Systems

Provide the translational research necessary to develop and produce high-quality, safe, and sustainable food and fiber systems with local, national, and global impacts.

Strategic Priority Three: Economic Strength

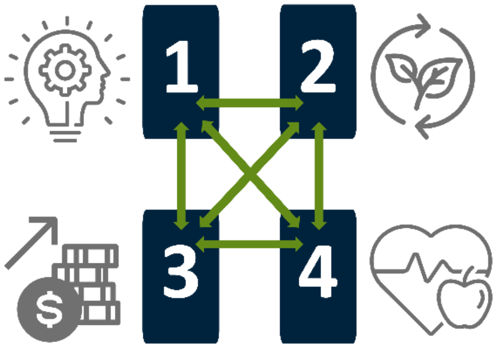
Enhance the efficiency, profitability, and resiliency of agriculture, natural resources, and food systems in the state of Texas and around the world.

Strategic Priority Four: Healthy Living

Discover, disseminate, and facilitate the adoption of scientific evidence at the intersection of nutrition, human health, and agriculture.

Synergistic Interactions Among Priorities

These four research priority areas interact synergistically to deliver healthy living to Texans. Innovative research is the foundation of this strategy, which empowers the nexus between agriculture and human health by cultivating science-based solutions to develop sustainable, profitable, and resilient agriculture that provides affordable, high-quality, nutritious food.



Vernon Center Strategic Priorities

1. Increase the number of research collaborations
2. Increase grant funding
3. Increase the Center's research capabilities & impact
4. Increase stakeholders' input
5. Increase our visibility
6. Continued organizational improvement

RESEARCH PROGRAM INTRODUCTIONS

Agrohydrology

The agrohydrology program in Vernon is led by Srini Ale, Ph.D., professor. It develops and evaluates climate-resilient, regenerative agricultural strategies for conserving soil and water, enhancing crop water productivity, and protecting soil and water quality in diverse agroecosystems. We use hydrologic, ecosystem, and crop growth models and data analysis approaches to achieve our research goal. Major focus areas of our research program, in crop and rangeland settings, include: i) assessing hydrologic and environmental impacts of changes in land use and management, ii) improving crop water use efficiency and development of irrigation decision support tools, iii) assessing climate change impacts on crop production and evaluation of adaptation strategies, iv) improving soil health and enhancing ecosystem services, and v) characterization of groundwater quantity and quality.

Environmental Soil Science

The Environmental Soil Science program at Vernon is led by Paul DeLaune, Ph.D., professor. The Environmental Soil Science Program has expansive and diverse research experience evaluating the impact of climate-smart agricultural approaches on soil improvement, water quality, C sequestration, greenhouse gas emissions and overall soil and environmental health. Regenerative agricultural approaches, including implementation of cover crops, crop rotation, conservation tillage, manure/compost/biochar applications, and integrated crop-livestock, have been shown to improve environmental health and subsequent agronomic and economic viability when properly managed. The goal of the Environmental Soil Science Program is to cultivate best management practices that improve overall soil health and function, thus creating a resilient agricultural production system that protects water resources while maintaining agronomic and economic viability under changing climatic conditions. Development of such practices reverses soil degradation and reduces the environmental footprint of agriculture for a healthy ecosystem and healthy living. Through our research, we highlight the link between the positive stewardship of today’s innovative agricultural practices and subsequent intersection with everyday human health.

Regenerative System Ecology

The Regenerative System Ecology program at the AgriLife Center in Vernon is led by Nuria Gomez-Casanovas, Ph.D., assistant professor. Better stewardship of agricultural land is needed to achieve the Paris Agreement goal of limiting warming to 2°C above pre-industrial levels. Achieving this climate target must be accomplished while meeting rising food and energy demands and optimizing the use of our natural resources (i.e., water, chemicals, land). Unfortunately, progress on these key sustainability elements has been limited. Water and greenhouse gas (GHG) footprints from food and energy sectors are now larger than they have been in recent decades. Moreover, current rates of yield and forage improvement are insufficient to meet future food demands forecasted by 2050, which could cause the expansion of agricultural land at high costs to natural systems. Therefore, to achieve climate, food and energy targets, we urgently need novel agricultural strategies that facilitate *sustainably, resilient*, *climate-smart systems*. The *overarching goal* of the research in the Gomez-Casanovas Lab at Texas A&M AgriLife Research is to address a major unsolved question: How can we sustainably meet the demand for plant biomass to provide sufficient food, feed, and energy with an increasing global population of 11 billion people while improving the resilience and sustainability of agricultural land? By addressing this question, using a combination of modeling and field experiments, the PI will contribute to solving the Grand Challenges of Food and Energy Security, and Climate Change.

Beef Nutrition

The beef nutrition program at the Texas A&M AgriLife Center in Vernon is led by Bill Pinchak, Ph.D., professor. The four pillars are: Sustainable resource utilization efficiency through integration of rangelands, croplands and pasture lands resources; Host-microbiome interactions/mutualism; Integrated nutritional ecology, metabolic dysbiosis and health, and Genotype x environment interactions integrated into bovine systems biology-based management.

Forage Grass Breeding

The forage grass breeding program at Vernon is led by Dariusz Malinowski, Ph.D., professor. The purpose of the research program has been to develop cool-season, perennial forage grasses complementary to wheat pastures that are adapted to changing climatic conditions in the Southern Great Plains. Significant effects of climate change in this region include rising temperatures, declining precipitation, abrupt patterns of precipitation and frequent, severe droughts. Traditional, continental types of improved cool-season forage grasses introduced to SGP in the 70s cannot cope anymore with the new climatic conditions and massively fail. Summer-dormant cool-season grasses evolved in the Mediterranean climate and are fully adapted to extended and severe summer drought as it often occurs in the SGP. Our long-term research suggests that summer-dormant cool-season grasses are fully adapted to current climatic conditions of the SGP and superior, both in forage productivity and persistency than traditional, summer-active types.

Hardy and Tropical Hibiscus Breeding

The hardy and tropical hibiscus breeding program at Vernon is led by Dariusz Malinowski, Ph.D., professor. There is a large demand for hardy and tropical hibiscus hybrids with novel flower colors and shapes. Among several national and international commercial winter-hardy hibiscus breeding programs, our breeding program has been the most advanced in developing novel flower colors, including blue, purple, coral, silver, magenta, maroon, and dual- and multiple-colored flowers.

Specialty and Organic Crop Breeding

The Specialty and Organic Crop Breeding program in Vernon is led by Waltram Ravelombola, Ph.D., assistant professor. The program aims to develop specialty crop cultivars that are uniquely suitable to organic cropping systems in Texas and beyond. His team focuses on developing cultivars with high yields, high nutritional values, good agronomic performance, better tolerance to abiotic stresses such as heat, drought, and salinity, and biotic stresses. In addition, the program seeks to advance understanding of the genetic and epigenetic mechanisms underlying important agricultural traits, to lead the development of better organic crop cultivars. The research group integrates conventional and modern tools in plant breeding, and they build specifically upon the needs of organic crop growers in Texas and beyond.

PRIORITY 1: INCREASE THE NUMBER OF RESEARCH COLLABORATIONS

VREC Specialty and Organic Breeding, Dr. Ravelombola

Background: Priority One supports efforts toward identifying genetic resources to improve the performance of plants. This priority area also supports research toward new crop variety development that contributes to enhancing the sustainability of agricultural production systems by assisting farmers to mitigate the impacts of climate and unpredictable weather events. Research in this priority area includes:

- Plant improvement using the latest technologies such as breeding tools
- Characterize natural and induced plant diversity more comprehensively and in new dimensions

Consumers' demand for healthier, organic, and environmentally produced food has significantly increased over the last decades. This has resulted in organic agriculture being an important component of U.S. agriculture. In 2019, reports have shown that organic crop sales were valued at $5.8 billion (USDA NAAS 2020). Texas has the largest number of farms in the U.S with more than 247,000 farms, only 379 are certified organic (USDA NASS 2020) even though Texas ranks third in the nation in terms of organic demand, sale, and consumption (USDA NASS 2020). This will be a missed economic opportunity for the farmers in the Southern Great Plains. Therefore, this program aims to improve adaptability of crops to organic farming systems using the latest technologies such as genomics and high-throughput phenotyping, which is in line with "Plant improvement using the latest technologies such as breeding tools" and "Characterize natural and induced plant diversity more comprehensively and in new dimensions."

Approach: Crops of interest include legumes (cowpea, guar, tepary beans) and barley. Each growing season, the program evaluates >100 lines and new germplasm for other breeding programs of each crop of interest for adaptation to organic farming system. Weed competitiveness and soil fertility are two major issues organic farmers face. Therefore, the program focuses on the science of crop traits that contribute to weed competitiveness (plant emergence, early seedling vigor, plant growth habit and architecture, etc.). Weed competitiveness can be monitored visually. However, doing so is labor-intensive and time-consuming when large breeding populations need to be phenotyped. In this context, we are developing a high-throughput phenotyping strategy using unmanned aerial system (UAS) to monitor weed competitiveness of potential organic crop cultivars rapidly and cost-effectively during the growing season. The program also aims to develop low-input specialty and organic crops by identifying drought-tolerant and low-requiring fertilizer germplasm using field testing. Both UAS and field-testing data are combined with genomics to advance our knowledge of the genetic mechanism underlying traits of interest (weed competitiveness, climate resilience, low input). In addition, genomics data are used to develop molecular markers (breeding tools) used for cultivar development.

Expected outcomes: The expected outcomes for the *Priority One* research area includes discovery of new knowledge and development of new technologies leading to achieving resiliency and sustainability of food production systems. The major research output leading to this outcome will be the development of new cultivars adapted to the Texas environment and soil conditions.

Metric of success: The short-term metric of success for *Priority One* will be the release of cultivars (>2 cultivar release/3 years), patent development (>2 patent/3 years), and publications (>5 publications/year). The medium-term metric of success will be the adoption of these cultivars by Texas farmers (evaluated using crop acreage of new cultivars) and the use of new knowledge (UAS phenotyping and genomics) (evaluated using citations) to further develop new cultivars meeting consumers' demand. The long-term metric of success will be the adoption of these cultivars nationally and internationally, which will provide more income to the program, the agency, and the farmers.

VREC Beef Cattle Sustainable Production, Dr. Pinchak

Integrating next-generation technologies, proven production practices, and biomarkers/biosensors allows for large-scale characterization of beef cattle phenotypes in contrasting environments. We are focusing on integrating multi-omic tools with cattle populations in contrasting environments. A subset of environments will instrumented with real-time geolocation systems of sufficient spatial resolution to quantify selection of landscape elements by beef cattle throughout the year. A subset of animals in each population will be fitted with body temperature sensors to determine the effects of the thermal environment on timing and duration of distribution of use in pastures. Layered over this data matrix will be an integrated GIS system to monitor changes in nutritive value across the landscape. We will use UAS and satellite imagery to determine seasonal and yearly variations in NDVI and plant functional group dynamics. Diet quality will be measured using fecal NIRS analyses and associated prediction algorithms. Rumen and fecal microbiome analyses will allow determination seasonal adaptations to varying forage availability and nutritive value. In aggregate, the approach will facilitate identifying grazing cattle phenotypes adapted to the land use type and environmental conditions
Metrics of success: Publication of scientific papers, growing extramural funding support and development of decision tools will be primary metrics to measure success. Graduate student and Post-Doctoral Associates mentoring are a measure of long-term success of the program. Engaging stakeholders and facilitating adoption are the targeted endpoints.

PRIORITY 2: INCREASE GRANT FUNDING

VREC Regenerative System Ecology, Dr. Gomez-Casanovas

Examine how innovative agricultural strategies in concert with changes in the environment impact supporting – soil health –, provisioning – production and food quality – and regulating ecosystem services – GHG and water regulation – from agricultural land, and how these strategies affect soil-plant resiliency to changes in climate change.
To address these two key objectives, the Gomez-Casanovas Lab will use a variety of tools to measure an array of biogeochemical processes across multiple spatial scales (from the cell to the ecosystem and the atmosphere; and from local to globe) as well as temporal scales (past, present, and future). These approaches include a combination of state-of the art techniques such as biometric and soil tools, and stable isotopes along with plant, soil, and ecosystem gas exchange approaches as well as technologies including eddy covariance methods, artificial intelligence, process-based modeling, and remote sensing approaches.
We need innovative approaches to healthier lives and livelihoods, environments and economies built on educated decision-making designed to meet high quality and affordable food and energy demands, reduce the impact of land use footprint of our agricultural systems on climate while preserving our declining natural resources and increasing long-term resilience of agriculture to climate change. Research in the Gomez-Casanovas Lab will advance our fundamental mechanistic understanding of significant knowledge gaps that present challenges to bringing sustainable food, energy and water systems to fruition. With that context in mind, the research program in the Gomez-Casanovas Lab will deliver crucial insights and understanding to help

solving the current and future challenges in agricultural production. Further, cross-disciplinary collaborations strategically established with researchers at AgriLife Research, who focus on the four research priorities of the *Texas A&M AgriLife Research Strategic Plan*, will help to synergistically advance innovations needed to deliver healthy living to Texans and communities around the world.

Progress toward milestones over a 5-year period will be assessed using a myriad of methods including generating publications and presentations, mentoring (graduate and post-doctorate) students, and submitting grants.

Science milestones. Over a 5-year period, the PI **anticipates at least ten multi-authored scientific publications to be submitted based on findings. 1. How innovative agricultural management strategies impact ecosystem process and function as well as underlying mechanistic drivers; 2. How climate impacts ecosystem service production; and 3. The tradeoffs and synergies among ecosystem services and resilience to climate change of** agricultural land under standard and alternative practices. Ecosystem processes and function related with ecosystem service production will include forage/yields quantity/quality; net ecosystem C storage; CO_2 and non-CO_2 GHG (ecosystem/plant/soil CO_2, CH_4 and N_2O fluxes; enteric ruminant CO_2 and CH_4 fluxes); water fluxes; water quality; and Soil Organic Carbon and fractionation. Further, this research will generate understanding of how alternative management and changes in the environment affect key ecosystem metrics including water use efficiency; carbon use efficiency; Net GHG exchange; and Net Biome Productivity. The Gomez-Casanovas Lab will present results at annual meetings including the American Geophysical Union and the Ecological Society of America meetings as well as the ASA-CSSA-SSSA International Annual Meeting. In addition, the research will be brought to the Institute for Advancing Health Through Agriculture (IHA), the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI), and the USDA LTAR network to foster increased cross-site research and synthesis on GHG exchange, water use efficiency, and forage/yields quality/productivity.

Education, outreach, and extension milestones. The PI anticipates mentoring and training at least two Postdoctoral Fellow students, one graduate students, one technician and two post-baccalaureate students. Links to findings, reports, metadata, publication, extension and outreach activities and products will be posted on the Lab Website. Findings will also be disseminated through AgriLife Today, and the Department of Rangeland, Wildlife and Fisheries Management (RWFM).

VREC Agrohydrology, Dr. Ale

Our research focuses on the following areas identified under this priority:

- Optimizing the use of water in crop production
- Soil health – sustainability, reducing loss and degradation
- Carbon sequestration quantification methodology
- Internet of things and connectivity in agriculture
- Using systems approach for digital in-season crop management systems

Poor crop and grazing management practices have decreased soil health contributing to decreased crop/forage yields and profitability in many parts of the Southern Great Plains. Rapidly declining groundwater levels, recurring droughts and projected warmer and drier climate in the future pose additional challenges to sustain agriculture in this semi-arid region. This program assesses the impacts of regenerative agricultural practices such as cover crops, conservation tillage, crop rotation, integrated crop-livestock systems, and pasture cropping on soil health, ecosystem services and climate change mitigation potential, and suggests best management practices for reversing soil degradation and decreasing environmental footprint. The program also suggests strategies for increasing water use efficiency and develops decision support tools for precision real-time irrigation management based on projected short-term weather forecasts, water availability and expected crop yield/economic return goals. In addition, this program develops strategies for increasing resource use efficiency in irrigated areas transitioning into dryland cropping systems. Furthermore, this program assesses the impacts of climate change on crop production and suggests adaptation/mitigation strategies.

We forge strong interdisciplinary collaborations and use hydrologic, ecosystem and crop growth models along with Unpiloted Aerial System (UAS) based data, Big Data and Artificial Intelligence programs to achieve our program objectives. The application of big data (from in-field sensors, UASs, GPS-equipped farm equipment) along with weather and market data assists in developing strategies for coping with the pressures from increasing food/fiber demand, declining water availability and changing weather patterns. The use of predictive models and machine learning algorithms (e.g., Artificial Neural Networks, Support Vector Machines, Deep Learning) enables identification of the best management practices for improving soil health and resource use efficiency and thereby increasing crop/grass yields and delivering safe, nutritious food to communities under varying environmental conditions. Big data generated from the field experiments will be used in combination with other publicly available data to train ecosystem models and artificial intelligence tools. The evaluated models/tools will then be used to predict the outcomes of regenerative agricultural practices and develop decision support systems, which can assist consumers and producers in making informed decisions.

Expected Outcomes

- Evaluated strategies for enhancing irrigation water use efficiency.
- Decision support tools for efficient irrigation management.
- Evaluated strategies for improving soil health, sequestering carbon, reducing greenhouse gas emissions, and enhancing ecosystem services on crop and rangelands.
- Evaluated climate change adaptation strategies for crop production and grazing land management.

Metrics of success

These include increased adoption of suggested efficient irrigation and grazing management strategies and decision support tools by producers/ranchers; increased number of journal articles, popular press articles and invited talks based on research results; increased number of research collaborations and funding.

Our research focuses on the following areas identified under this priority:

- Optimizing the use of water in crop production
- Soil health – sustainability, reducing loss and degradation
- Carbon sequestration quantification methodology
- Internet of things and connectivity in agriculture
- Using systems approach for digital in-season crop management systems

VREC Forage Grass Breeding, Dr. Malinowski

Summer-dormant cool-season grasses are perennial forage crops. When compared with annual grazing systems (wheat and other cereals), perennial grazing systems have higher carbon sequestration, are more resilient to biotic and abiotic stresses, and better contribute to environmental sustainability. Introduction of summer-dormant tall fescue cultivars to grazing systems in Southern Great Plains is estimated to increase value of gain from $0.80/lb beef on graze-out winter wheat to $1.18/lb on summer-dormant tall fescue pasture. Total cost of beef production is estimated to drop from $182/acre on graze-out wheat to $134/acre on summer-dormant tall fescue. Gross revenue is estimated to increase from $236/acre on wheat to $321/acre on summer-dormant tall fescue pasture. Finally, net return is expected to increase from $54/acre on wheat to $188/acre on summer-dormant tall fescue pasture (Nyaupane N et al. 2018. Economic Assessment of Perennial Summer Dormant Tall Fescue and Annual Wheat Forage Grazing Systems in the Southern Great Plains. Noble Research Institute, LLC, Ardmore, OK).
Major goals of the summer-dormant cool-season grass breeding program include:

1. Develop and commercialize new cultivars of summer-dormant tall fescue, orchardgrass, and heat-tolerant perennial ryegrass.
2. Assess profitability of new summer-dormant cool-season grass cultivars as components of grazing systems in the Southern Great Plains.
3. Determine legume species compatible with new summer-dormant grasses.
4. Assess the potential for invasiveness of novel summer-dormant cool-season grasses in SGP native grasslands.

Milestones and Deliverables (5 years)

1. Conduct large-scale grazing systems studies in Texas and Oklahoma, and Australia and New Zealand to assess productivity and persistence of advanced breeding lines and cultivars of summer-dormant tall fescue, orchardgrass, and heat-tolerant perennial ryegrass.
2. Commercialize TAL-02 and TAL-18 summer-dormant tall fescue, and CHDG summer-dormant orchardgrass.
3. Evaluate half-sib families of tall fescue, orchardgrass, and perennial ryegrass and select superior genotypes for final crosses.
4. Publish economic analysis of profitability of animal production from grazing systems with summer-dormant cool-season grasses.

5. Determine the potential for invasiveness of summer-dormant grasses as introduced species to native plant communities in the SGP.

VREC Environmental Soil Science, Dr. DeLaune

Our research focuses on, but is not limited to, the following:

- Soil health — sustainability, reducing loss and degradation
- Soil-plant resiliency — increasing soil organic matter and improving microbiome interactions
- Optimizing the use of water in crop production
- Increasing nutrient use efficiency in crop production systems
- Carbon sequestration promotion/quantification methodology
- Using systems approach for digital in-season crop management systems
- Responsive agriculture

Recent catastrophic events related to drought conditions have highlighted climate change and water scarcity. These events also raise awareness of the potential impact on the global food chain and agriculture in general. Drought is not just the absence of rain; it is fueled by land degradation and the climate crisis. A great portion of the world's food is produced in semi-arid and arid regions. Providing sufficient food, feed, and fuel for an increasing global population without degrading natural resources has been identified as a significant agricultural challenge of the 21st century. With a growing population, there is an ever-increasing need for not only food but for the very water that is critical to producing much of the World's food. Competing entities for water resources continue to heighten and pressure policymakers to guide decisions on how water is allocated. In some instances, reduced water allocation for agriculture or declining aquifer levels have led traditionally irrigated agricultural acres to reduce irrigation inputs or transition to rainfed agricultural environments.

Soil degradation has been estimated to have decreased soil ecosystem services by 60% between 1950 and 2010. Soil health and soil quality have recognized renewed importance due to strong links to human health and livelihoods. Once the process of soil degradation is set in motion, often by land misuse and soil mismanagement along with extractive farming, it feeds on itself in an ever-increasing downward spiral. Improper use of tillage often initiates degradation of soil physical properties and a subsequent decline in resilience and quality of soil and the environment. Such processes are particularly severe in rain limited environments, where rainfall variability exacerbates crop failure and resource degradation. Soil quality can be maintained or restored through sustainable management, which often begins with some form of regenerative agriculture.

Approach

Progress toward these goals will be quantified through small plot, field scale, and on-farm quantification of nutrient and water use efficiencies, water quality and quantity, soil C sequestration and stocks, GHG emissions, and soil health and function because of sustainable agricultural practices. Collected data will be shared with transdisciplinary teams to better understand agronomic, economic, environmental, and social impacts of evaluated agricultural practices.

Expected outcomes

- Identify agricultural systems that enhance carbon sequestration and GHG mitigation.
- Identify regenerative agricultural systems that capture and store water more efficiently.
- Determine agricultural practices that improve soil health and function while improving economic, agronomic, and economic viability.
- Increase adoption of regenerative agricultural practices in cropland and rangeland that will reduce carbon footprints, improve livelihoods, increase social awareness of regenerative agriculture, and subsequently link the positive stewardship of today's innovative agricultural practices with everyday human health.

Metric of success

The shorter-term metric of success will be increased adoption of regenerative agricultural practices as a result of research findings presented through field days, stakeholder conferences, and scientific meetings and/or literature. The longer-term metric of success will be identification and quantification of novel soil processes and mechanisms that lead to enhanced agricultural productivity and environmental sustainability due to more resilient production systems.

VREC Beef Cattle Sustainable Production, Dr. Pinchak

Enhancing the sustainable yield of agroecosystems goods and services under variable climate and economic conditions is essential to the long-term viability of agriculture in Texas and beyond. We employ a "Soil to Sirloin" adaptive, regenerative beef cattle-natural resource-based approach. Central to the approach is the focus taking care of the soil so it can take care of you. Incorporating cattle grazing into agronomic cover crop systems, crop rotations, and organic crop production should enhance nutrient cycling and soil health via cattle excretory processes. Coupling rangeland, introduced pasture and cropland grazing will increase flexibility in management of all three systems under variable climatic conditions. This approach will improve and decrease variability yield of goods and services from agroecosystems.

Metrics of success

Publication of scientific papers, growing extramural funding support and development of decision tools will be primary metrics to measure success. Graduate student and Post-Doctoral Associates mentoring are a measure of long-term success of the program. Engaging stakeholders and facilitating adoption are the targeted endpoints.

PRIORITY 3: INCREASE THE CENTER'S RESEARCH CAPABILITIES & IMPACT

Building field and range research capability

Our goal is for the Vernon Center to have the finest field and range research capability in the TAM System. To achieve this priority, field and range equipment must be continually upgraded. If researchers have access to field/rangeland plots and the latest equipment, their grants are more likely to be funded. Vernon administration has implemented a 10-year Equipment Replacement Plan, which lists the tractors, combines, loaders, spreaders, discs, irrigation, sensors, and vehicles that need to be purchased to keep Vernon at the forefront of climate smart research. The fund to purchase this equipment is a combination of IDC, farm receipts, and R&G funds.

PRIORITY 4: INCREASE STAKEHOLDER INPUT

VREC Specialty and Organic Breeding, Dr. Ravelombola

Background

In the U.S., the interest in alternative-meat products (alt-meat) using plant-based protein has become an economically important segment of U.S. agriculture and will be valued at more than $1.4 billion by 2026 (Global Food Institute 2021; Newton and Blaustein-Rejto 2021). For example, the rapid demand in sales and consumption of new organic plant-based alt-meat products, Impossible™ Burger and Beyond Burger®, have provided considerable profits to companies (van Vliet et al. 2020). In addition, the heath, economic, and environmental benefits of consuming plant-based proteins have been well demonstrated (Shepon et al. 2018**).** This program aims to develop novel high-protein legumes that will increase crop profitability, which is in line with Priority Four "Healthy Living". Research in this priority area includes Precision nutrition.

Approach

All legume breeding lines at the preliminary yield trials are analyzed for total seed protein content. Protein is analyzed using the standard nitrogen combustion technique. However, this method is expensive and destructive. Thanks to the AgriLife Equipment grant (FY2022), our lab has purchased a Near-Infrared (NIR) analyzer that is used to predict protein content using whole legume seeds. This new approach is cheaper and faster, thus allowing us to rapidly select for high-protein germplasm. To further strengthen our high-protein breeding program, we also develop genomic tools (molecular markers) to screen for high-protein germplasm, which will significantly increase the number of lines to be tested under field conditions. Doing so will allow us to focus on elite lines, thus being more efficient and cost-effective in our breeding operations.

Expected outcome

The expected outcomes of Priority Four research area includes new discoveries to create an interdisciplinary pathway toward cutting-edge innovations that advance human health. In this context, the development of novel high-protein legumes is a major outcome that supports the Texas A&M AgriLife Research vision.

Metric of success

The short-term metric of success will be the development of new high-protein breeding lines (>5 novel breeding lines/3 years) that will be used as candidates for cultivar release for high-protein legumes. In addition, the short-term success will be also defined by the development of high-throughput technology (NIR, Raman Spectroscopy, etc.) to evaluate protein rapidly and cost-effectively in legumes. The medium-term metric success will be determined by the number of seed companies willing to contract the novel high-protein legumes. The long-term metric of success will be defined by the number of farmers and seed companies utilizing these novel high-protein cowpeas and the number of consumers including these products in their diet. We will collaborate with AgriLife Economists and Extension Personnel to collect the data on metric of success.

VREC Hibiscus Breeding, Dr. Malinowski

Besides nutrition, mental health has a very important role on human wellbeing and healthy living. It has been well documented that gardening has tremendous positive effects on human health by reducing daily stress, lowering blood pressure and body weight, increasing concentration, and promoting a positive mood. In this context, our hibiscus breeding program delivers plant products that directly and positively affect mental health.

We have disclosed to AgriLife Intellectual Property & Commercialization 490 hardy and 230 tropical hibiscus hybrids with unique flower colors and other traits not reported earlier, i.e., prostrate growth habit or long-lasting flowers. Eight winter-hardy and one tropical cultivar have been patented. There are over 40 hybrids that are currently being evaluated by nursery companies. The trade marked series Summer Spice Hibiscus commercialized by J. Berry Nursery received two Medals of Excellence in 2018. Success will be measured by the number of hybrids that are licensed.

STRATEGIC PRIORITY 5: INCREASE VISIBILITY

Expanding marketing and communications

The Vernon Center has formed a Communications Committee that is made up of Vernon Research and Extension staff, and MarComm staff. This committee will coordinate with MarComm on idea generation and content production. Each faculty member and extension specialist will be responsible for a minimum of one video and one podcast per year. The Vernon Center will utilize multiple platforms such as Facebook, podcast hosting services, Twitter, YouTube, and Instagram.

STRATEGIC PRIORITY 6: ORGANIZATIONAL IMPROVEMENT

Continual improvement is critical to the success of the Vernon Center. All our administrative procedures have written SOPs that have a target time for task completion. Examples are issue PO requests in 2 hours, requisitions completed same day, travel requests completed in 2 days, ProCard requests completed in 1 day, all HR tasks submitted in WorkDay within 3 days, and pay invoices within 3 business days. Every year Vernon administration will perform and internal audit to see it we are meeting our goals. If the staff is not meeting a goal, changes will be made to the SOPs in an effort to meet the goal. If the goal is being met, the time to accomplish the task will be shortened.

APPENDIX: TEXAS AGRICULTURE, NATURAL RESOURCES, THE FUTURE

Agriculture

By 2050, the U.S. and world population are expected to increase by 30%, and global real incomes per capita are expected to double. Population and income growth translate into higher demand for both staple products and high-valued foods, such as more animal and plant proteins, fruits, and vegetables. Higher real incomes also mean a growing demand for livestock and feed for livestock. As a result, agricultural productivity has increased dramatically over the years. Today's farmers produce 262% more food with 2% fewer inputs than in 1950. A major component of this increase in agricultural productivity is due to investments in public agricultural research with a benefit-cost ratio of 32, which means that every dollar spent on public agricultural research and extension returns 32 dollars to society. Therefore, large benefits exist for investments in U.S. public agricultural research.

Rapid agricultural productivity increases, relative to gains in other food sectors of the U.S. economy, have translated into falling real prices of food consumed at home. For example, in 1948-2018, the share of U.S. household income spent on food at home declined from 22.3% to 6.4%, while total food consumption increased. With Americans spending 6.4% of their income on food, the other 93.6% is available for spending on a wide range of other goods and services, including recreation, housing, transportation, education, and health care. Therefore, the long-term rise of civilization and living standards worldwide largely tells a story about increasing agricultural productivity. The U.S. is the largest exporter of agricultural products. Since 95% of the world's population lives outside the U.S., the possibilities and opportunities to continue feeding the world are endless.

Agriculture has long been a mainstay of the Texas economy, and the success of Texas agriculture has paved the way for the development of new industries and sustained the diversification of our economy.

The food and fiber systems' contribution to the Texas gross domestic product (GDP) was valued at $145.8 billion in 2017. This represented 9.1% of the state's total economic activity. The top ten commodities in market value are cattle, cotton, milk, broilers, greenhouse, sorghum, wheat, fruits, vegetables, and eggs (Figure 3).

Additionally, agriculture-related activities such as hunting, fishing, and recreation, among others, are worth over $2 billion.

Cattle	$12.3 billion
Broilers	$2.9 billion
Cotton	$2.6 billion
Milk	$2.1 billion
Corn	$1.1 billion
Greenhouse	$840 million
Fruits and Vegetables	$629 million
Eggs	$500 million
Sorghum	$490 million
Wheat	$276 million

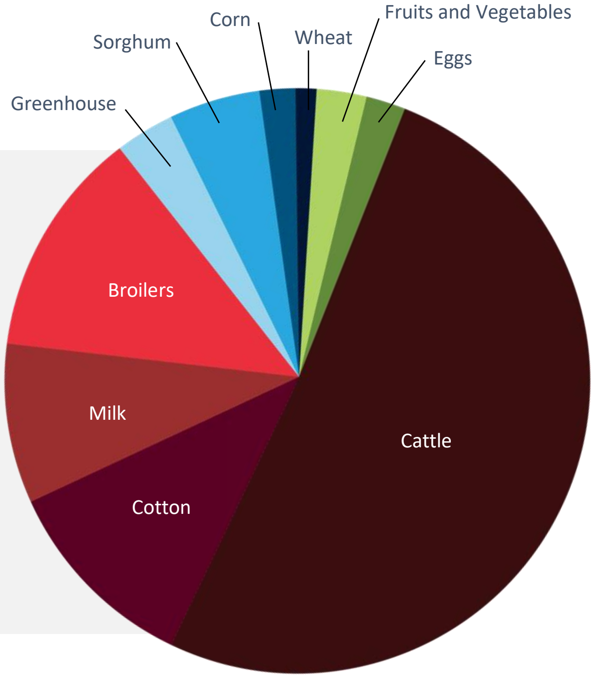


Figure 3. Texas top 10 commodities in terms of market value

Texas is the top state in the nation for producing crude oil, natural gas, and wind-based energy, which provide significant competitive advantages. In 2020, Texas accounted for 43% of the nation's crude oil production and 26% of its marketed natural gas production. Texas also has abundant renewable energy resources. It is first in the nation in wind-generated electricity and a leader in biomass-based renewable energy. With many sunny days across vast distances, Texas is also a leader in solar energy potential. Ranking second in the nation in both population and economy, Texas consumes a large share of the nation's energy. Therefore, as U.S. and world economies grow, two main variables sustain such growth — energy and food — and Texas is a key player in both. Integrating and taking advantage of the synergies of both industries will contribute greatly to the continued growth of the Texas and U.S. economies.

Natural Resources

Texas's natural resources are expansive, with nearly 172 million acres of landmass. The state is home to more than 142 mammal species as well as 615 bird species, of which half are migratory.

Freshwater lakes, ponds, and reservoirs cover about 1.2 million Texas acres. This includes nearly 185,000 miles of river, more than 350 miles of coast along the Gulf of Mexico, and 1,254 miles along the Rio Grande bordering Mexico. Texas waters house more than 250 freshwater fish species and 1,500 saltwater species.

Within this natural ecosystem, 141 million acres — more than 80% of the state's total acreage — consist of privately owned working lands and more than 60,000 working landowners. Texas working lands are privately owned farms, ranches, and forests producing agricultural products. This includes 25.8 million acres of cropland, 105.8 million acres of grazingland, 8 million acres of timber, 5.3 million acres of wildlife management, and more than 780,000 acres of other working lands.

At the same time, from 1997 to 2017, Texas lost approximately 2.2 million acres of working lands converted for nonagricultural uses. Of those acres, 1.2 million were converted in the last five years.

The Future

Texas is becoming an urban state and is home to four of the top 10 most populous cities in the country (Houston, San Antonio, Dallas, and Austin) and 69 of the top 780 cities. The Census Bureau estimates that Texas has three of the ten fastest-growing counties in the country (Hays, Comal and Kendall) and almost a quarter of the top 100 fastest-growing counties. Although Texas has a large rural population, almost 4.5 million, it only accounts for about 15% of the total, which means that around 25 million people live in urban areas.

The COVID-19 global pandemic pushed the world several years prematurely into cyberspace and wreaked havoc on the global food supply chain, causing tremendous decreases in food security. Texas was no exception. COVID-19 exposed Texans' poor health status regarding obesity, hypertension, diabetes, heart diseases, and other chronic diseases related to diet and nutrition. COVID-19 also revealed the need to examine food production and distribution systems, uncovering the need for a more agile food supply system that provides nutritious, affordable, and accessible food to consumers while financially supporting our farmers, ranchers, and agricultural workers, even when there are multifactored disruptions at one time throughout the supply chain.

We are keenly aware that hunger, specifically undernutrition, is one of our most important global issues. Both a cause and a symptom of poverty, it can ultimately lead to conflict, mass migrations, and the rise of terrorism, all of which can impact Texans. We believe that we can help alleviate human suffering associated with hunger and poverty through agricultural science and, in that way, help prevent these outcomes while building a better world for present and future generations. With proper investment today, AgriLife Research will set the foundations of the infrastructure necessary to ensure food security for future generations.

Over-nourishment presents a double-burden paradox that affects nutrition and increases the risk of chronic diseases. Texas agriculture and AgriLife Research are uniquely positioned to partner to improve public nutrition and health by providing a healthier, more nutritious, and abundant food supply.

As Texas agriculture grows, it has a positive multiplier effect throughout the economy. For every dollar of agricultural production in Texas, another $2.19 is generated by other industries in the state to support this additional output. The interconnected nature of Texas agriculture to other sectors of the economy — and the everchanging relationships across these sectors — make it imperative that AgriLife Research is positioned to anticipate and respond to critical needs and emerging challenges.

AgriLife Research's roots are firmly embedded in production agriculture and natural resources. We seek to expand the agency's focus to apply the power of fundamental life sciences to solve real-world issues. Discoveries in genetics, crop and animal management systems, and links between poor human nutrition and chronic diseases are accelerating our impacts on sustainable food and fiber supply chains. Our approach integrates basic and applied research to create, as stated in our vision, "healthy lives and livelihoods improved through abundant, affordable, and high-quality food and agricultural products in Texas and the world."