

**Strategic Plan for the
Texas Small Grains
Research and Extension
Program**

Small Grains Advisory Committee

Texas AgriLife Research

Texas AgriLife Extension

Texas A&M System

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REVISED

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**TEXAS SMALL GRAINS RESEARCH AND EXTENSION
PROGRAM STRATEGIC PLAN**

EXECUTIVE SUMMARY

I. PURPOSE AND SCOPE OF THE STRATEGIC PLAN

The Texas small grains strategic plan was developed as a guide for restructuring the small grains program to: a) clearly define objectives, b) give an appropriate statewide perspective to the small grains production regions of Texas, c) ensure efficient use of all available resources, and d) assure a sound financial basis for the program. The strategic plan covers all aspects of the small grains program from scientific manipulation at the molecular level to public education and marketing of released varieties. We emphasize the statewide perspective in the strategic plan to maximize coordination and cooperation among regionally administered programs so that their activities complement each other and pursue common goals. The proposed structure seeks to concentrate personnel and other resources in fewer well equipped locations, minimize unnecessary duplication, and eliminate major deficiencies in expertise, and thereby improve efficiency throughout the program. Finally, the strategic plan proposes a financial management package that seeks to balance income and expenses for program stability and scientific currency.

II. ORGANIZATION OF THE TEXAS SMALL GRAINS PROGRAM

- The proposed Texas small grains program is organized into two Centers of Excellence, one at the Texas AgriLife Research and Extension Center at Amarillo and one at College Station.
- Each Center of Excellence will have a complement of scientists who work in multi-disciplinary teams to address a broad range of small grains improvement, management, and extension issues.
- Specific needs will be addressed at the Texas AgriLife Research and Extension Center at Vernon, Texas A&M University at Commerce and possibly at other locations as appropriate.
- Emphasis is placed on small grains as dual-purpose grain and forage crops to fully develop Texas' competitive advantage as a premier winter pasture region of the U.S.
- The Center of Excellence at Amarillo will develop varieties for the High Plains irrigated and dryland acreage and for the Rolling Plains, using technical support in the Rolling Plains that the Vernon Center provides.
- Multi-disciplinary teams at Amarillo and Vernon will develop and deploy production and management programs for small grains as dual-purpose crops with the objective of optimizing income from grain and livestock in integrated crop/livestock systems on the High Plains and Rolling Plains.
- The Center of Excellence at College Station will develop varieties and management programs for small grains in the humid regions of central, eastern and southern Texas, provide classroom instruction to undergraduate and graduate students, and focus on

grain quality improvement through close interdisciplinary ties, especially among scientists in the biotech, cereal quality, and breeding programs.

- The small grains Extension program will be coordinated from the College Station Center of Excellence by a full-time small grains Extension Specialist who, in cooperation with regional Extension specialists from various disciplines and county Extension agents, will conduct a statewide educational program that includes development of written & electronic publications, a variety of educational programs and highly visible on-farm demonstrations and crop testing activities.
- New varieties will be produced and marketed through Texas Foundation Seed Service and private companies with royalties being returned to the small grains research and education program.

III. FINANCIAL MANAGEMENT FOR THE SMALL GRAINS PROGRAM

- Actual and potential sources of income have been identified to provide long-term financial stability to the program.
- Pooling of royalty revenue is a recommended strategy to support purchases of capital equipment.
- State and federal funding initiatives will continue to be pursued.

IV. IMPLEMENTATION AND OVERSIGHT

- The Texas A&M AgriLife administration will implement the Texas Small Grains Strategic Plan by stating a clear intention to do so by encouraging Unit Heads to endorse the Strategic Plan; by encouraging reallocation of resources within and among units to support the Strategic Plan; by following this Strategic Plan when approving requests for new faculty positions; in developing program priorities; and related budgetary purposes. The Small Grains Advisory Committee (SGAC) will annually review implementation and functions of the newly restructured program and provide appropriate recommendations to the Texas A&M AgriLife administration.

STRATEGIC PLAN FOR THE TEXAS SMALL GRAINS RESEARCH AND EXTENSION PROGRAM

Texas AgriLife Research and Texas AgriLife Extension Service

Texas A&M System

A. INTRODUCTION

The pervasive impact of small grain crops (wheat, oat, triticale, rye and barley) on society has led to ever increasing improvement of the crops and their production systems by researchers and educators. Small grains research and extension programs within the Texas A&M System are a local, state, regional, national and international source of knowledge, education, and training. The strengths of the TAMUS small grains programs reside in its people and their ability to carry out seven broadly defined goals. These goals are (1) Integrate conventional and biotechnological research to increase our knowledge base for small grains; (2) Develop superior plant materials for local, state, national and international use; (3) Characterize the biotic and abiotic stresses of small grain crops, and provide solutions for their management; (4) Facilitate and develop management practices and cropping systems that maximize the genetic potential of plant materials and which optimize and sustain land and water resources; (5) Meet and exceed end-use requirements for marketability of our small grain commodities; (6) Develop and disseminate science-based information for the production of small grains; and (7) Conduct economic research and educational programming to increase the profitability of small grain production. The Strategic Plan presented here was developed and will be reviewed annually and revised as needed by the Texas A&M AgriLife Small Grains Advisory Committee (SGAC).

B. BACKGROUND INFORMATION

In the 1990s, Texas producers have annually sown 6 to 7 million acres of small grains, consisting of approximately 86% wheat, 11% oat, 2% rye, and 1% barley and triticale. The farm-gate production value of the grain averaged \$420 million per year. Beyond grain production, these crops are also valued as winter pasture for domesticated grazing animals, i.e., beef, dairy cattle, sheep, goats and wildlife. Thus, production schemes can focus on grain production only, grazing plus grain, grazing only (graze-out), or hay (or silage) production. Estimates suggest that about 65% of the small grain acreage is grazed annually to some degree, with a value (in pounds of animal production) greater than \$400 million. Oats, rye and triticale are often valued more for their vegetative production rather than grain. Approximately 60 to 80% of oats are grazed-out each year, within the ratio of grain to graze out depending on crop conditions and the relative price of grain and beef.

In 2007, Texas produced 140.6 million bushels of wheat averaging \$6.30/bushel for a total value of production of \$885,780,000 or roughly double the average estimated value of Texas wheat from combined enterprises of grain and livestock production in the decade of the 90s.

Small grains research and extension programs in the Texas A&M System include scientists who specialize in agronomy, animal science, biotechnology, breeding, entomology, genetics,

information technology, pathology, physiology, intrinsic quality, economics and marketing. The vast land area and varied climate in which the small grain crops are produced in Texas offer unique challenges and opportunities unparalleled in the United States and perhaps, the world.

C. TEXAS SMALL GRAINS ADVISORY COMMITTEE

History – The Vice Chancellor for Agriculture and Life Sciences established the Small Grains Advisory Committee (SGAC) on August 23, 1999 to “establish a framework of activity and issues for an External Assessment Panel to pursue” during their review of research and education programs in small grains. The initial SGAC consisted of eight current and one former unit head from the Departments of Pathology, Entomology and Soil and Crop Sciences and the AgriLife Research and Extension Centers located at Overton, Dallas, Vernon/Chillicothe and Amarillo and from the Southern Center for Crop Improvement. The external assessment of the Texas Small Grains Program occurred October 24-28, 1999.

Current Membership - The present SGAC membership was established on January 14, 2000 and it has evolved slightly since inception. Recent membership of this committee included two faculty from the small grains program, the Executive Vice President and President of the Texas Wheat Producers Board, a faculty member from a cooperating land grant university, a representative from private industry, the administrator from each of the System units with key faculty participation in the statewide Small Grains Program (College Station, Vernon/Chillicothe, Amarillo, Soil and Crop Sciences and Plant Pathology). System Administration is represented by the Director of Technology & Commercialization and the Director of Texas AgriLife Extension Service.

Beginning in 2008, the Director of Texas Foundation Seed Service and the head of the Department of Entomology were added as members, and faculty will be represented by 3 individuals, each serving 3-year rotating terms. Faculty membership will comprise one representative from each of the two Centers of Excellence and a third individual with statewide small grains responsibility. Faculty representatives will be elected by their peers (e.g. Small Grains Workers Group). Membership will be reviewed periodically by the SGAC with recommendations for appropriate changes sent from the committee to the system administration.

Committee Charge - As defined in a memorandum from the Vice Chancellor for Agriculture and Life Sciences on January 14, 2000, the charge of the SGAC was to 1) develop a long-term statewide small grains improvement strategy that addressed all major points identified in the Small Grains Review, 2) monitor progress on the small grains strategy, and 3) recommend actions that will properly position the Texas Small Grains Program to be among the very best in the U.S. The SGAC has fulfilled much of its original charge and continues to monitor progress and recommend actions to fulfill the invited charge.

Interaction with Research and Extension Centers, Departments, and Texas AgriLife Administration - The SGAC was organized to coordinate and to be an advocate for Small Grains

Research and Educational activities within the Texas AgriLife Research and Extension program. To accomplish this, the SGAC will:

- Make specific recommendations to the Texas AgriLife administration for enhancing the effectiveness of small grains research and educational activities.
- Provide a mechanism for faculty, farmers, and industry to interchange ideas and develop a common vision for addressing the needs of small grains in Texas.
- Coordinate solicitation and prioritization of all small grain research and education programs administered by the Texas AgriLife Research and Texas AgriLife Extension Service.
- Periodically review membership and leadership of the SGAC and recommend appropriate changes to agency administrators.

D. VISION STATEMENT

We envision the multi-disciplinary, statewide program in small grains research and extension to be the premier source for new knowledge, plant materials, applied problem solving, and Extension education for the local, state, national, and global communities.

E. MISSION STATEMENT

In the land-grant tradition, we exist to develop and deliver science-based, site-specific and global information, knowledge, and plant materials related to wheat, oat, triticale, and barley.

F. GOALS AND OBJECTIVES

The goals and objectives for the Texas A&M System small grains research and extension programs flow logically from our mission and relate directly to agriculture and core science activities. Our goals and objectives translate our mission into actions and seek to fulfill our vision. In this strategic plan, our goals are broadly conceived targets that the small grain research and extension programs will focus on to achieve their mission. Collectively, the goals provide direction for focusing small grains activities, and the objectives are more specific, tangible and measurable for achieving the goals.

Goal 1. Integrate conventional and biotechnological research to increase our knowledge base for small grains.

Objectives:

- Improve our understanding of the molecular genetics of wheat, oat, triticale and barley.
- Incorporate both input-based and end-use based molecular genetic traits into adapted germplasm.

Goal 2. Develop superior plant materials for local, state, national and international use.

Objectives:

- Develop high-yielding, drought tolerant, disease and insect resistant small grains cultivars with excellent intrinsic grain and forage qualities.

- Develop small grain varieties and germplasm adapted for dual-purpose (grazing and grain) uses.
- Contribute to and participate in regional, national and international small grain nurseries and promote the free exchange of germplasm.
- Through commercialization partnerships, protect and leverage the intellectual property developed by System scientists to demonstrate return on investment and to return royalties to the small grains research programs.

Goal 3. Characterize the biotic and abiotic stresses of small grain crops, and provide solutions for their management.

Objectives:

- Evaluate the evolutionary progenitors of wheat, oat, and barley for improved traits and incorporate those traits into adapted small grains.
- Develop and implement strategies for long-term management of important disease and insect pests of small grains.
- Pursue research into the genetic basis of plant resistance to important diseases and insects of small grains.
- Investigate the molecular basis of pathogenicity.
- Investigate the biotic and abiotic interactions that negatively impact wheat yield and quality.
- Evaluate the biological cost of water, heat, and cold stress on small grain plants.
- Evaluate conditions important to pathogen ecology and epidemiology.

Goal 4. Facilitate and develop management practices and cropping systems that maximize the genetic potential of plant materials and which optimize and sustain land and water resources.

Objectives:

- Determine optimum cropping systems for small grains that emphasize moisture conservation and storage.
- Expand research and educational activities to provide knowledge on soil management, tillage, seedbed preparation, and erosion control.
- Develop nutrient requirements and fertilizer placement and timing for all small grain production areas of Texas.
- Conduct research and education for weed, insect and disease management in small grains.
- Expand and coordinate research and education on production and grazing management of dual-purpose cereal grains including grazing intensity, frequency and duration as they influence both animal and grain production.

Goal 5. Meet and exceed end-use requirements for marketability of our small grain commodities.

Objectives:

- Improve our knowledge base on the nature of end-use quality of cereal grains.
- Expand research into alternative uses for grain of small grain crops.
- Identify qualities that meet or exceed bread wheat end use requirements.

- Become the leading source of knowledge for wheat quality appropriate for flour tortilla production and other novel uses of processed wheat flour.
- Investigate the genetic and molecular basis of end use quality and incorporate improved and/or novel traits into modern cultivars.
- Investigate sustainable utilization of crop residues for building materials, bioenergy and other uses.

Goal 6. Develop and disseminate science-based information for the profitable production of small grains.

Objectives:

- Improve the capability of small grain producers to be successful through timely knowledge transfer.
- Develop farmer-friendly recommendations for dual-purpose small grains management that optimize economic returns from wheat and livestock production.
- Expand public understanding of small grains to help create an informed citizenry.
- Interact with the Texas A&M College of Agriculture and Life Sciences to train undergraduate and graduate students.

Goal 7. Conduct economic research and educational programming to increase the profitability of small grain production.

Objectives:

- Evaluate the economic implications of international, federal, and state trade policies on the viability of small grain producers.
- Conduct intensive educational programming for small grains producers to improve their marketing and management skills.
- Determine economically optimal risk management strategies for small grains production systems (grazing and grain) and disseminate results to producers.
- Determine the end use value of wheat and other small grains.
- Evaluate the economic feasibility of small grains in emerging markets (e.g. biofuels production).
- Conduct and disseminate economic research into small grains cropping systems that maximize returns to producers.

G. CURRENT SMALL GRAINS PROGRAM

1. Faculty, Technical Support and Operating Budgets

Pre-2000 Benchmarks

Prior to 2000, research and Extension faculty and staff FTEs devoted to small grains included wheat breeders (full or part-time) at Amarillo, Vernon, Dallas, College Station and Overton. Faculty and staff FTE positions began to be eliminated or re-directed in the 1990's to the extent that industry concerns lead to the creation of the 1999 External Assessment Panel that looked at the program strengths, shortcomings and ways to improve and strengthen them.

2000 Benchmarks:

As of summer 2000, following erosion of faculty/staff FTE's in small grains in the 1990's, Texas A&M small grains research and education programs were located primarily at four Research and Extension Centers (Amarillo, Vernon, Dallas, Overton) and in the Soil and Crop Science Department and the Department of Plant Pathology at College Station (Table 1). Additional programs were located at the Research and Extension Centers at San Angelo and Uvalde and in the Agricultural Economics Department. Total research faculty positions allocated to small grains research was 5.8 FTE. Extension faculty positions in small grains totaled 3.85 FTE. Combined allocations to small grains for the two agencies totaled 9.65 FTE faculty. Research also had 11.2 FTE support personnel positions, and Extension and Research shared 1.8 FTE support positions for a total of 13.0 Support Staff FTE's. Faculty positions in small grains breeding and genetics were generally dedicated 100% to small grains, with the one exception being a breeder at Overton working 50% in small grains. Research positions in disciplines other than breeding and genetics and all extension faculty generally allocated 30% or less of their time to small grains, the one exception being the Small Grains Extension Specialist who devoted 50% of his time to small grains. The total number of faculty members involved in the small grains program may have been greater than the number of FTEs reported. This situation lent itself well to development of multi-disciplinary programs that addressed problems from a systems perspective.

2008 Benchmarks

Following the approval of the original (2000) SGAC Strategic Plan, several key faculty positions have been added or redirected. Faculty-level small grains breeders occupy positions at both of the now-established Centers of Excellence, supported by several post-docs or Assistant/Associate/Research Scientists that are largely grant supported.

The May/June 2008 assessment showed a total of 5.0 faculty FTEs research; 3.5 FTEs Extension; and state total of 8.5 faculty FTEs (Table 1). Many changes have occurred due in part to attrition, budget constraints (2002-2003) and re-direction of programs since adoption of the 2000 Strategic Plan, while 5.1 faculty FTEs have been appointed to existing or new positions in either Research or Extension using available resources. The main changes have been a) consolidation of the wheat breeding faculty positions as replacements or additions in Amarillo and College Station (Soil & Crop Sciences Department) in accordance with the Center of Excellence concept; b) a state Extension Small Grains Specialist position at College Station; c) a small grains geneticist-Research position at College Station; and d) a small grains Extension Plant Pathologist added at Amarillo. Nevertheless, as Table 1 shows, a net downward trend in faculty FTEs devoted to small grains has occurred since 2000. Further 2008 benchmarks for research and Extension faculty and staff are shown in greater detail in Tables 2 and 3.

2. Equipment, Facilities, and Land

Each Research and Extension Center and the small grains programs in the Soil and Crop Sciences Department have plot equipment for small grains research and education

programs. Recently, a significant reinvestment has been made back into the program in the form of new equipment and vehicles. College Station has seen the greatest reinvestment in new equipment and vehicles due to the addition of new faculty in research and extension. While scientists have obtained grant funds to pay for labor, operating costs, and supplies, getting grants for major equipment items is difficult.

Programs requiring specialized laboratories are located mostly in College Station, and include the grain quality laboratory and the biotech laboratory. The grain quality laboratory clearly needs more equipment and personnel to serve the wheat improvement program with research on grain quality and new products. In the rapidly changing area of molecular biology/genetics, continuous updating of equipment and facilities is very important and challenging. Texas AgriLife Research at Amarillo also has a wheat genetics laboratory in which DNA research with molecular markers and marker-assisted selection is conducted by staff that includes a Research Scientist/Wheat Genetics and two grant supported post-doctoral plant geneticists under the supervision of the wheat breeder.

H. ORGANIZATION OF THE TEXAS SMALL GRAINS PROGRAM

The Small Grains Advisory Committee endorses the recommendation of the Texas Small Grains External Assessment Panel to support two (2) Centers of Excellence for small grains research in Texas. These Centers of Excellence are located in Amarillo and College Station. The SGAC recommends that all small grains research and extension efforts have a focused, multi-disciplinary team approach.

The AgriLife team at Amarillo focuses on research for the High and Rolling Plains regions of Texas, including both dryland and irrigated small grains in dual-purpose production systems. The team should consist of a breeder and a germplasm enhancement specialist, and support from a research or extension entomologist, pathologist, agronomists, animal scientists, an economist, and a water management scientist along with partial appointments from several support disciplines including soil fertility, plant pathology, entomology, marketing and with collaborative investigations with modeling efforts at Temple.

The College Station team focuses on research and extension efforts for the higher rainfall areas of Texas, especially the Blacklands, and central and south Texas. Small grains breeding, pest management, and production research are primary objectives. This team will be responsible for all oat research in Texas. The team includes a small grains breeder, a molecular biologist, a wheat quality specialist, and an Extension small grains specialist at College Station.

Texas has diverse climatic and environmental conditions, and small grains are grown throughout the state. Winter wheat predominates in the northern and southern High Plains and Rolling Plains regions (approximately 80% of the total wheat area). Oats are grown in central and south Texas and are an important forage crop in these regions. Triticale has potential as a winter

forage crop throughout the state, and barley may have promise as a feed grain/silage crop in selected areas of the state.

The Centers of Excellence concept will enhance coordination and encourage multi-disciplinary research, while increasing resource efficiency and effectiveness. **AgriLife Research must provide sufficient financial support and appropriate personnel to achieve the goal of two nationally and internationally recognized Centers of Excellence for small grains research in Texas.** The team approach based on the Center concept should be more effective in attracting new sources of funding and be more successful in winning outside grants.

The Texas AgriLife Research and Extension Center at Amarillo is located in the major wheat growing region, and the existing small grains research program has strong support from the agricultural community. This Center will be responsible for developing winter wheats and winter forage triticales for irrigated and rain fed conditions of the High Plains and Rolling Plains. Developing cultivars and improved management practices for the dual-purpose system will also be a primary objective, and a multi-disciplinary research and Extension team in Vernon will complement this research effort for the Rolling Plains. The Amarillo team, with professional and technical support from the Texas AgriLife Research and Extension Center at Vernon, will be primarily responsible for developing cultivars for the Rolling Plains, which is ecologically distinct from the High Plains. An Extension plant pathologist was appointed in 2007 at Amarillo to conduct educational programs and transfer information to small grains producers throughout the state, working closely with the state small grains Extension specialist. Resources and staffing allocations will be required to address the specific constraints and requirements of this region. Remaining personnel required to fully staff the small grains research program at Amarillo include:

- *Geneticist/Germplasm Development Scientist* (1 FTE) to work closely with the small grains breeder. Responsible for introgressing greater genetic variability into the breeding program and development of breeding materials with improved resistance to biotic and abiotic stresses. Also will pursue biotechnology applications (e.g. markers) for the breeding program. A post-doc Research Scientist has occupied this role for the last 8 years, with potential to upgrade this position to faculty level with an opportunity to participate in training graduate students.

The Center at College Station will stress small grains breeding, molecular genetics/biotechnology research on small grains, industrial quality assessment of breeding materials, statewide leadership in extension education and the involvement of graduate students in the small grains research program. The following remaining personnel and facilities will be required to fully staff the program at College Station:

- *Cereal Chemist* (1.0 FTE). Evaluate advanced breeding lines for quality characteristics required by industry. Additional support on quality is urgently needed for the wheat improvement program to provide high quality varieties for Texas producers.

- *Plant Pathologist* (1.0 FTE). Major research responsibility will be leaf, stem and stripe rusts, with work on other diseases and their importance as production constraints. Scientist will help coordinate pathology research within the small grains program.
- *Dual-purpose system agronomists* (0.25 FTE), economists (0.1 FTE), and animal scientists (0.3 FTE). Investigate the complex management system for central, northeast and south Texas. This research will be closely coordinated with the research at Vernon and Amarillo. Research on oats as a forage crop is justified for the central and southern regions of Texas.
- *Entomologist* (0.5 FTE). Emphasis will be given to research on aphids and to vectors of barley yellow dwarf virus.
- *Support Staff*. Require a permanent additional research associate/research assistant (1.0 FTE) for the breeder and one research associate (1.0 FTE) for the molecular geneticist

Adequate facilities and transportation are required for the program, with sufficient financial support for travel requirements. The capital asset management strategy must replace and upgrade field and lab equipment on a timely basis. Modern greenhouse facilities dedicated to the small grains breeding program are a critical need.

Vernon and Dallas/Commerce will continue as selection and testing sites for small grains germplasm. The Amarillo program will develop materials for the Rolling Plains and High Plains regions and provide leadership for improvement activities at Vernon. The program in College Station will develop materials (wheat and oats) for the south, central, and Blacklands regions and provide leadership for testing of varieties and advanced experimental lines in north central Texas. To facilitate research, trained support staff (research associate or research assistant) must be stationed at Vernon (1.5 FTE) and Dallas/Commerce (1.0 FTE). Support staff must be supervised by respective project leaders at Amarillo and College Station. Sufficient travel support will be needed for off-station trials and field and lab facilities at respective sites, and appropriate equipment will be needed for the small grains improvement program and related research activities. Timely replacement of the field and lab equipment will be required.

I. CRITICAL COMPONENTS FOR SUCCESS

1. Germplasm Modification. Germplasm is the pool of genetic diversity of a crop species, and includes wild relatives, land races, plant introductions, intermating populations, haploid lines, breeding lines, mapping populations, segregating populations, cytogenetic lines, and developed varieties. Additionally, tissue culture lines, cell lines, and even molecular genetic libraries of genes and gene constructs are part of the genetic germplasm pool that plant improvement scientists can use for genetic diversity. Biotech modification of germplasm includes the development of transgenic plants, identifying molecular markers for specific genes, chromosomal and molecular cytogenetic mapping, and other applications for capitalizing on an ever-increasing knowledge of molecular biology. More conventional germplasm modifications

include introgression of genes from wild relatives and unadapted lines into adapted genotypes, generation and selection of novel genetic mutations, and development of breeding lines with specific trait polymorphisms. Scientists involved in germplasm modification and development should include molecular biologists, cytogeneticists, and basic science-oriented chemists, physiologists, pathologists, and entomologists. Screening germplasm is a critical process in identification of useful germplasm focused on incorporating specifically identified traits into genetically stable plant material that can be readily hybridized with adapted varieties and breeding lines. Besides discipline-oriented scientists (pathologists, entomologists, etc.), plant geneticists and plant breeders are involved in these screening and development processes.

Germplasm modification in the Texas A&M AgriLife small grains improvement program must continue to be a multidisciplinary activity with close collaboration between basic and applied sciences. **The faculty-level germplasm development scientist proposed for the Amarillo Center of Excellence is a critical component** of the long term plan for plant improvement and approval of this new position should be a priority. This position will serve as a conduit between bench scientists and plant breeders and will facilitate rapid introgression of new genes and new traits. Traditional plant breeding, historically a hallmark of the Texas AgriLife small grains improvement program, will be a future cornerstone. Small grains breeders fill several critical roles in the total small grains program including training of new plant breeders, incorporation of newly generated germplasm into products with commercial potential, testing of potential new products and generation of unbiased data. It is the responsibility of the breeder and the breeding teams to assure that the highest standards of science are observed in the development and release of improved plant materials.

2. Biotechnology. Texas must continue to position itself as a leader in new technologies. New discoveries relating to genes, gene processes, gene products and gene function promise to revolutionize agriculture. While commercialization of transgenic wheat is not an immediate reality, the success of transgenics in other crops suggests a bright future for transgenic wheat. Consequently, **continued research on wheat transformation is a critical component for the future.** Biotechnological research is expensive and many of its important elements are proprietary. **Partnerships with other research programs, both private and public, also are critical components for future success.** Continued and enhanced molecular and biotechnology research in small grains should focus on the following major categories:

- a. Marker Assisted Selection
- b. The Molecular Basis of Factors Associated with Grain Development and Grain Quality.
- c. Gene Expression as it Relates to Biotic and Abiotic Stresses.
- d. Genome Organization, Gene Expression and Gene Silencing.
- e. Wheat Transformation.

3. Entomology. Major areas to be addressed in wheat entomology research include greenbugs, Hessian fly, vectors of barley yellow dwarf virus, vectors of wheat streak mosaic virus, armyworms, other minor pests, and multifaceted ecological evaluations. These challenges can be met with multidisciplinary teams, enhanced coordination of research conducted by faculty at research and extension centers, and basic research concentrated in the Department of Entomology and the Crop Biotechnology Center on the Texas A&M campus. Significant strides have been made in understanding the basic biology of many entomological pests of wheat important to Texas, but additional research is needed in biology and epidemiology. Long term solutions can be achieved by combining traditional approaches with new technologies. For example, resistance in wheat to Russian wheat aphid is difficult to track in wheat breeding populations naturally or artificially infested with aphids. Currently identified resistance is multigenic. A collaborative program could result in developing a marker assisted selection process to facilitate identification of multigenic inheritance in segregating populations without infesting with aphids. Substantial evidence suggests that commonality exists between wheat and sorghum genomes making collaborative research between commodities attractive from both an intellectual and a sponsorship basis.

Hessian fly has been an historic small grains pest in specific regions of Texas. Recently its range has expanded and it currently is damaging in all major wheat regions of Texas except the Panhandle. Host plant resistance and delayed planting have been effectively utilized by other states as control methods. However this combination of controls has limited effect in Texas. **An integrated approach to Hessian fly is a critical component of future success.**

We must recognize that wheat and other small grain crops are part of a larger ecosystem. Pests in wheat are likely dependent on multiple interacting factors. To improve IPM, long-term research that addresses seasonal abundance of all aphids, predators, and parasitoids in wheat, other small grains and wild hosts (i.e., native grasses and other refugia) are needed to build a useable database and develop predictive models.

4. Plant Pathology. Diseases are major limiting factors in producing small grains in Texas. In traditionally lower rainfall areas (principally the High Plains), virus diseases and diseases that affect the roots tend to be more common and severe than other diseases. Small grains produced in those areas that have greater amounts of rainfall (Rolling Plains, Cross Timbers, Blacklands, East Texas, Central Texas, South Texas, and the Gulf Coast) tend to suffer more from fungal and bacterial diseases, although viral diseases such as barley yellow dwarf virus and wheat streak mosaic virus are common and cause significant annual loss. New challenges include stripe rust and new, potentially damaging races of stem rust.

On oat, the primary disease problems are crown rust, stem rust and barley yellow dwarf virus. On barley, barley yellow dwarf virus is the most widespread and damaging disease. Smuts and bunts occur on small grains in Texas. Efficient management of

Texas small grains includes inherent disease resistance, crop protectants and improved cultural practices.

Resources for genetic management of the major small grain diseases are a major objective of the small grains improvement team. A major thrust in breeding for resistance to the rusts and major viral diseases (BYDV, WSMV, SBMV) of small grains will result in cultivars with durable resistance to these diseases. For genetic improvement in disease resistance to succeed, the program must employ modern techniques including molecular markers and transgenics, with traditional resistance breeding, and be guided by the application of epidemiological principles.

A Small Grains Pathology Research Scientist with statewide responsibility is a critical component to success. Extension Associate positions at key locations (such as the Rolling Plains, and Blacklands) should be developed as part of the statewide effort in Extension Pathology.

- 5) **Production and Management.** Weather variables that damage small grains include drought, heat, winter kill and spring freeze injury, improper grazing management, inadequate or improper fertilizer management, post maturity damage from excessive rainfall, crop damage from aphids (greenbug and Russian wheat aphid), Hessian fly and mites, and yield and quality damage from weeds. Each of these is affected by basic small grains management techniques. Increased commodity prices create a need to revisit input opportunities for wheat production. Practices previously considered to be of marginal economic benefit may now be profitable.

While recent data from Texas AgriLife Extension Service indicates that the value of small grains as a forage resource in the Rolling Plains may be overstated, the fact remains that Texas small grains provide a major source of income for cattle producers. Agronomic constraints to efficient production of small grains may be exacerbated by grazing. Multidisciplinary research and education teams currently are developing region-specific data bases which incorporate new knowledge on nutrient management, basic cultural practices such as planting date and planting rate, efficient grazing management techniques such as grazing duration and grazing intensity, utilization of small grains for novel forage systems and economic analyses of the total system. **Continued investigations of efficient small grains management systems and science-based data on production inputs are critical components for future success.**

While dual-purpose management systems were initially targeted by the 2000 External Review Panel as critical to success, the potential use of small grains as a biofuel or ensilage begs some emphasis for future research and education programs. Management systems which incorporate biofuel potential may help transition Texas small grains from a dual-purpose to a triple-purpose crop.

- 6) **Intrinsic Quality** Domestic wheat buyers demand increasingly higher intrinsic quality with consistent and predictable performance across a range of environments. There also is a domestic movement to rapidly increase amounts of identity preserved (IP) grain in which the IP system is preserved from the farm gate to the final processor. Many larger baking companies in the United States already are involved in IP programs or are developing IP capabilities. Texas is unprepared for this change due to inadequate storage capacity and an inadequate data base on genotype/environment interaction. Texas is poised to become the world leader in wheat enhancement for tortilla quality. It is critical that research conducted at the Texas A&M Cereal Quality Laboratory on flour quality for tortilla production be expanded.

If Texas AgriLife Research is to remain competitive in wheat germplasm enhancement and wheat cultivar development, **a critical component for success will be increased emphasis on enhancement of intrinsic quality.** Texas is challenged in this regard in several ways. Its diversity creates opportunities for intermingling market classes and a consequent discount in quality. Environmental diversity also decreases predictability of quality. Some of the proteins with major effects on intrinsic quality are deposited in the grain late in the grain-filling process. These proteins are highly heat sensitive and respond negatively to the temperature load in Texas wheat fields during grain filling.

The Texas A&M AgriLife Research and Extension programs must increase these investments in research and education programs relating to intrinsic quality. The recent addition of a molecular geneticist with emphasis on abiotic factors effecting quality was a significant step forward. However, **capacity for analysis of intrinsic quality in the Cereal Quality Laboratory has not been increased and is a critical component for success.**

- 7) **Small Grains Educational Programs.** There are two components to Educational Programs in small grains. The first component is the extension and outreach education of producers, millers, and consumers of small grain products. The second component is the education and training of students for a career in the area of small grains, including breeding, biotechnology, pest management, and quality. Both of these components are critical to the success and implementation of the Small Grains Strategic Plan.

An important part of extension education in small grains is in-field demonstrations of new technologies, including fungicidal and insecticidal seed treatments, weed control, tillage, forage and grazing management, varietal comparisons, seed quality, pesticide resistance, herbicide resistant wheats and agronomic management practices such as planting dates, seed rates, nutrient management, etc. Varietal comparisons, traditionally managed within research programs, have transitioned to Texas AgriLife Extension Service specialists as a part of the statewide small grains improvement effort. This successful transition has added efficiencies and should serve as a model for other applied research efforts.

Training of undergraduate and graduate students in all major areas of small grains is critical to meet the need for academic and industry positions. Faculty and staff from the Texas A&M University System will teach vital classes related to small grains production, biotechnology and cereal quality. Faculty will also train and mentor undergraduate and graduate students through course work, internships, and research projects .

8) Texas Foundation Seed Service (TFSS) Five major objectives of the TFSS in relation to the Small Grains Breeding Programs:

- Work with plant scientists to develop entrance strategies for the orderly purification and multiplication of potential new varieties, and exit strategies for the commercial release and long term maintenance of varieties.
- Increase seed of the controlled generation classes (Breeder, Foundation, Registered, and Certified) of new small grain varieties as rapidly as possible.
- Keep seed pure during increase and through the certification process.
- Have pure seed of new varieties available to licensees on an equitable basis and at a reasonable price.
- Maintain adequate supplies of pure seed of previously released TAM varieties, and increase as necessary.

Seed purification and multiplication (P & M) is begun by the breeder. The sooner P & M activities are initiated, the sooner large quantities of seed can be made available to licensees. Besides the production and maintenance of breeder seed, the plant breeder is responsible for the preparation and completion of all information and forms relating to Plant Variety Protection (PVP), and the preparation of information and advertisements that relate to a new variety. P & M activities should be a cooperative effort between the breeder and TFSS, with responsibility for purity gradually moving away from the breeder and toward TFSS as generations of selfing increase.

9) Development of Intellectual Property, Commercialization and Industry Interactions.

In 1987, the Texas Legislature recognized the dawning of a new day in commercialization of the products of agricultural research at Texas A&M University System. This was the year Texas AgriLife Research was directed to use available legal protections for plant cultivars and develop procedures to capture a return on the State's research investment through licensing fees, royalties and other forms of partnerships with industry cooperators. Without this directive, partnerships between Texas AgriLife Research and industry would have been unlikely, particularly with wheat and other small grains. In its final report to Texas AgriLife Research, the October 1999 small grains External Assessment Panel also encouraged Texas AgriLife Research to rapidly explore avenues of collaboration with industry. Since this practice was

implemented, there has been more than a ten-fold increase in revenues from small grains annually entering the System from seed royalties, seed sales and licensing fees. Most of this revenue has been reinvested in science programs.

Texas AgriLife Research seeks to develop strong relationships with private companies that can promote a Texas small grains industry that is sustainable and competitive. Primary goals of these relationships are production and sale of high quality and pure seed, support of the Texas certified seed industry, and delivering to Texas farmers the benefits of new technologies. To facilitate these goals, Texas AgriLife Research will work with the commercial seed industry to release improved cultivars and grant commercial licenses to private companies that can maximize availability and benefits of quality seed. Moreover, Texas AgriLife Research looks to these relationships for generating some of the revenue needed to sustain Texas small grains research and education programs (e.g., purchase and maintenance of equipment and instrumentation, maintenance of Texas Foundation Seed Service, and marketing varieties with limited utility or distribution).

Texas AgriLife Research recognizes that free release of small grain varieties to independent seedsmen does not effectively promote proper business principles or a healthy certified seed industry for small grains. To facilitate needed business principles, Texas AgriLife Research will file appropriate protection instruments in the United States for licensing new varieties including patents, plant patents, or certificates of protection. Private sector partnerships will be pursued that develop appropriate business mechanisms, assure proper seed distribution, confirm quality controls for seed production, and protect and enforce intellectual property rights. Partnerships will include elements described below:

- Performance-testing services for licensed varieties, to identify and promote regional adoption of licensed varieties and other intellectual property.
- Evaluation of intrinsic quality of licensed varieties using industry protocols and standards.
- Assurance that sublicensees, distributors and associates have valid contracts for production and sale of licensed varieties.
- Effective monitoring of seed sales and usage.
- Audits that assure accurate reporting of sales of licensed varieties.
- Enforcement of intellectual property rights in Texas and in other states that protects licensed varieties from infringement and abuse.
- A program for seed increase and production for licensed varieties that effectively meets public and market demand.
- Pricing of licensed variety seed similar to pricing of other proprietary varieties that have similar demand and have been released for equivalent periods.
- Working with Texas AgriLife Research scientists on release of new varieties, developing needed marketing and production plans for these varieties.

- Maintaining all certification standards as required by certifying agencies for jurisdictions where production takes place.
- Using care in all aspects of production, conditioning, distribution and sale of licensed products to insure quality and purity of all products sold.
- Selling licensed products to the public under a commercial name that identifies the variety as originating from the Texas A&M University System, and only using a variety name and not selling as Variety Not Stated ("VNS").

J. NEEDS

1. Positions

The four highest priority positions as of 2008 are as follows:

- Geneticist/Germplasm Development Scientist.* Amarillo. Recommended new faculty-level position to introgress novel genes from wild relatives and related species into adapted germplasm. The position could expand into production of doubled haploids and other areas of germplasm enhancement.
- Cereal Chemist.* College Station. Emphasis on enhancement of flour quality for tortilla production as well as collaborative research to increase intrinsic quality for leavened pan bread production.
- State Small Grains Pathologist-Research.* College Station. Focus on epidemiology of small grains diseases and remediation of yield losses due to currently endemic pathogens.
- State Small Grains Entomologist.* College Station. Research focus on Hessian fly and aphid vectors of disease causing viruses. Additional research needed on economic thresholds and integrated pest management strategies.

2. Facilities and Equipment

Specific examples of needed facilities and associated equipment include:

- New greenhouse. College Station. Small grains breeding program.
- Seed processing facilities. College Station. Small grains breeding program.
- Upgrade of cereal quality laboratory. College Station.
- Laboratory for marker assisted breeding and molecular genetic research. College Station. Small grains breeding program.
- Wheat field lab facilities. College Station. Small grains breeding program and statewide small grains agronomy program.
- Irrigation facilities for high management small grains research. College Station.
- Equipment storage for research and education activities and research farm. Commerce, Texas.
- Wheat genetics research laboratory for marker-assisted selection/breeding. Amarillo.
- Small grains pathology research and extension laboratory. Amarillo.

3. Programmatic

More formal organization and coordination of multidisciplinary teams is needed to address specific subject matter areas in small grains, such as dual-purpose systems, intrinsic quality and bioenergy.

K. IMPLEMENTATION PLAN

The envisioned small grains research and education program described in Section H above will be implemented by the Vice Chancellor and Dean, Agriculture and Life Sciences; the Director, Texas AgriLife Research; and the Director, Texas AgriLife Extension Service, using the Strategic Plan for Small Grains and other forthcoming recommendations of the Small Grains Advisory Committee as guidelines.

The SGAC will meet quarterly, review new and ongoing issues in small grains, make additional recommendations to the Vice Chancellor and the Directors of Texas AgriLife Research and Texas AgriLife Extension Service, as appropriate. The SGAC will modify as needed the Small Grains Strategic Plan for the purpose of maintaining a truly statewide perspective to the small grains program and to enhance the procurement and efficient use of resources.

To bring stability and assure adequate resources for the small grains program, there must be continued sources of income, consistent with the program requirements. The following section describes the resource needs and strategies to keep the program productive and current and a financial plan to provide for the required resources.

1. Purchase and Replacement of Equipment:

Investigators in small grains have working knowledge of the condition of capital assets in inventory and any additional equipment requirements of his or her project. Investigators should be encouraged to seek outside funding for capital assets as they are available. It is the intent of the Small Grains Advisory Committee to coordinate funds available from state initiatives, redirected Texas AgriLife Research, Texas AgriLife Extension Service and unit funds, and funds from the Texas Wheat Producers Board, as well as monies from royalties, contracts and grants, as appropriate. The ultimate objective will be to prevent the lack of capital assets from limiting the scope of small grain research and education programs. The Small Grains program and its two Centers of Excellence will be a statewide, multi disciplinary effort to improve production and profitability of the largest crop in the state. The success of this strategic plan will hinge on the buy-in from the leadership of the departments and units involved. If a truly successful *statewide* program is to be accomplished, it needs statewide coordination by scientists, administrators and representatives of the wheat industry. It is proposed that the SGAC serve in this function concerning capital asset management, annually

reviewing equipment condition and needs, and also making recommendations regarding allocation of pooled resources.

2. Funding the Statewide Strategic Plan

Full funding for implementing the Statewide Small Grains Strategic Plan as recommended herein will require new resources. Sources of funding should include but are not limited to:

- a. Redirected resources within Texas AgriLife Research, Texas AgriLife Extension Service and/or specific units thereof;
- b. Partnerships with other institutions or agencies (e.g. USDA-ARS, KSU, TTU, etc.);
- c. Industry including the Texas Wheat Producers Board with the SGAC serving in a technical review and advisory role;
- d. Royalties from wheat varietal development and sales;
- e. Contracts and grants; and
- f. Participation in appropriate state and federal initiatives.

The SGAC believes that the distribution of any new state resources that may become available will be most effective if allocated and committed on a 2 to 4-year basis (except large, non-recurrent expenditures such as capital equipment items). Funds distribution should be made according to stated program goals and objectives recommended in this Strategic Plan (see Section F above). Additional resource development and allocation measures will be needed to fully fund the Strategic Plan for Small Grains Research & Extension. The SGAC should be assigned a strong role in the development and allocation process of new resources to assure fulfillment of the Strategic Plan.

Moreover, because funds will be needed to implement the recommended elements and components of this small grains strategic plan for Texas, it is hereby recommended that the prior System policy be continued that Texas AgriLife Research royalties (excluding payments to inventing scientists and OTC i.e., currently 37.5% of total allocated by TAMUS-OTC) from small grains varietal development henceforth received by the Texas AgriLife administration and administrative units be set aside for use solely for the statewide small grains program.

Specifically, the SGAC recommends that Texas AgriLife Research continue its policy of earmarking all royalties received for small grains for use solely by the statewide small grains program. This redirection of funds does not include the distributions to scientists, Texas Foundation Seed Service, or to the TAMUS Office of Technology Commercialization. The recommended policy should be reevaluated by the SGAC at 5-year intervals to assure the appropriate development and delivery of small grain varieties and management practices.

Texas Small Grains Improvement Program Baseline Survey Resource

**Table 1. AgriLife Research and AgriLife Extension Small Grains Faculty Positions
July 2000 & May/June 2008**

Unit	July 2000			May/June-2008		
	TAES	TCE	Total	Texas AgriLife Research	Texas AgriLife Extension	TOTAL
A. Off-Campus Centers	FTE	FTE	FTE	FTE	FTE	FTE
Amarillo	2.3	1.0	3.3	1.60	1.10	2.70
Dallas	1.0	0	1.0	0.20	0.10	0.30
Vernon	0.7	0.9	1.6	0.60	0.50	1.10
Overton	0.5	0	0.5	0.05	0	0.05
Uvalde	0.25	0	0.25	0.10	0	0.10
San Angelo	0	0.45	0.45	0	0.45	0.45
Corpus Christi	0.05	0	0.05	0	0	0
Lubbock	0	0	0	0	0.10	0
SUB-TOTAL	4.8	2.35	7.15	2.55	2.25	4.70
B. On-Campus Departments						
Soil/Crop Sciences	0.9	0.85	1.75	2.45	0.75	3.20
Ag. Economics	0.1	0.45	0.55	0	0	0
Plant Pathology	0	0.20	0.20	0	0	0
Entomology	0	0	0	0	0.50	0.50
SUB-TOTAL	1.0	1.50	2.50	2.45	1.25	3.70
TOTAL	5.80	3.85	9.65	5.00	3.50	8.50
C. Overall Faculty Positions in Small Grains Established Since July 2001						
Wheat Breeder @ Amarillo	0	0	0	1.0	0	1.0
Environmental Soil Scientist @ Vernon	0	0	0	0.1	0	0.1
Molecular Biologist@ Soil/Crop Sciences	0	0	0	1.0	0	1.0
Extension Small Grains Specialist, C.S.	0	0	0	0	1.0	1.0
Extension Plant Pathologist, Amarillo	0	0	0	0	1.0	1.0
Wheat Breeder @ College Station	0	0	0	1.0	0	1.0
TOTAL	3.0	2.0	5.0	3.1	2.0	5.1

Table 2. Texas Small Grains Research Program Benchmarks, June-2008 FY08 Small Grains Workers, Texas AgriLife Research

FACULTY					
Location	Name	Department	Discipline	Title	% Small Grains
Amarillo	Jackie Rudd	Soil and Crop Sciences	Breeding/Genetics	Associate Professor	100
	Charlie Rush	Plant Pathology and Microbiology	Plant Pathology	Professor	30
	Jerry Michels	Entomology	Entomology	Professor	30
	Bill Payne	Soil and Crop Sciences	Plant Physiology	Professor	10
	Brent Bean	Soil and Crop Sciences	Agronomy	Professor	10
Lubbock	Christian Nansen	Entomology	Entomology	Assistant Professor	30
Vernon	Dariusz Malinowski	Soil and Crop Sciences	Forage Physiology	Associate Professor	30
	John Sij	Soil and Crop Sciences	Agronomy	Professor	20
	Bill Pinchak	Ecosystem Science & Management	Grazing Management	Professor	10
	Paul DeLaune	Soil and Crop Sciences	Soil Sciences	Assistant Professor	10
Commerce	Jim Heitholt	Soil and Crop Sciences	Plant Physiology	Associate Professor	20
Overton	Lloyd Nelson	Soil and Crop Sciences	Forage Testing	Professor	10
College Station	Amir Ibrahim	Soil and Crop Sciences	Breeding/Genetics	Associate Professor	100
	Dirk Hays	Soil and Crop Sciences	Molecular Genetics / end-use quality	Assistant Professor	60
	Lloyd Rooney	Soil and Crop Sciences	Food Science - bread quality	Professor	20
	Joseph Awika	Soil and Crop Sciences	Food Science - tortilla and specialty	Assistant Professor	30
	Mike Chandler	Soil and Crop Sciences	Weed Ecology	Professor	5
	Kevin Bronson	Soil and Crop Sciences	Soil Fertility	Professor	5
	Brent Bean	Soil and Crop Sciences	Weed Science	Professor	5
	Christine Morgan	Soil and Crop Sciences	Soil Hydrogeology	Assistant Professor	5
	Scott Finlayson	Soil and Crop Sciences	Physiology	Assistant Professor	5
	Frank Hons	Soil and Crop Sciences	Soil Fertility	Professor	10
Uvalde	Giovanni Piccinni	Soil and Crop Sciences	Plant Physiology	Associate Professor	10

SUPPORT PERSONNEL					
Location	Name	Faculty Assignment	Discipline	Title	% Small Grains
Amarillo	Yiqun Weng	Rudd	Wheat Genetics	Research Scientist	100
	Ravindra Devkota	Rudd	Wheat Breeding	Assistant Research Scientist	100
	Jonny Simmons	Rudd	Wheat Breeding	Research Assistant	100
	Azhaguvel Perumal	Rudd	Wheat Genetics	Assistant Research Scientist	100
	Huangjun Lu	Rudd	Wheat Genetics	Assistant Research Scientist	100
	VACANT			Associate Research Scientist	30
Vernon	Jason Baker	Rudd	Wheat Breeding	Research Associate	100
	Murray Martin	Malinowski/Rudd	Wheat Breeding	Ag Research Technician I	50
Commerce	Russell Sutton	Baltensperger	Wheat Breeding	Assistant Research Scientist	75
College Station	Bryan Simoneaux	Ibrahim	Wheat Breeding	Research Assistant	100
	Linda Dykes	Rooney	Wheat Breeding	Research Assistant	20

Table 3. Texas Small Grains Extension Faculty and Support Personnel, May, 2008

FACULTY					
Location	Name	Department	Discipline	Title	% Small Grains
Amarillo	Brent Bean	Soil & Crop Sciences	Agronomy	Professor	35
	Ron French	Plant Pathology	Entomology	Assistant Professor	50
	Steve Amosson	Ag Economics	Ag Economics	Professor	25
	VACANT	Entomology	Entomology	Assistant Professor	50
College Station	Gaylon Morgan	Soil & Crop Sciences	Agronomy	Associate Professor	75
Lubbock	Calvin Trostle	Soil & Crop Sciences	Agronomy	Associate Professor	10
Dallas	Allen Knutson	Entomology	Entomology	Professor	10
San Angelo	VACANT	Soil & Crop Sciences	Agronomy	Assistant Professor	30
	Chris Sansone	Entomology	Entomology	Associate Professor	15
Vernon	Todd Baughman	Soil & Crop Sciences	Agronomy	Associate Professor	25
	Stan Bevers	Ag Economics	Ag Economics	Professor	25
SUPPORT PERSONNEL					
Location	Name	Faculty Assignment	Discipline	Title	% Small Grains
Amarillo	Roberto Villareal	Payne	Physiology	Technician I	30
College Station	Daniel Hathcoat	Morgan	Agronomy	Program Specialist	50