
FABIAN GARCIA SCIENCE CENTER AND LEYENDECKER PLANT SCIENCE RESEARCH CENTER
NM
STATE

Notice to Users of This Report

This report has been prepared by Science Center staff to document the results of the various research projects from the past year and to record data for future reference. These are not formal Agricultural Experiment Station Report research results, and the reader is cautioned against drawing conclusions or making recommendations as a result of data in this report. In many instances, data represents only one of several years' results that will constitute the final formal report. Although staff members have made every effort to check the accuracy of the data presented, this report was not prepared as a formal release. None of the data is authorized for release or publication, without the written prior approval of the NMSU Agricultural Experiment Station.

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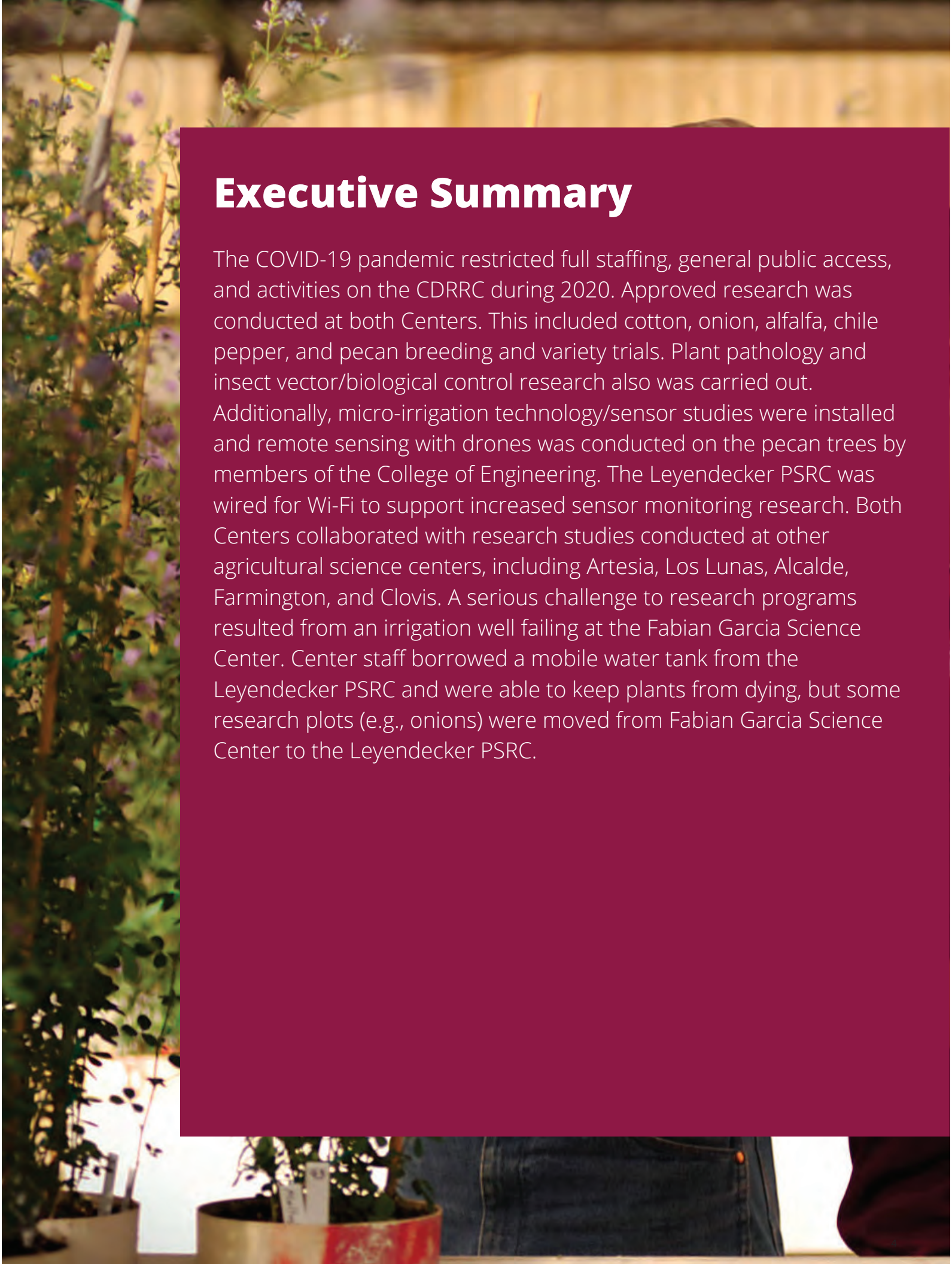
Conversion Table for English and Metric (SI) Units

The following conversion table is provided as an aid for those who may wish to convert data appearing in this report from English (U.S.) units to Metric (SI) units, or vice versa. (Calculations are approximations only.)

To convert English to Metric, multiply by	English (U.S.) units	Metric (SI) units	To convert Metric to English, multiply by
2.540	inches (in)	centimeters (cm)	0.394
0.305	feet (ft)	meters (m)	3.281
1.609	miles (miles)	kilometers (km)	0.621
0.093	square feet (ft2)	square meters (m2)	10.764
2.590	square miles (mile2)	square kilometers (km2)	0.386
0.405	acres (ac)	hectares (ha)	2.471
28.350	ounces (oz)	grams (g)	0.035
29.574	fluid ounces (fl oz)	milliliters (mL)	0.034
3.785	gallons (gal)	liters (L)	0.264
0.454	pounds (lbs)	kilograms (kg)	2.205
907.185	ton (2000 lbs) (t)	kilograms (kg)	0.001
0.907	ton (2000 lbs) (t)	metric tonnes (t) or Megagrams (Mg)	1.102
1.000	parts per million (ppm)	ppm (mg/kg)	1.000
1.121	pounds/acre (lbs/ac)	kilograms/hectare (kg/ha)	0.892
2.240	tons/acre (t/ac)	Megagrams/hectare (Mg/ha)	0.446
16.018	pounds per cubic feet (lbs/ft3)	kilograms per cubic meter (kg/m3)	0.062
0.070	cubic feet/acre (ft3/ac)	cubic meters/hectare (m3/ha)	14.291
73.078	ounces/acre (oz/ac)	milliliters/hectare (mL/ha)	0.014
62.710	bushels/acre (corn: 56# bu)	kilograms/hectare (kg/ha)	0.016
67.190	bushels/acre (wheat: 60# bu)	kilograms/hectare (kg/ha)	0.015
125.535	Cwt/acre (100 wt)	kilograms/hectare (kg/ha)	0.008
0.042	Langleys (Ly)	Megajoules (MJ)/m2	23.900
(°F-32)÷1.8	Fahrenheit (°F)	Celsius (°C)	(°C x 1.8) + 32

For additional helpful English-Metric conversions, see: https://www.extension.iastate.edu/agdm/wholefarm/html/c6-80.html and https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/null/?cid=stelprdb1043619



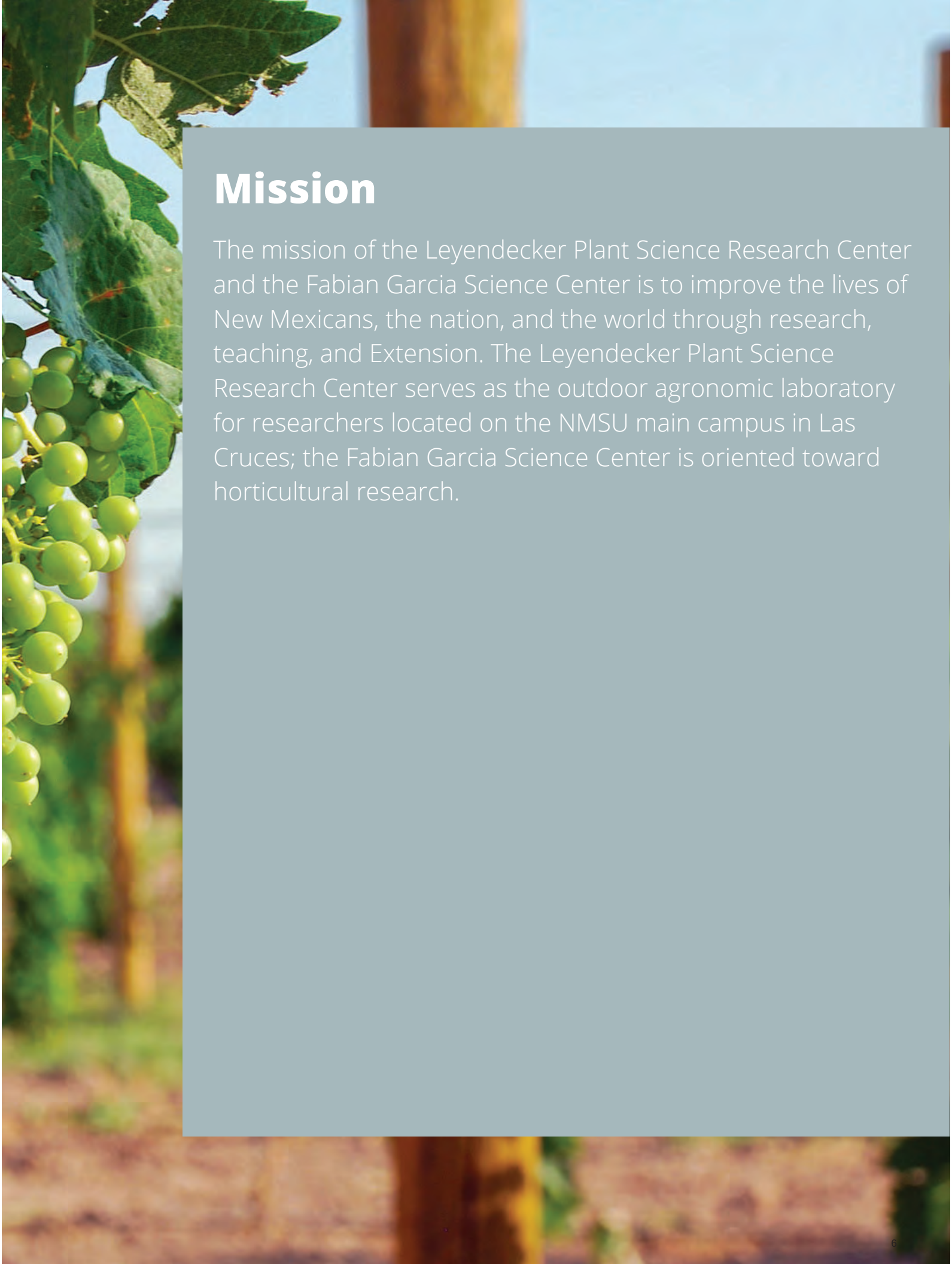
Executive Summary

The COVID-19 pandemic restricted full staffing, general public access, and activities on the CDRRC during 2020. Approved research was conducted at both Centers. This included cotton, onion, alfalfa, chile pepper, and pecan breeding and variety trials. Plant pathology and insect vector/biological control research also was carried out. Additionally, micro-irrigation technology/sensor studies were installed and remote sensing with drones was conducted on the pecan trees by members of the College of Engineering. The Leyendecker PSRC was wired for Wi-Fi to support increased sensor monitoring research. Both Centers collaborated with research studies conducted at other agricultural science centers, including Artesia, Los Lunas, Alcalde, Farmington, and Clovis. A serious challenge to research programs resulted from an irrigation well failing at the Fabian Garcia Science Center. Center staff borrowed a mobile water tank from the Leyendecker PSRC and were able to keep plants from dying, but some research plots (e.g., onions) were moved from Fabian Garcia Science Center to the Leyendecker PSRC.

Meeting the needs of New Mexico

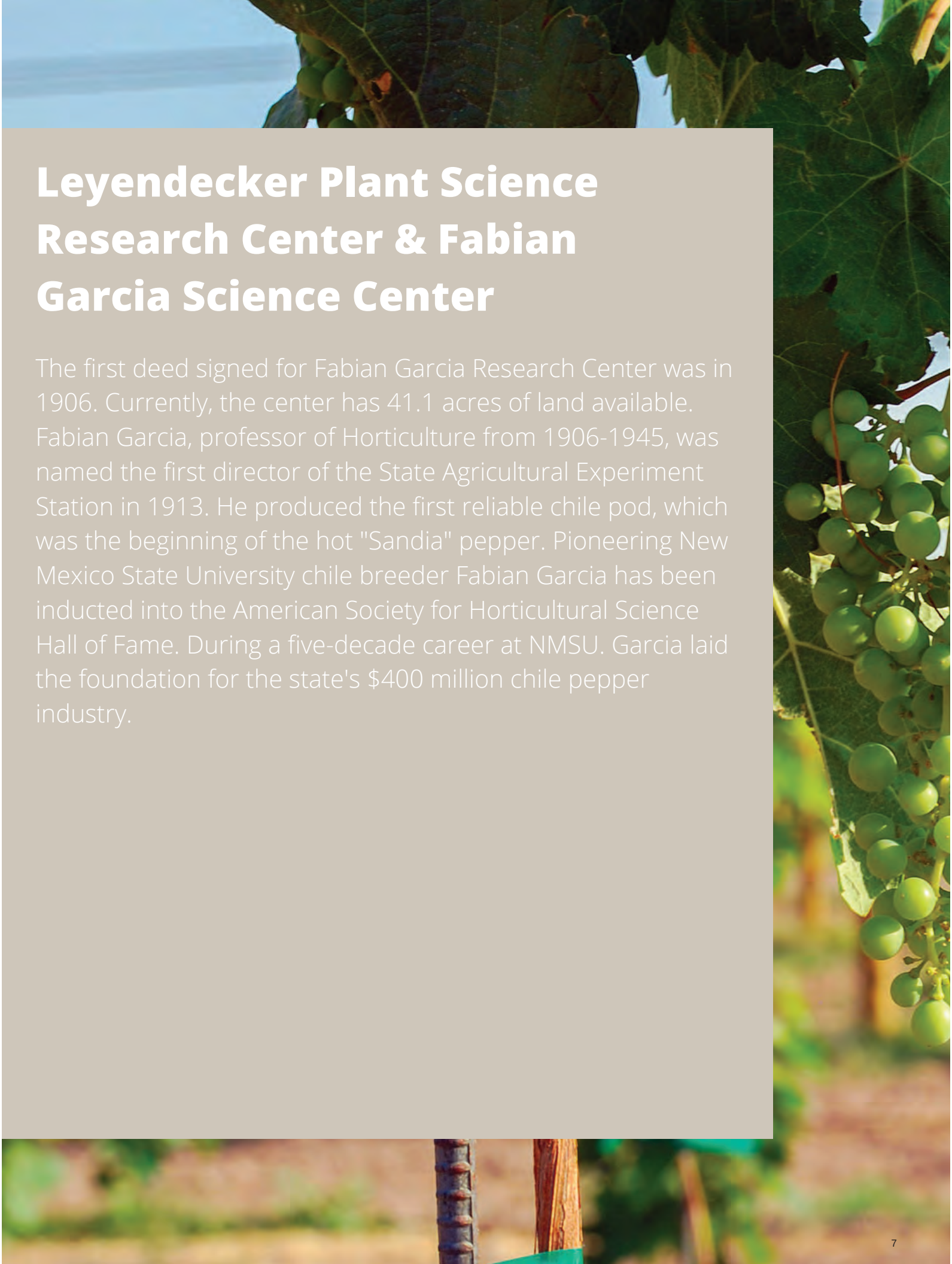
The Agricultural Experiment Station (AES) system is the research arm of New Mexico State University's (NMSU) College of Agricultural, Consumer, and Environmental Sciences (ACES), consisting of scientists on the main campus and at agricultural science centers (ASCs) throughout New Mexico. The 12 ASCs support fundamental and applied research under New Mexico's varied environmental conditions to meet the agricultural and natural resource management needs of communities in every part of the state. ASCs consist of two types: 1) facilities without resident faculty, which serve as research support field laboratories for campus-based faculty, and 2) off-campus facilities with faculty stationed at the centers that also serve, in part, as research support field laboratories for campus-based faculty.

The Fabian Garcia Science Center and the Leyendecker Plant Science Research Center accommodate the field research needs of Las Cruces-based researchers. These scientists are principally from the College of Agricultural, Consumer and Environmental Sciences, with others from the Colleges of Arts and Sciences and Engineering, and the USDA Agricultural Research Service.



Mission

The mission of the Leyendecker Plant Science Research Center and the Fabian Garcia Science Center is to improve the lives of New Mexicans, the nation, and the world through research, teaching, and Extension. The Leyendecker Plant Science Research Center serves as the outdoor agronomic laboratory for researchers located on the NMSU main campus in Las Cruces; the Fabian Garcia Science Center is oriented toward horticultural research.



Leyendecker Plant Science Research Center & Fabian Garcia Science Center

The first deed signed for Fabian Garcia Research Center was in 1906. Currently, the center has 41.1 acres of land available. Fabian Garcia, professor of Horticulture from 1906-1945, was named the first director of the State Agricultural Experiment Station in 1913. He produced the first reliable chile pod, which was the beginning of the hot "Sandia" pepper. Pioneering New Mexico State University chile breeder Fabian Garcia has been inducted into the American Society for Horticultural Science Hall of Fame. During a five-decade career at NMSU. Garcia laid the foundation for the state's $400 million chile pepper industry.

Agricultural Experiment Station

What Is the Agricultural Experiment Station?

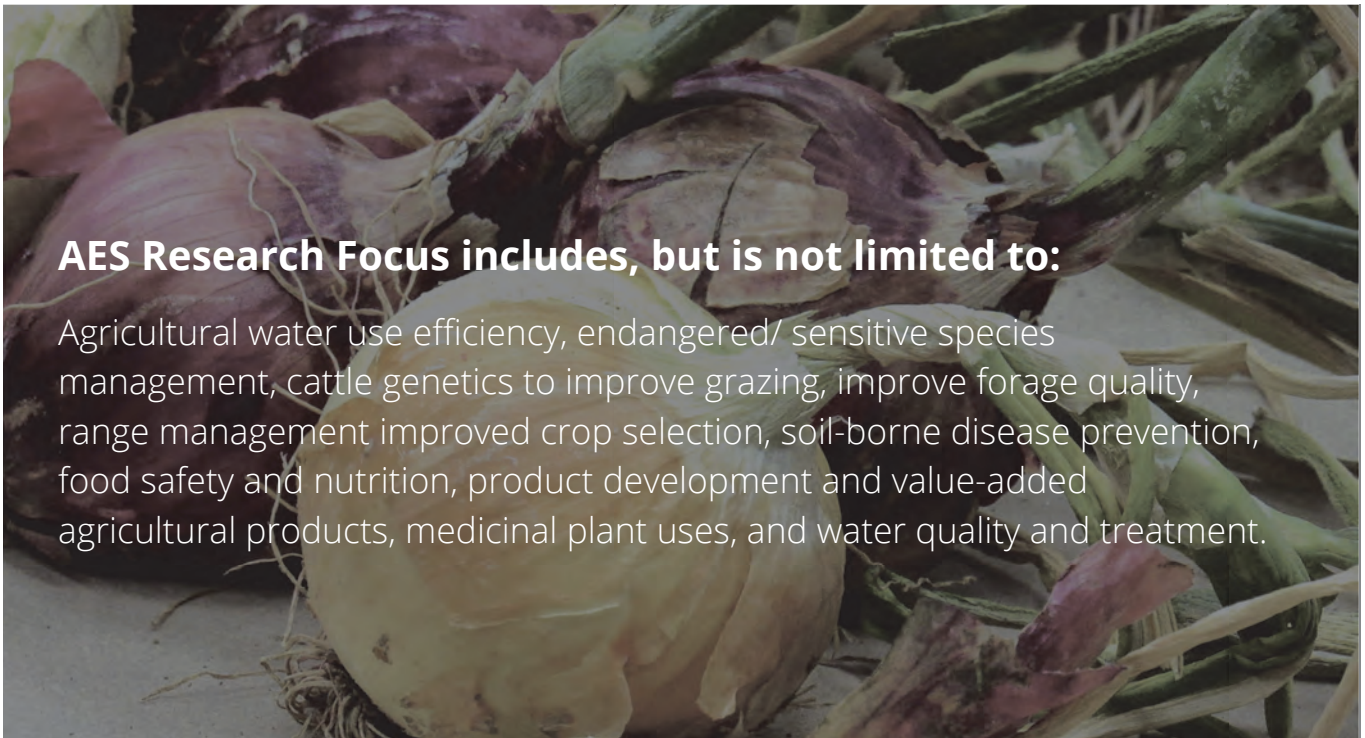
NMSU's Agricultural Experiment Station is the principal research unit of the College of Agricultural, Consumer and Environmental Sciences. All research faculty in the college have appointments in the Agricultural Experiment Station.

Mission

The Agricultural Experiment Station is not a physical site, but rather a system of scientists who work on facilities on the main campus in Las Cruces and at 12 agricultural science and research centers located throughout the state. The Agricultural Experiment Station system also interacts with other university research units and various state and federal agencies to provide opportunities for research that will benefit the citizens of New Mexico.

The Agricultural Experiment Station supports research designed to:

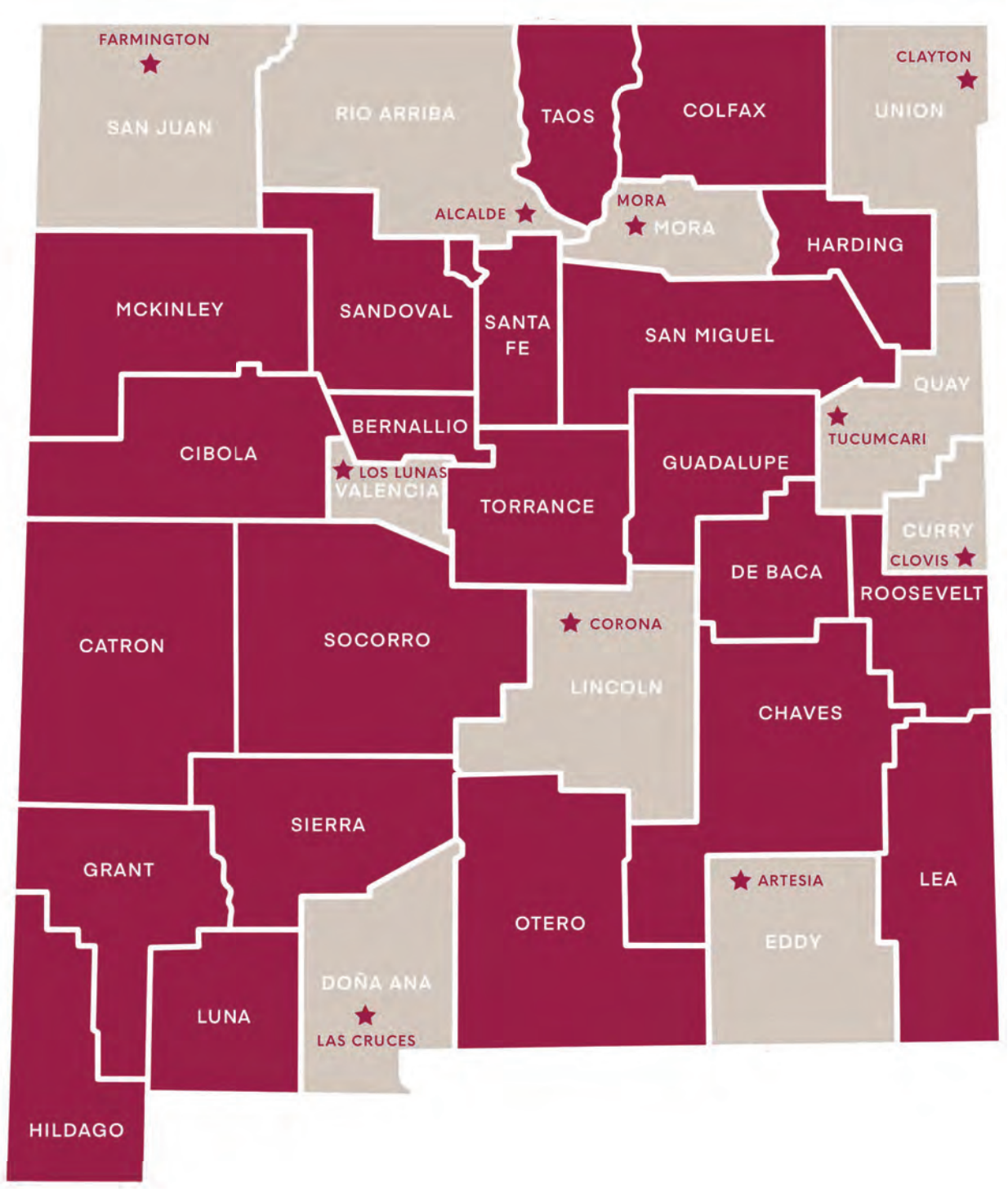
- Enhance agricultural profitability.
- Stimulate economic development using natural resources.
- Improve the quality, safety and reliability of food and fiber products.
- Sustain and protect the environment with ecologically sound practices.
- Manage and protect natural resources.
- Improve the quality of life for the people of New Mexico.



AES Research Focus includes, but is not limited to:

Agricultural water use efficiency, endangered/ sensitive species management, cattle genetics to improve grazing, improve forage quality, range management improved crop selection, soil-borne disease prevention, food safety and nutrition, product development and value-added agricultural products, medicinal plant uses, and water quality and treatment.

NMSU Agricultural Experiment Station



Fabian Garcia Science Center

Faculty and Staff

Anthony Arranda
Farm Manager

Diego Garcia

Jorge Garcia

Dante Ogaz

Liberato Valdez

Carlos Valles

Leyendecker Plant Science Center

Faculty and Staff

Dave Lowry
Farm Manager

Rolando Gonzalez

Pablo Holguin

Autumn Martinez

Martin Melon

Orlando Moralez

Wade Robinson

Ralph Treviño

Acting Superintendent of Fabian Garcia Science Center and Leyendecker Plant Science Research Center: Dr. Steven Loring, Associate Director, Agricultural Experiment Station

Cooperators/Collaborators

1. USDA ARS Cotton Ginning Laboratory
2. NDrip (Israel)
3. Los Alamos National Laboratory
4. Cyanotech Corporation
5. Phase Genomics, Inc.
6. Qualitas Health, Inc.
7. Hudson Alpha
8. Noble Foundation
9. University of Arizona
10. Texas A&M University
11. Colorado State University
12. University of California-San Diego
13. University of Nevada-Reno
14. Oklahoma State University
15. University of Georgia

Fabian Garcia Ag Science Center

Fiscal Year: **2020**

Fiscal Period: **30-Jun-20**

Department	Acct Type	Account Index Desc	Revenue YTD	Expense Budget	Expense YTD	get Balance Available	Fund Balance Dr/(Cr)
Fabian Garcia Ag Science Ctr	APPLIED CHARGES	FABIAN GARCIA/HORT FARM SERVICES	$0.00	$0.00	$2,550.50	($2,550.50)	$3,408.79
Fabian Garcia Ag Science Ctr	APPLIED CHARGES	FABIAN GARCIA/HORT FRM TRACTOR SVC	$0.00	($1,000.00)	$3,625.57	($4,625.57)	($5,594.25)
Fabian Garcia Ag Science Ctr	SALES & SERVICE	FABIAN GARCIA RESEARCH CTR SALES	$6,795.24	$0.00	$15,564.96	($15,564.96)	($58,521.26)
		Total Sales and Service Funds	**$6,795.24**	**($1,000.00)**	**$21,741.03**	**($22,741.03)**	**($60,706.72)**
							* See note
Fabian Garcia Ag Science Ctr	STATE APPROPRIATIONS	FABIAN GARCIA RC-SALARY		$143,990.90	$152,573.24	($8,582.34)	
Fabian Garcia Ag Science Ctr	STATE APPROPRIATIONS	FABIAN GARCIA RC-OPERATIONS		$14,333.00	$5,639.75	$8,693.25	
		Total State Appropirated Funds		**$158,323.90**	**$158,212.99**	**$110.91**	

Note: " ( ) " In the Fund Balance column indicates a positive number

Leyendecker Plant Science Research Center

Fiscal Year: **2020**

Fiscal Period: **30-Jun-20**

Department	Acct Type	Account Index Desc	Revenue YTD	Expense Budget	Expense YTD	Net Balance Available	Fund Balance Dr/(Cr)
Leyendecker Plant Sci Res Ctr	APPLIED CHARGES	LEYENDECKER RC-IRRIGATION SVC	$0.00	($2,000.00)	$11,899.01	($13,899.01)	$38,734.02
Leyendecker Plant Sci Res Ctr	APPLIED CHARGES	LEYENDECKER RC-TRACTOR SVC	$0.00	($6,000.00)	$15,004.31	($21,004.31)	$8,351.25
Leyendecker Plant Sci Res Ctr	SALES & SERVICE	LEYENDECKER RESEARCH CENTER SALES	$110,415.68	$20,875.00	$71,174.77	($50,299.77)	($39,501.42)
		Total Sales and Service Funds	**$110,415.68**	**$12,875.00**	**$98,078.09**	**($85,203.09)**	**$7,583.85**
							* See note
Leyendecker Plant Sci Res Ctr	STATE APPROPRIATIONS	LEYENDECKER RC-SALARY		$398,916.43	$360,175.76	$38,740.67	
Leyendecker Plant Sci Res Ctr	STATE APPROPRIATIONS	LEYENDECKER RC-OPERATIONS		$28,665.00	$43,985.77	($15,320.77)	
		Total State Appropirated Funds		**$427,581.43**	**$404,161.53**	**$23,419.90**	

Note: " ( ) " In the Fund Balance column indicates a positive number

AES RESEARCH

NMSU's Agricultural Experiment Station research publications provide information to help improve production techniques and efficiencies for farmers, ranchers, dairies, and other agricultural producers.

Forestry

Agronomy

Dairy

Weather and Climate

Horticulture

Task Force Reports

Livestock and Range

Water

Economics

ONION BREEDING PROGRAM

Investigators: Christopher Cramer, Plant and Environmental Sciences

Open-pollinated, male-sterile, maintainer, and pollinator breeding lines were screened for disease resistance, bulb yield, bulb quality, maturity date, and bulb color. Fifty-nine different lines were evaluated this past year. Seeds of 261 different lines were produced this year. This work contributes to the progress of developing a commercial onion cultivar that can be used by growers.

Seeds of original, intermediate, and advanced FBR-selected populations and one resistant and one susceptible check were sown in fields at the Fabian Garcia Science Center (FGSC) in Oct. 2019. There were a total of 28 entries in the study that were replicated four times. After harvest, the basal plate of all bulbs from the plot was cut transversely and a 1 cm diameter plug of PDA inoculum of a FOC isolate was applied to the cut surface. After 21 days from inoculation, the basal plate of each bulb was cut again and the basal plate was rated for disease development. Of the FBR-selected populations, recent selections of 'NuMex Chaco', 'NuMex Crispy', and 'NuMex Mesa' exhibited less disease than their original cultivar generation, the susceptible check, and the resistant check. Recent selections of 'NuMex Luna', 'NuMex Sweetpak', and 'NuMex Vado' exhibited less disease than their original cultivar generation and the susceptible check. These results indicate that breeding for FBR resistance has been successful in producing germplasm that is more resistant than currently-available short-day commercial cultivars. The seed was produced from a total of 16 different germplasm lines associated with this project.

On 7 Jan. 2020, the seed of 4 NMSU germplasm lines and 'Stockton Early Yellow', an IYS-susceptible cultivar was sown in flats. Plants were transplanted to 3.3 m long field plots on 10-11 Mar. with 2 rows of plants per plot and 7.5 cm between plants within the row. The field was arranged using a split-plot design with irrigation as whole plots and selections as subplots. Each whole plot was replicated 3 times and within whole plots, selections were arranged in an RCBD with 4 replications. On 8 May, irrigation treatments were initiated. Ten plants were randomly selected from each plot and identified with a plastic label. Starting on 12 May and every 2 weeks afterward, plant height, leaf number, and sheath diameter were measured for each of the 10 plants. Starting on 18 May and 4 additional times 2 weeks apart, adult and juvenile thrips were counted from the 10 plants in each plot. On 3 June, IYS symptom severity was rated for the ten plants on a scale of 0 to 4, where 0 = no symptoms; 1 = 1-2 small lesions per leaf; 2 = more than 2 medium-sized lesions; 3 = lesions coalescing on more than 25% of the leaf tissue; 4 = more than 50% leaf is dead. These ratings were repeated 3 additional times 2 weeks apart. Once a plant matured, the plant was harvested, the date of maturity was recorded and bulb height, diameter, and weight were measured. At bulb maturity, individual bulbs, that exhibited fewer IYS disease symptoms, were selected from plots.

At 9 and 11 weeks after transplanting (WAT), plants of 'Stockton Early Yellow' possessed more juvenile and total thrips than plants of the four NMSU germplasm lines when averaged over-irrigation treatments. There were no differences in thrips number per plant between the two irrigation treatments. Thrips number per plant increased from 9 to 13 WAT and decreased afterward for all entries. At each observation date, plants of all entries exhibited a similar number of leaves, plant height, and sheath diameter when grown using either irrigation treatment. At 11, 13, and 15 WAT, plants of 'Stockton Early Yellow' exhibited more severe IYS than plants of all other four entries. Plants of NMSU 12-238 produced bulbs of the largest size while plants of 'Stockton Early Yellow' produced the smallest bulbs.

PRODUCTS

Mandal, S. and C.S. Cramer. 2020. An artificial inoculation method to select mature onion bulbs resistant to Fusarium basal rot. HortScience 55:1840-1847 https://doi.org/10.21273/HORTSCI15268-20 .

Mandal, S., A. Saxena, C.S. Cramer, and R.L. Steiner. 2020. Comparing efficiencies of two selection approaches for improving Fusarium basal rot resistance in short-day onion after a single cycle of selection. Horticulturae 6:26. doi 10.3390/horticulturae6020026.

TURFGRASS RESEARCH PROGRAM

Investigators: Ryan Goss, Plant and Environmental Sciences

Due to COVID-19 and limited access to Fabian Garcia Science Center, Dr. Goss has no progress for 2020. During complete lockdown and a delayed response for Fabian Garcia access, the turfgrass plots grew tall around the sprinkler heads. Irrigation was thus blocked to the rest of the plots. A vast majority of his plots are currently dead and need to be reestablished. He has been acquiring supplies to prepare for reseeding of the turfgrass areas. Most of the supplies are available, but he is waiting for warmer weather and some assurance we will not be in lockdown again. He also has some equipment in disrepair from neglect that needs to be worked on. When he begins seeding, it will be critical to have daily and consistent access as the tender seedlings emerge.

PROGENY SELECTION OF BIGTOOTH MAPLES (ACER GRANDIDENTATUM)

Investigators: Rolston St. Hilaire, Plant and Environmental Sciences

Bigtooth maple (Acer grandidentatum Nutt.) is a woody deciduous tree that is indigenous only to North America. The plant is valued for its fall foliage color, but it is not widely used in managed landscapes. The plant has a wide contiguous geographic range that covers 18° degrees of latitude and includes regions in Utah, Idaho, Wyoming, Arizona, New Mexico, and Texas. This extensive range gives the bigtooth maple taxa one of the largest ecological ranges among the North American Acer genus. Because the plant is small and adaptable to many soils, horticulturists speculate that bigtooth maple merits more use in managed landscapes.

In 2004, we planted a replicated block of bigtooth maples at the Fabian Garcia Agricultural Science Center. Seedlings for the planting block were grown from mature seeds of bigtooth maples collected from trees occurring in natural stands in New Mexico, Utah, and Texas. Seedlings were previously assessed for resilience to environmental stresses such as drought, salinity, and irradiance using both greenhouse and field studies. Plants from the replicated block have been maintained for the past decade and a half. The plant is being observed for desirable ornamental traits such as fall foliage color and plant architecture. Clonal material from promising material in the planting block is being selected and through material transfer agreements, plant materials are being assessed by external partners. In 2013, on the cultivar, JFS-NuMex 3 bigtooth maple (Acer grandidentatum 'JFS-NuMex 3') was released from this planting. Work on the assessment of additional materials is ongoing.

EXTENSION VEGETABLE PROGRAM

Investigators: Stephanie Walker, Extension Plant Sciences

The projects described below utilize the facilities and personnel from both Leyendecker and Fabian Garcia Science Centers. Other chile trials are located at Las Lunas ASC.

Applied Chile Pepper Research for NM Growers

The goal of this research program is to develop cultivars specific to NM growers. The projects include improved red pigmentation of paprika varieties for added value, development of open-pollinated cayenne varieties with mechanical harvest traits, improved fruit size of heritage variety "NuMex Heritage 6-4," and New Mexico-type green chile that is amenable to mechanical harvest. This requires upholding the quality of the crop, i.e. taste and disease tolerance, alongside improving yield and harvest efficiency. Successful mechanical harvest requires a high percentage of plants with single stems, increased height to fruit set (main bifurcation), and reduced force to remove the fruit from the plants. This year marks the release of 'NuMex Odyssey,' which possesses traditional New Mexican green chile pepper flavor, low heat, and provides a higher percentage of mechanically harvested, marketable green chile fruit without mechanical damage compared to current, standard industry NM type green chile pepper cultivars.

Figure 1- NM-type green chile mechanical harvest trial

In collaboration with researchers at UC Davis, we are also conducting a study on the genetic elements that control the degree of attachment of the chile pedicel to the fruit. Utilizing a cross between NM-type green chile and "easy de-stemming" wild pepper germplasm, we are conducting a genome-wide association study (GWAS) to discern the genotypes responsible for easy removal of the stem for post-processing efficiency.

The Jose Fernandez Memorial Garden

This project involves the cultivation of a vegetable research and demonstration plot at the Fabian Garcia Science Center that will introduce vegetable crops and/or varieties relatively unknown in NM and determine which selections have the potential to perform well in southern New Mexico. Recent interactions with farmers and agricultural professionals in the South Pacific and the desert southwest have highlighted vegetable selections that produce in the heat, and horticulturists from these areas have shared information on promising varieties. The project also investigates some traditional southwestern vegetables, as well as other unusual entries not commonly grown in the state.

Figure 2- Lettuce variety trials for heat tolerance

Figure 3- Cover crop strategies demonstrated in parts of the field (Sesbania shown)

COTTON BREEDING

Investigators: Jinfa Zhang, Plant and Environmental Sciences

Dr. Zhang's cotton breeding program is field-tested at the Leyendecker Plant Science Research Center. His research has confronted a strategic threat to the U.S. cotton industry from the expansion of Fusarium wilt race 4 (FOV4) into Texas and New Mexico. In 2019, he publicly released two Upland cultivars with demonstrated resistance to FOV4 and, in the past two years, has published six peer-reviewed articles on FOV4 with three more in review. Contributions to the research community have been critical to creating a better understanding of cotton as a field crop and improving the genetics through germplasm releases, of which several have been the basis of breakthroughs in fiber quality with the added benefit of increased production. Dr. Zhang has released several glandless lines that are gossypol-free and worked to establish a niche market for this material, which is a high-value food source and can be produced in low input environments. A breeder with Corteva, said, "it takes knowledge of the U.S. cotton industry to anticipate the need for a trait such as FOV4 and then ... to develop germplasm that will be useful to private breeders in the development of commercial varieties with resistance to FOV4. This a perfect example of basic research conducted by public breeders that is most valuable to the cotton industry."

Testing and Development of Competitive High-Quality Upland Cotton through Enhanced Ginning/Textile Processing Performance

The objective of this cooperative research project is to evaluate new strains of Upland cotton including long-staple (30-35 mm of fibers) Acala 1517 for their ginnability and textile quality as means for guiding variety development. In addition to fiber length, strength, and micronaire, other properties such as seed size, seed coat fragments, neps, short fiber content, and fiber uniformity will be evaluated in the breeding process.

This study addresses issues related to cottonseed size and fiber quality, which affects ginning and textile quality, which are important to raw cotton pricing. As a result, long-staple cultivars, Acala 1517-99W (2008), Acala 1517-08 (2011), Acala 1517-09R (2011), Acala 1517-16 B2RF (2016), Acala 1517-18 GLS (2018), Acala 1517-20 (2019) and Acala 1517-21 (2019) and high-yielding cultivar NuMex COT 19 (2019) have been released by NMAES.

We will continue developing long-staple cotton with low levels of seedcoat fragments and short fiber content will increase the competitiveness of the New Mexico cotton in the world market. The New Mexico Acala cotton enjoys 6-7 cents of price premium per pound than another medium staple (25-30 mm fiber length) cotton.

Development of Superior Sea-Island Cotton Cultivars for a Specialized Market

The objectives of this research project are: (1) to test new Sea-Island cotton lines with superior fiber quality in New Mexico for their yield potential and fiber quality; (2) to further improve the lint yield and fiber quality of the existing Sea-Island cotton; and (3) to provide technical assistance for seed production.

An extra-long-staple Sea-Island cultivar NMSI 1331 was released from NMAES. Sea-Island belongs to Gossypium barbadense and produces extra-long-staple (>35mm). New Mexico cotton growers have enjoyed growing an NMSI cultivar for the Japanese market.

Introduction and Testing of Exotic Glandless Cotton Germplasm in New Mexico

Since 2010, this project has evolved from the introduction and testing of glandless cotton germplasm lines to develop glandless cotton cultivars and lines with high yield, good fiber quality, and disease resistance.

The cottonseed has been treated as a by-product of cotton fiber production. However, cottonseed oil and protein can be a good source of nutrients for human consumption and animals if the toxic gossypol (contained in glands) is removed. Developing glandless cotton cultivars with high yield, good fiber quality, and disease resistance can genetically solve the problem. Fusarium wilt race 4 resistant, glandless cultivars NuMex COT 15 GLS (2016) and NuMex COT 17 GLS (2018), and glandless long-staple cultivar Acala 1517-18 GLS (2018) were released by NMAES.

Glandless cottonseeds can be used as human food and feed for non-ruminant animals, which will bring added value to cottonseed. Texas is currently growing NM glandless cotton cultivars in a limited acreage. Importantly, the two Fusarium race 4 resistant cultivars have become an important source of breeding effect for race 4 resistance in the U.S.

NEW MEXICO SOIL HEALTH AND ENVIRONMENTAL QUALITY

Investigators: April Ulery, Plant and Environmental Sciences

Inadequate water, environmental contamination, and poor soil quality plague New Mexico. NMSU's Soil Chemistry lab analyzed plants, water, and soils for at least 10 major agricultural and environmental projects representing over $500K in grant funding and hosting at least 12 graduate and undergraduate student assistants who designed and tested management strategies to improve water use, soil quality, and sustainable practices like composting and alternative water use to irrigate bioenergy crops. Greenhouse studies demonstrated that certain oilseed crops absorb uranium and radium, and may contribute to the remediation of mine tailings. COVID restrictions limited lab use and slowed down analyses.

NEW MEXICO VITICULTURE PROGRAM

Investigators: William ("Gill") Giese, Extension Plant Sciences/Los Lunas Agricultural Science Center

LAVIGNE PROJECT

Growers within the state are using or considering the use of LalVigne on their vineyards. The inactivated yeast product (~$100.00/acre) is reputed to enhance and advance the maturity of wine grapes. The goal of this project is to test the efficacy of this product in collaboration with Scott Labs, Petaluma, CA under New Mexico vineyard conditions. The applications were replicated and compared to untreated controls in up to six cultivars over three seasons (2018-20). Grape berry chemistries were measured in-house at Fabian Garcia and by an independent lab (ETS, St. Helena, CA) for phenolic (tannins and red color) and glutathione (flavor precursor in white grapes) levels. This project is in the final stages and data will be compiled and released to growers for incorporation into their management decisions and submitted to the peer-reviewed journal "Catalyst" (American Society of Enology and Viticulture).

PHENOLOGY OF NINE CULTIVARS

The Fabian Garcia vineyard houses ~40 V. vinifera, and hybrid cultivars that are available to growers and gardeners for performance assessment under southern New Mexico conditions. Specifically, NMSU viticulture is tracking the seasonal phenological development of 9 selected wine grape cultivars in partnership with NGRA (National Grape Research Alliance, Sacramento, CA) who is tracking the same cultivars at several locations throughout the US. The growing degree days and phenological stages at the site are recorded to determine cultivar suitability within New Mexico. Phenological data is compiled, over-laid, and correlated with weather data to determine the environmental influence on the phenological development of these wine grape cultivars in New Mexico. Growers and investors can use this data for site and cultivar selection and vineyard management planning.

GROUND COVER VINEYARD SOIL HEALTH PROJECT

Various ground covers are compared to a cultivated control within the vineyard to determine impacts on Malbec wine grapes (yield and quality), vineyard soil health, the occurrence and frequency of pollinators, and beneficial insects. The standard practice in New Mexico vineyards is that of monoculture cropping of grapes with clean cultivated row middles. We are investigating the impact and practical feasibility of using cover crops and simultaneously measuring any effects the ground covers may have on the yield and primary grape chemistries at harvest. Beyond soil health enhancement and possible eco-services provided by vineyard cover crops is the likely insect biodiversity supported by this approach within New Mexico vineyards. Other possible research questions include the potential for carbon sequestration, destructive insect issues, and/or support of beneficial insects as well as water use impacts of the vineyard ground covers. This project is in its early stages and is designed as a multi-year, ongoing research platform for multi-disciplinary graduate students. Funding is partially provided by a NIFA grant in collaboration with IPM Extension Specialist, Dr. Amanda Skidmore. Ultimately, the findings are important for grape growers seeking sustainable viticulture goals in New Mexico and throughout Southwestern US.

WINE MAKING CLASS

NMSU Viticulture hosts and facilitates the lab session of Agriculture Economics 458 (Wine Production and Marketing for Boutique Wineries) every fall semester. In 2020 this class was exclusively offered to NMSU registered students. However, In a non-Covid year, this class is offered jointly as a public workshop. Students gain exposure and "hands-on" learning of the entire process of winemaking from grape harvest, applied grape and wine lab analyses, fermentation, finishing through bottling. This curriculum is made relevant and possible via the NMSU teaching vineyard and functioning grape and fermentation lab at Fabian Garcia ASC.

ALGAE RESEARCH

Investigators: Omar Holguin, Plant and Environmental Sciences

Over the past year, we have made significant infrastructure upgrades to the algae testbed facility and Fabian Garcia Science Center. These infrastructure investments have allowed us to maintain constant activity in the DOE biofuel portfolio by providing outdoor algae cultivation. Currently, Dr. Holguin serves as one of the co-investigators on the following two DOE grants being facilitated at the Fabian Garcia outdoor algae testbed. An outdoor facility at this scale is rare and is a facility resource that will allow us to have continued partnerships in the future.

Optimizing Selection Pressures and Pest Management to Maximize Algal Biomass Yield [OSPREY]

Award Number: DE-EE0008902

This DOE award is a four-year project lead by Dr. Alina Corcoran, an NMSU affiliate faculty, and built around outdoor cultivation. The team consists of one national lab partner Los Alamos National Lab, three industrial partners Cyanotech Corporation Kailua-Kona, HI), Phase Genomics, Inc. (Seattle, WA), Qualitas Health, Inc. (Imperial, TX), and three University Partners Colorado State University (Fort Collins, CO), New Mexico State University (Las Cruces, NM), University of California San Diego (San Diego, CA). Fabian Garcia is one of four outdoor testbeds involved in this project. The goal of the project is to make algal strains more productive and resilient to environmental stressors. Total award funding is $5M.

Success through Synergy: Increasing cultivation yield and stability with rationally designed consortia

Award Number: DE-EE0008122

This DOE award four-year year project led by Dr. Starkenburg, a LANL scientist, is built around communities of algae and bacteria to increase overall pond health and productivity. The team consists of Los Alamos National Lab and NMSU. Fabian Garcia is the only outdoor testbed involved in this project. The goal of the project is to make algal strains more productive and resilient to environmental stressors. Total award funding is $2.5M.

GUT BIOAVAILABILITY OF MEDICAL FOODS AND HIGH-VALUE COMPOUNDS

Investigators: Ivette Guzman, Plant and Environmental Sciences

Simulated human digestion and intestinal cell culture experiments have been used for over 20 years in pharmacological industries to understand how the gut metabolizes, breaks down, and absorbs pharmaceutical drugs. Our research group is modifying this in vitro system to measure the pharmacokinetics of food medicinal compounds. Chile carotenoids, hemp cannabinoids, algae omega-3 fatty acids are a few of the compounds that are being analyzed after human gut digestion and uptake by human intestinal cells. Native plants like sumac berries, Navajo Tea, and New Mexican goji berries will also be analyzed after digestion. Chile peppers are grown at the Fabian Garcia Science Center.

Because only 17.4% of New Mexicans are consuming five or more vegetables per day, the need to explore how our bodies digest New Mexico crops is important to assess their health-promoting properties. Chile, hemp, algae, and New Mexican native plants contain edible compounds that are health protective and may prevent chronic disease. The data revealed that in a vitro digestion system, chile and hemp consumed with foods like olive oil increased the percent gut uptake of their medicinal compounds. This research will impact how farmers, food industries, consumers, and families grow, harvest, prepare and consume plant foods.

BLUE CORN VARIETAL SELECTION – PART OF THE SOUTHWEST GRAIN COLLABORATIVE-CROPPING SYSTEMS RESEARCH PROGRAM

Investigators: Richard Pratt, Plant and Environmental Sciences

. Funded in part by NMSU Foundation current-use fund. Tepary bean regional trial in cooperation with NRCS (CA, UT) and the University of Nevada, and Oklahoma State University. This research was partially supported by the USDA NIFA Hatch project (Accession 1010445) entitled "Tepary bean: a prospective non-thirsty forage and cover crop."

A replicated trial of 12 tepary bean varieties was planted as part of a five-state regional trial to determine the suitability of tepary as a cover/forage crop in the semi-arid western USA. Growth and canopy-cover of all entries were excellent and samples were obtained for forage nutritional quality. (Results are not back yet).

Blue Corn varietal selection for heat-stress tolerance and overall grain quality was undertaken in one short-season heirloom blue corn variety. A total of 342 ears were harvested and 95 ears were selected for recombination and distribution to grower-collaborators in the Southwest Grain Collaborative.

MICRO GRAVITY DRIP IRRIGATION SYSTEM IN LEYENDECKER

Investigators: Manoj K Shukla, Adam Gonzalez, Research Assistant; Rosa Villalba, Undergraduate student tech; Plant and Environmental Sciences

A new project on improving water use efficiency was started in March 2020 in Leyendecker Plant Science Center. The experimental site is about 2.8 acres and is located on the north-east corner of the Leyendecker farm. About 105 one-year-old pecan trees were planted in six rows in April 2020. Sixteen rows of chile were planted during the last week of April. Two rows of drip tapes are installed for Pecans at a distance of 3 ft, while one row of drip line was installed on each chile bed at about 2-inch depth. The microgravity drip irrigation (fertigation) system was installed by NDrip, Israel. Drippers are designed to work with low (<0.87 psi or 0.06 bar) pressure and the entire system is completely recyclable. Microgravity drip system installation cost is about $900-1000 per acre for row crops (40-inch spacing) and about $600-$650 per acre for tree crops (30-foot spacing). Pressurized drip system costs about $2500 per acre.

Tal-Ya another Israeli company provided 50 trays and 30 of them are installed in May in Pecans. Another 14 trays were installed in the chile field. We are testing the trays for their potential of water-saving, weed control, increases in the rate of physiological growth, and durability of trays.

The research includes two irrigation rates 100% (control or typical for Las Cruces area) and 80% of control. Soil, plant, and water samples were collected and analyzed. The biomass and pod yields are also measured determined. Data analysis is currently ongoing. This research on improving water use efficiency is important for southern New Mexico as freshwater availability is becoming increasingly scarce. The experimental site also serves as a hands-on demonstration of water conservation innovation.

The project is supported by the Nakayama Professorship endowment and Center of Excellence for Sustainable Food and Agricultural Systems (CESFAS).

ALFALFA GENETICS RESEARCH IMPACTS WATER USE AND CONSERVATION, AND FOOD AND FIBER PRODUCTION

Investigators: Ian Ray, Plant and Environmental Sciences

Leyendecker Farm: Water resources for irrigated agriculture are rapidly diminishing worldwide. For more than 40 years, NMSU has used traditional and molecular breeding strategies among thousands of experimental populations to develop drought-resilient alfalfa varieties to help farmers conserve water and meet the livestock industry's feed demands. The long-lived nature of alfalfa requires our program to collect data over three years for every field-based research study. This mimics the production cycles of our clientele, New Mexico alfalfa growers. Current research involves federal and private-industry sponsored projects with yield data collected from more than 1,500 field plots multiple times throughout each year (total of ~ 5,000 plots harvested annually). Many field plots are also sampled to determine their nutritional value. Extensive DNA sequence databases have also been developed for hundreds of these populations to help us to identify genetic factors influencing drought tolerance and forage nutritive value. Seed increases for nine advanced populations are also underway to allow us to test these new materials in state-wide and region-wide yield trails to determine their commercial potential. Our drought-resilient alfalfa cultivar, NuMex Bill Melton is being commercially marketed in NM with estimated hay sales valued at $500,000 annually.

Fabian Garcia: The NMSU Alfalfa Breeding and Genetics program currently maintains 500+ greenhouse plants at the Fabian Garcia Research Center. Many of these plants are the parents (i.e. seed producers) of multiple private industry-sponsored field research projects. Seed from these plants is used to establish field research studies involving hundreds of replicated elite alfalfa populations. These populations are then extensively characterized for yield productivity under deficit irrigation management and nutritional value. DNA is also isolated from the greenhouse parent plant tissue and used to develop extensive DNA sequence databases. Integrated analysis of DNA sequence and field-based data are conducted to help us identify genetic factors influencing drought tolerance and forage nutritive value to develop drought-resilient alfalfa cultivars for the arid southwestern U.S.

The agricultural science centers at Artesia, Los Lunas, Farmington, and Tucumcari participate in the field evaluation studies of alfalfa.

REDUCED TILLAGE AND COVER CROPS ENHANCE FARMERS PROFITABILITY AND ENVIRONMENTAL SUSTAINABILITY

Investigators: John Idowu, Extension Plant Sciences, and Kulbhushan Grover, Plant and Environmental Sciences

Sustainable soil management is challenging in arid and semiarid agroecosystems. Major issues affecting the sustainability of arid farming are the frequent, intensive tillage operations for crop production in the region and the lack of cover crops during the period of intense wind erosion in the spring. The intensive tillage operations practiced in the region and wind erosion, normally lead to degradation of soil health, necessitating a yearly increase in production input costs to compensate for the lost productivity. Through applied research, this program documented that different reduced tillage practices such as no-tillage and strip tillage, combined with yearly cover crops can maintain field crop yields in the region and reduce the impacts of wind erosion. This research program established that reduced tillage systems can save farmers up to $100 per acre on the cost of tillage practices and with the application of winter grasses as cover crops, sediment loss by wind erosion can be reduced by up to 92%.

Guar and guayule are industrial crops capable of providing alternative income streams for farmers in New Mexico. Through the agronomic optimization of these crops, farmers can be assured of maximum yields of guar and guayule from their farm fields. This research will help farmers have the information they need to grow guar and guayule successfully in New Mexico. Growing these industrial crops in NM will help farmers to increase their farm income and promote the sustainability of farms in NM.

Rotational benefits of guar in cropping systems of NM - Some studies have shown that guar as a rotational crop provides yield and soil quality benefits to crops that follow it in a rotational plan. However, specific savings and net economic benefits have not been quantified. Beyond the current studies, we plan to conduct research that will quantify the benefits of guar in a rotational system. Such information would be helpful for farmers who are seeking to reduce input costs associated with soil management.

These studies are being conducted at Leyendecker PSRC, and the Agricultural Science Centers at Artesia, Los Lunas, and Clovis. Research collaboration includes the University of Arizona.

SYSTEMS APPROACH AT IMPROVING THE LONG-TERM COMPETITIVENESS OF U.S. PECANS BASED ON THEIR NUTRITIONAL AND HEALTH-PROMOTING COMPONENTS

Investigators: Richard Heerema, Extension Plant Sciences; with Blair Stringam, Plant and Environmental Sciences, and Alexander Fernald, Animal and Range Sciences

Among the tree nuts, pecans have the highest antioxidant activity and unsaturated fatty acid content, which contribute to their favorable nutritional profile. This has piqued a great deal of interest among researchers, industry marketers, and health-conscious consumers. The biochemical makeup of pecan kernels varies as a function of cultivar, environmental conditions, crop load, and horticultural practices. Thus, there could be management techniques for producers to maximize nutraceutical composition in pecan kernels. It would be especially appealing for pecan growers if such production techniques were also known to have positive impacts on crop yield, other nut quality parameters, or overall tree health.

As part of a graduate student's master's thesis research, a field study was conducted in which pecan trees were fertilized with ethylenediaminetetraacetic acid (EDTA) chelated zinc three seasonal rates for a total of three treatments: 0 (control), 2.2, or 4.4 kg·ha−1 Zn. Nut samples were hand-harvested for two cultivars in two seasons and analyzed for kernel oil yield, hydrophilic antioxidant capacity, fatty acid profile, and γ-tocopherol content.

The 2.2 and 4.4 kg·ha−1 Zn treatments' kernel oil contents were, respectively, 2.5 and 3.1% points higher than that of the untreated control. Furthermore, kernels from the 2.2 kg·ha−1 Zn treatment had a significantly higher proportion of monounsaturated fatty acids than the control, but kernels from the 4.4 kg·ha−1 Zn did not have a significantly different monounsaturated fatty acid proportion from the control. Both the 2.2 and 4.4 kg·ha−1 Zn fertilizer treatments had significantly higher kernel γ-tocopherol content than for the control.

Assuming the 28 g serving size for pecan used by the USDA National Nutrient Database a consumer eating pecan kernels would ingest ≈0.9 g more cardiovascular health-promoting pecan oil per serving if the nuts came from trees grown under 4.4 γ-tocopherol content treatment than if they were grown under the untreated control conditions. Furthermore, the increased γ-tocopherol may provide added vitamin E activity, antioxidant activity, and anti-inflammatory activity to the pecan kernels. The positive effects on human health-promoting aspects of pecan kernels from soil application of Zn are valuable to pecan growers and distributors for product promotion amongst health-conscious consumers.

COORDINATED DEVELOPMENT OF GENETIC TOOLS FOR PECAN

Investigators: Richard Heerema, Extension Plant Sciences, and Jennifer Randall, Entomology, Plant Pathology, and Weed Science

The genetics of pecan is poorly understood and genetic improvement takes decades to make even small improvements. A better understanding of pecan genetics will allow faster improvement to pecan cultivars and rootstocks. Potentially pecan genotypes that are better suited to New Mexico's semiarid environment will allow producers to maintain yields and profitability even in the face of limited irrigation water resources, salinity, and alkaline soil pH. This project has collaborators from Texas A&M University, University of Arizona, University of Georgia, USDA Agricultural Research Service, Hudson Alpha, and the Noble Foundation.

PECAN ROOTSTOCK FIELD TRIAL

Investigators: Jennifer Randall, Entomology, Plant Pathology, and Weed Science

Clonal Pecan Rootstock Field Trial

Private Industry (San Simone Research Group); USDA SCRI 2016-51181-25408.

Clonal pecan rootstock trees that were derived by micropropagation are planted as a field trial at Leyendecker (New Mexico State University) and in Bowie Arizona. On June 3, 2019, we planted approximately 130 clonal pecan trees for field observation. The rootstocks are being evaluated for their performance in the field and growth measurements were taken this year. We anticipate that they will be budded to a scion to further evaluate graft compatibility. Plans are in place to plant an additional 200 clonal pecan trees during the spring of 2021

Flowering Genetics

USDA SCRI 2016-51181-25408.

During the past several years Wichita and Western trees were utilized for RNA-Seq experiments to determine gene expression and used to determine the timing of flowering initiation in pecan protandrous and protogynous trees. This work has resulted in several posters and oral presentations at National and International meetings. Dr. Hormat Rhein completed her Ph.D. October 2020 with her dissertation (abstract at the end of the report) focused on flowering using the trees at Leyendecker. Three publications are in progress to be submitted to disseminate the results of this work.

Mitigation of Alternate Bearing in New Mexico Pecan Trees Grown Under Deficit Irrigation

USDA Specialty Crop Block Grant NMDA-2017-2021.

Alternate bearing is caused by fluctuations in the number of female flowers produced in tree canopies. Flower development in pecan trees occurs when vegetative tissues transition to flowers. The genetic signals that cause this transition occur before visible flowers on pecan trees. In our previous work, we obtained better resolution for the timing of alternate bearing mitigation approaches. As water is becoming more limiting to our pecan growers it is essential to understand the effect that lack of water will have on pecan nut production. In this study, we plan to evaluate the effects of lack of water on flower induction in pecan that will directly relate to yield production for growers. In this study, we plan to utilize analytical chemical methods to measure specific carbohydrates such as trehalose-6-phosphate and abscisic acid that may directly impact the fitness of the tree for flower production and ultimately gene expression for flower induction. The data from these studies will allow us to determine the effects that limiting water usage will have on pecan nut production. This will also help our understanding of how this will affect alternate bearing in pecan and to determine if the plant growth regulator delivery that we previously investigated can be used to mitigate alternate bearing in water-stressed trees as with non-water stressed trees. As water becomes more limiting for agriculture these studies are imperative for understanding the effect that water has on flower induction in pecan and ultimately pecan nut production. **We are evaluating and measuring the impacts of deficit irrigation on pecan tree flower production in Pawnee trees. This will allow us to understand the role drought stress has on pecan nut production.** We reported in 2020 that the deficit irrigated Pawnee trees produced 25% fewer nuts than the control irrigated Pawnee trees.

Revealing the New Mexico pecan root-soil microbiome to improve plant health and productivity ACES Competitive Funding 2020-2021. (R. Heerema, J. Randall, N. Pietrasiak).

Pecan tree roots and soil were collected from selected trees at Leyendecker to include in microbiome analysis. These samples were used to extract DNA that will be sent for microbiome analyses.

Summary of effort: Pecan roots lack root-hairs which allow many other plants to more efficiently explore and exploit the soil for resources such as nutrients and water. However, pecan roots can form symbiotic relationships with mycorrhizal fungi that might serve a similar function as root-hairs by dramatically increasing the volume of the soil "mined" by the tree's root system. Currently, very little is known about the occurrence and kinds of mycorrhizal fungi species forming associations with pecan roots in the Southwestern US or how orchard soils, irrigation systems, and orchard management practices may affect their presence/absence. In this study, we will document the diversity and abundance of the microbes (including mycorrhizae) associated with pecan tree roots in the Southwest. We will furthermore evaluate the relationships of pecan tree micronutrients to the root microbiome and attempt to identify potential key microbes that could increase pecan tree health and productivity. We expect that this information will allow New Mexico pecan farmers to begin to conscientiously manage the root microbiome to their advantage. This work directly addresses the first NMSU ACES Pillar for economic and community development, Food and Fiber Production and Marketing, by addressing a potential solution for a major limitation to production and profitability of pecans, one of the most important economic contributors to New Mexico's agricultural industry

BIOLOGY AND MANAGEMENT OF PLANT-ASSOCIATED VIRUSES AND ENDOPHYTIC FUNGI IN NEW MEXICO

Investigators: Rebecca Creamer, Entomology, Plant Pathology, and Weed Science

Beet curly top curtovirus (BCTV), which is transmitted by the beet leafhopper, causes losses in New Mexico to chile, tomatoes, and occasionally melons. This virus infects a broad range of hosts that include other crops and weeds in many plant families. Additionally, the leafhopper vector feeds and breeds on an extensive range of plant families. Our research on the genetics of the viruses has shown that several different curtoviruses infect crops and weeds in southern New Mexico, although the viral species have changed over the last 10 years. We identified novel curtovirus strains (pepper yellow dwarf virus and pepper curly top virus) infecting chile that have arisen by recombination. We showed that pepper yellow dwarf was prevalent in weed hosts as well as peppers, and proportionally increased compared to other curtoviruses from 2001 through 2005. Our work has demonstrated the very high level of variability and recombination found in curtoviruses compared to other plant viruses and showed that the variability does not appear to be associated with a single plant host. However, we have not determined what factors are controlling the high levels of recombination.

The beet leafhopper transmits BCTV, but the mechanism of transmission is not well understood. Precisely where and how the leafhopper needs to feed to transmit the virus is not known. Similar viruses have been shown to require the mediation of insect gut endosymbionts for transmission, as well as specific protein interactions between insect and viral capsid. We are currently studying the interactions between viruses, insects, and plants. Our current work has identified endosymbionts of the leafhopper rand led us to study the relationship between a bacterial endosymbiont protein and the viral coat protein. To understand the movement of the virus we have researched the insect vector.

The research activities at Leyendecker PSRC are part of a long-term (20 years) project to monitor beet leafhopper's presence around chile fields. Monitoring was done using 4 sets of yellow sticky traps that were changed weekly in March - October and every 2 weeks all other months. Beet leafhoppers were counted from each trap and summarized by week. Leafhoppers were also collected via sweep net weekly mid-May through late October. Data from 2019 and 2020 will be included in a paper that characterizes patterns in leafhopper activities at Leyendecker.

MARKER-ASSISTED BREEDING IN ELITE ALFALFA GERMPLASM TO ENHANCE BIOMASS PRODUCTIVITY DURING DROUGHT

Investigators: Ian Ray, Plant and Environmental Sciences

A major goal is to develop and utilize molecular tools to accelerate the breeding of alfalfa varieties with enhanced yield potential, forage quality, and suitable fall dormancy for drought-prone regions of the U.S. In this regional project, 215 elite NMSU alfalfa families have been genetically characterized with 12,884 DNA markers. These materials are also being evaluated for biomass productivity and other traits under deficit irrigation management conditions over 3 years in NM (Leyendecker PSRC), CA, and WA. Integrated analysis of DNA marker and biomass data is being conducted using association mapping and genomic selection modeling to identify plants with the greatest genetic potential to improve alfalfa drought resilience.

NM alfalfa variety evaluation trials

Evaluate forage yield performance of 24 commercial varieties and advanced NMSU breeding lines under standard irrigation management (trial 1) and summer irrigation termination management (trial 2) over 3 to 4 years. The goal is to identify populations that can perform well under variable irrigation management to help NM farmers conserve water.

Proximal Sensing for Modeling Development Curves and Accelerated Breeding of Climate Resilient Crop Varieties

The goal of this proposed research is to develop tools and approaches that can accelerate breeding for crop resilience to changes in climate. We will collect multispectral aerial imagery data, as well as forage yield and nutritional quality data from 24 alfalfa varieties grown under well-watered and deficit-irrigation management over two years. These data will be integrated with extensive DNA marker genotype data for each alfalfa variety for use in building open source software to extract and store high throughput phenotyping information and fit genotype-specific growth curves throughout the growing season in optimum and drought-stressed environments. Data will be analyzed to determine the extent to which crop aerial imagery data correlates to stable performance in varying environmental conditions.

Seed increase for regional evaluation of the commercial potential for advanced NMSU alfalfa breeding lines

Conduct bee-pollinated breeder seed production under cage isolation for multiple elite NMSU alfalfa populations to ensure sufficient seed is available to evaluate these materials for commercial acceptability in statewide and regional variety trials.

GENETIC IMPROVEMENT OF CHILE PEPPER (*CAPSICUM SPP.*) GERMPLASM FOR NEW MEXICO

Investigators: Dennis Lozada, Plant and Environmental Sciences

The NMSU chile breeding and genetics program aims to improve chile production in New Mexico through the development of genetically superior cultivars. It integrates different approaches such as marker-assisted selection, high-throughput phenotyping, and genomic selection to drive the process of genetic improvement of chile peppers. The research and breeding outcomes of the program benefit growers, processors, and ultimately the consumers. The research program is the leading breeding and genetics program of chile in the world and is held in high regard by colleagues worldwide. We strive to provide fresh and relevant results to our stakeholders. Our chile cultivars make a significant difference in helping to overcome obstacles faced by the chile industry of New Mexico. High-quality cultivars that have a direct economic impact on New Mexico's Chile-based foods and value-added products have been developed in the past. The program has continued to be a proactive partner with the New Mexico chile industry, aggressively seeking to maintain the best possible representation of our iconic crop. A breeding and genetics program is ongoing and long-term, with objectives that are modified as the industry changes. For the 2020 growing season, replicated trials for Phytophthora-resistant Heritage Big Jim were conducted at the Leyendecker Plant Science Research Center, Las Cruces, NM. Single plant selections of cayenne, paprika, and New Mexican pod-types are also currently evaluated for yield, disease resistance, flavor, and heat profiles.

Breeding new, higher-yielding, resistant to pests and diseases, and heat and drought-resistant varieties will ensure continuous production of chile peppers in the state. In New Mexico, the processing of chile pepper is nearly a $500 million industry. Chile wilt caused by Phytophthora capsici and Verticillium dahliae can destroy up to 100% of a farmer's field. Resistant cultivars, which do not add cost to the seed, are arguably the best way to manage diseases. Higher-yielding breeding cultivars and pest and disease resistance increase production efficiency and can save on costs. The NMSU chile pepper breeding program has developed many improved New Mexican chile pepper varieties in the past. Chile cultivars developed at NMSU make a significant difference in helping to overcome obstacles faced by the chile industry of New Mexico. As a result of the NMSU chile breeding program, high-quality cultivars that have a direct economic impact on New Mexico's Chile-based foods and value-added products were developed and released. The program has continued to be a proactive partner with the New Mexico chile industry, aggressively seeking to maintain the best possible representation of our iconic crop. A breeding and genetics program is ongoing and long-term, with objectives that are modified as the industry changes.

The long-term objective of this project is to develop varieties of chile pepper with improved yield and disease resistance through classical phenotypic selection, marker-assisted breeding, and high-throughput phenotyping. The goal will be to provide new chile pepper cultivars to New Mexico growers so that they will be competitive in a global market. Along with the cultivar releases, manuscripts will be published on our research in peer-reviewed international journals. Research on molecular breeding techniques will produce novel and patentable DNA-based markers that can be licensed by NMSU for use by other breeders. The decision to a patent will be reached in consultation with AES and NMSU Intellectual Property Office.

COVER CROPS IN THE SOUTHWEST: OBTAINING ECOSYSTEM SERVICES WHILE MINIMIZING WATER USE

Investigators: E. Lehnhoff1, J. Idowu2, S. Sanogo1, B. Schutte1, N. Pietrasiak2, S. Thomas1 and J. Libbin3

1 New Mexico State University, Department of Entomology, Plant Pathology and Weed Science
2 New Mexico State University, Department of Plant and Environmental Sciences
3 New Mexico State University, Department of Agricultural Economics and Agricultural Business

POTENTIAL IMPACT(S)

It is well known that winter cover crops planted in lieu of winter fallow reduce wind erosion, improve soil structure, enhance fertility, and facilitate pest management. Yet, growing winter cover crops requires water which is scarce. The purpose of this project is to investigate how we can minimize irrigation inputs while still obtaining adequate cover crop agroecosystem services including enhanced soil health, weed seed bank depletion, reduction in weed competitiveness, disease suppression, and increased crop yield. The goal is to be able to produce beneficial cover crops while greatly reducing irrigation water usage.

In 2017, New Mexico farmers spent $489 million on inputs (excluding animal feed), and a large portion of this was for inputs such as nitrogen fertilizer (63,000 tons). Not all fertilizer applied is used by crops, and much is lost over the winter or leached by spring irrigation. Cover crops can significantly reduce fertilizer requirements because they are grown without supplemental fertilization, scavenge nutrients from the soil and prevent leaching of soluble nutrients. Furthermore, leguminous crops (through a relationship with soil bacteria) fix atmospheric nitrogen, providing a free source of this essential nutrient. When these crops are terminated and incorporated into the soil in the spring, nutrients slowly release and are available for crops. Management of pests such as weeds and pathogens is another major crop production expense. Irrigation in any cover crop will reduce the weed seed bank as weed seeds germinate but do not survive the cover crop phase. Also, some crops such as rye or barley may have allelopathic effects preventing weeds seedlings from surviving, even after the cover crops have been terminated. Finally, Brassica cover crops act as biofumigants and can be very effective at suppressing soil-borne diseases.

This project will provide us with the data to promote the use of cover crops and make recommendations for best management practices, even in this area where irrigation water is severely limited. Results will be presented at local and regional crop production meetings, leading to increased adoption and impact throughout the state.

METHODS

Four irrigation amounts (i.e., four separate irrigations of ~8 cm) and four cover crop types (barley, mustard, pea, and 3-way mix) are planted in a split-plot design with four replications. We are assessing changes to soil physical, chemical, and biological properties, impacts on the weed seed bank and weed growth, and yield of the cash crop, sweet corn over two years. Physical soil properties being assessed include wet and dry aggregate stability which are measures of water and wind erosion. Chemical properties include a suite of soil nutrients such as N, P, and K. For soil biology, we have collected samples to evaluate total microbial composition, beneficial fungi and pathogenic fungi, and nematodes. We are conducting greenhouse experiments to evaluate cover crop effects on the soil-borne pathogen Phytophthora capsici. Weeds are assessed by counting seedlings during the cover crop growing season and harvesting and weighing weeds at cover crop termination. The effects of cover crops on weeds during cash crop growth are evaluated by comparing weed-free plots (managed with glyphosate) to unmanaged weedy plots and assessing weed cover and corn yield.

RESULTS

We have collected and analyzed two years of data. One of the most interesting results was that cover crop biomass was not influenced by irrigation amount, regardless of species or mix. We were able to grow similar biomass when cover crops were irrigated once (not counting initial irrigation to germinate seeds), twice or three times. While this is a positive result, it is likely the result of well-timed but unusual precipitation that fell during winter, reducing irrigation needs. Soil dry aggregate stability increased by an average of 34% in all cover crop plots compared to fallow, and wet aggregate stability in the 3-way species mix increased by 22% compared to fallow. Plots planted with a pea cover crop required 21 lb/acre less nitrogen to grow sweet corn than did fallow plots, resulting in a savings of ~$7/acre. Weed emergence after cover crop termination and before corn planting was reduced by an average of 67% compared to fallow plots, indicating the pre-emergent herbicides can be greatly reduced or eliminated, which would result in savings of ~$25 per acre. However, growers must be aware that elimination of pre-emergent herbicides, and relying solely on post-e mergent herbicides may increase the risk of weeds developing herbicide resistance.

With respect to cover crop impacts on soil-borne fungal pathogens, we have begun greenhouse and laboratory experiments. Results show that mustard cover crops have the potential to greatly reduce the growth of Phytopthora capsici, and the reduction is even greater when pots are covered with plastic to trap the mustard's volatile compounds. We are conducting similar experiments to test the efficacy of barley against P. capsici.

BUILDING A TRANSDISCIPLINARY RESEARCH PROGRAM FOR IMPROVED PEST MANAGEMENT IN ONION

Investigators: Brian Schutte, Entomology, Plant Pathology, and Weed Science

Onion production in New Mexico is challenged by weeds that reduce crop yield and provide refuge for insect pests and crop diseases. To identify new tools for controlling weeds in onion, NMSU researchers (1) evaluated candidate herbicides for onion, and (2) surveyed farmers and professionals for their preferences on new weed control tactics for onions. Farmers and professionals indicated strong support for specific herbicides that are projected to reduce the costs and potential environmental impacts of weed control programs for onions. These promising herbicides will be the focus of future research projects that will include further collaborations with farmers.

JUJUBE CULTIVAR TRIAL AND MARKETING

Investigators: Shengrui Yao, Chaddy Robinson, and Steve Guldan (sguldan@nmsu.edu, Plant and Environmental Sciences/Agricultural Economics and Agricultural Business/Alcalde Sustainable Agriculture Science Center

To find alternative ways to manage the late frost issue that challenges the fruit industry in New Mexico, we are testing jujube cultivar performance at different locations in New Mexico and recommend cultivars to growers in each location. Leyendecker is one of three jujube cultivar trial sites. The others are at Alcalde and Los Lunas centers. Growers and home gardeners are adopting this new crop and plant them in their yards or orchards.

DEVELOPING TOOLS FOR CONTROL OF LEPIDOPTEROUS PESTS IN THE FACE OF DEVELOPING RESISTANCE TO BT GENES

Investigators: Jane Pierce, Extension Plant Science

We are monitoring the level of resistance to Bt genes and developing alternative tools for controlling lepidopterous pests. In New Mexico, we have relatively high levels of environmental and biological control. Our desert environment with low relative humidity and high temperatures have a significant impact often producing 40-60% mortality. NMSU has produced several okra leaf cottons which could produce a microclimate that is hotter and drier than conventional cotton and result in higher mortality from desiccation in lepidopterous pests allowing an opportunity to provide an alternative means of control to Bt cotton or insecticides for NM cotton growers.

Results from field trials in 2020 indicate that bollworm mortality is often higher in okra leaf vs standard cotton varieties. Data collected throughout the season indicated an average of 70% control from desiccation vs 45% in the standard cotton leaf variety a 55% increase. We are also monitoring the development of resistance to Bt genes in New Mexico in commercial fields and research trials. VIP genes are still effective but even those most effective Bt genes have allowed the development of some bollworms in commercial corn fields indicating that resistance is inevitable and emphasizes the need to be prepared.

Reduction in insecticide use has numerous positive impacts for growers and the general public. Applicator safety reduced environmental impacts, and increased biodiversity and conservation of beneficial arthropods are benefits in addition to the more apparent cost savings from reducing inputs. As Bt corn and cotton become ineffective controls with the development of resistance it is important to have alternatives to conventional insecticides.

MANAGING SOILBORNE PLANT PATHOGENS

Investigators: Soum Sanogo, Entomology, Plant Pathology, and Weed Science

Production of vegetable crops such as chile pepper and onion, field and forage crops such as peanut and alfalfa, and nut crops such as pecan may be significantly reduced by diseases incited by soilborne pathogens. Effective control of these diseases requires knowledge of the ecology of their causal agents. Basic knowledge of the diversity of pathogenic populations, responses to abiotic factors, and interspecific microbial interactions is needed to enhance or develop management strategies of soilborne diseases in New Mexico crops. Studies on these aspects will provide producers with preparedness information to gauge the threat from new diseases and employ appropriate management options to protect and increase the socio-economic benefits from agricultural production in New Mexico.

Multi-scale experiments in greenhouse, NMSU Ag Experiment Station fields, and producers' farms are being conducted to evaluate the efficacy of biorational approaches on reducing the activities of soilborne pathogens in various crops including fruiting and non-fruiting vegetables, fruit and nut tree crops, and other crops such as cotton, peanut, and alfalfa.

Interest in non-chemical approaches for managing soilborne pathogens has increased, with several producers using microbial formulations. The use of these biorational approaches will safeguard environmental health and biological diversity in production systems while enabling producers to secure profitable returns in a sustainable production environment.

Crops such as chile, onion, peanut, cucurbits, alfalfa, cotton, and pecan generate annually more than 200 million dollars to the state of New Mexico. Currently, production is significantly reduced by soilborne diseases, which can wipe out crops and reduce yield up to 100%, therefore limiting monetary returns to producers and revenues to New Mexico. Studies on soilborne pathogens provide producers with preparedness information to gauge the threat from new diseases and employ appropriate management options to protect and increase the socio-economic benefits from agricultural production in New Mexico.

OTHER RESEARCH/ EDUCATION PROJECTS

David Dubois; Plant and Environmental Sciences: weather station monitoring for climatology program
Colby Brungard; Entomology, Plant Pathology and Weed Science: soil pits for teaching soil science
Brad Lewis; NMDA: insect pest management studies
Salim Bawazir; Civil Engineering: deploying drone and sensors to complement pecan research
Zohrab Samani; Civil Engineering: collaboration with weather station instrumentation
David Johnson; Civil Engineering; natural organic fertilizer techniques

Activities

Due to COVID-19 restrictions, outreach activities were suspended in 2020.

Leyendecker PSRC Farm Manager Dave Lowry made a Zoom presentation to 2nd graders in California about agriculture and what is done at the Leyendecker PSRC. Their teacher is the granddaughter of Phillip Leyendecker, former Dean of the College of Agriculture and Home Economics (now ACES), for whom the Center is named.

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