

## FY 2020 Annual Report of Accomplishments and Results

<b>New Mexico</b>
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<b>New Mexico State University</b>
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### I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your FY 2020 Plan of Work located in the Institutional Profile. Use this space to provide updates if needed.

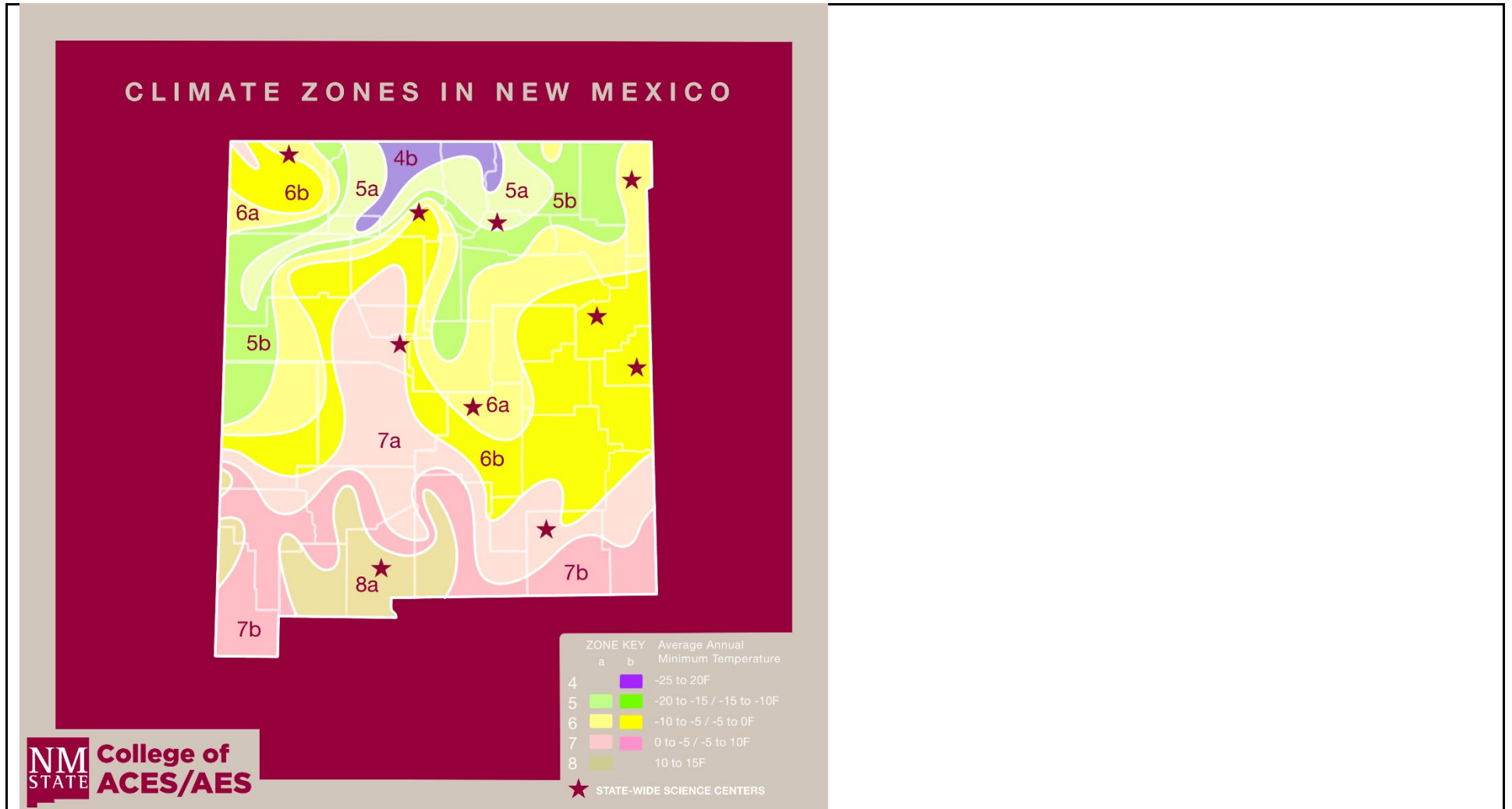
<b>1. Executive Summary (Optional)</b>
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New Mexico State University’s College of Agricultural, Consumer, and Environmental Sciences (ACES) has a mission to improve the lives of New Mexicans, the nation, and the world through research, teaching, and extension. Research and Extension programs focus on four identified critical issues for New Mexico that will also have a global impact. These planned programs are (1) Food & Fiber Production and Marketing, (2) Water Use and Conservation, (3) Family Development and Health of New Mexican, (4) Environmental Stewardship all of which are based on the foundation of education and training of qualified professionals in the field of agriculture.

NMSU Cooperative Extension Service has staff in all 33 counties and many Tribal areas in New Mexico and collaborates with over 1,000 organizations, state and federal agencies, other universities, and 10,000 volunteers.

Every year, Extension faculty reach over 550,000 New Mexicans—more than one-third of the state’s population—who benefit from wide-ranging CES educational programs in areas such as economic and community development, human nutrition and health, agriculture, environmental stewardship, and family and child development.

NMSU researchers and scientists conduct their research throughout the Agricultural Experiment Station (AES) system. This system consists of research on-campus and research conducted at agricultural science/research centers located around the state. New Mexico is unique with four crop production regions, 11 plant hardiness zones, five defined watersheds, and 126 distinct soil types. Therefore, agricultural production varies from north to south and east to west. Having strategically placed agricultural science centers allows NMSU research to inform agricultural producers from around the state about best practices and advancements specific to their climate zone.



Core programs and research areas are determined and guided by the identified critical issues in New Mexico. Researchers also respond to stakeholder requests throughout the year and respond to major scientific needs as they occur. In 2020, NMSU researchers collaborated with Sandia National Laboratories in response to the COVID-19 pandemic. Additionally, two large-scale environmental impact projects have been taken on by researchers in response to mass migratory bird loss in NM and rabbit hemorrhagic disease, both of which were well-publicized mass mortality events that could have broad environmental factors.

In 2020, NMSU broadened areas of research and Extension to focus on value-added agriculture in the state of New Mexico. New Mexico is a large agricultural producer, with limited processing options. Research and Extension programs are being developed to address this need and grow economic opportunities for producers and create educational experiences to have work-force ready graduates. See project summaries for examples of projects with a value-added component.

## II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Process	Updates ONLY
<b>1. The <u>Merit Review Process</u></b>	All projects conducted by AES and CES are subject to a merit-review process. Planned activities and research can be brought forward by faculty and/or specialists in response to an area of interest or high demand or can be brought forward by external advisory boards. These advisory boards provide suggestions to ensure research is meeting the needs of the communities that CES and AES serve in varying parts of the state.
<b>2. The <u>Scientific Peer Review Process</u></b>	All projects conducted by AES and CES are subject to a peer-review process. Planned activities and research can be brought forward by faculty and/or specialists in response to an area of interest or high demand by faculty. Faculty ensure that research is meeting stakeholder needs and upholding the research integrity of NMSU.

### III. Stakeholder Input

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA’s attention.

Stakeholder Input Aspects	Updates ONLY
<p><b>1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation</b></p>	<ul style="list-style-type: none"> <li>• NMSU AES adopted a strategic plan for each of the Agricultural Science Centers around the state. These strategic plans encouraged stakeholders to provide feedback/suggestions for a five-year research plan for each center. Specific objectives in the strategic plans align with New Mexico’s identified critical issues reported to NIFA.</li> <li>• All 33 County CES offices meet annually with the advisory board to review the previous year’s work and to get input on programming needs for the coming year.</li> <li>• Due to COVID-19, virtual communication efforts were used to keep in contact with stakeholders during advisory committee meetings and to seek additional feedback.</li> </ul>
<p><b>3. Methods to identify individuals and groups and brief explanation.</b></p>	<p>Stakeholders were identified by faculty and current stakeholder recommendations. Advisory board membership consideration is given to location, gender, and race to ensure broad representation.</p>
<p><b>4. Methods for collecting stakeholder input and brief explanation.</b></p>	<p>Please refer to Plan of Work, no updates.</p>
<p><b>5. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.</b></p>	<p>Input assists in determining research priorities and planning extension programming. Any stakeholder input is deemed valuable in helping guide programs forward. NMSU relies on stakeholders to learn about what has been tried and the degree of success or lack thereof.</p>

#### IV. Critical Issues Table of Contents

No.	Critical Issues in order of appearance in Table V. Activities and Accomplishments
1.	Food & Fiber Production and Marketing: addresses the production, protection, and marketing of plant and animal products. College of ACES faculty and staff foster technological innovation to enhance competitiveness and security of New Mexico agriculture, and increase value-added in the state.
2.	Water Use and Conservation: Water is the most limiting resource for New Mexico. All aspects of water use affect agricultural efficiency, profitability, and human health. Water management will become more critical as water demands for urbanization and industrialization increase.
3.	ACES' Family Development and Health of New Mexicans: the family is the fundamental institution of society. The College of ACES researches human behavior, child and adolescent development, human nutrition and food science, clothing and textiles, and family resource management. The College's research and Extension programs on human nutrition and wellness are aimed at keeping people from becoming ill and are likely considered "preventive medicine" programs.
4.	Environmental Stewardship: Rural and urban human activities affect land, water, and air. Through teaching, research, and extension programs, the College of ACES is committed to furthering our understanding, using science-based knowledge, of human impacts on the environment and supporting environmentally-sound agricultural and natural resource practices

#### V. Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). In your outcome or impact statement, please include the following elements (in any order): 1) the issue and its significance (e.g. who cares and why); 2) a brief description of key activities undertaken to achieve the goals and objectives; 3) changes in knowledge, behavior, or condition resulting from the project or program's activities; 4) who benefited and how. Please weave supporting data into the narrative.

No.	Project or Program Title	Outcome/Impact Statement	Critical Issue Name or No.
<b>Food &amp; Fiber Production and Marketing</b>			
1.	Food Bioengineering Technology of Agro industrial Products	High quantities of agro-industrial food waste are generated in the food supply chain, especially during food harvesting, transportation, and processing. For this reason, the Food and Agriculture Organization (FAO) recommended conducting research related to utilization and value-added products based on food waste. Agro-industrial waste is rich in fiber, sugars, and proteins, and is normally used as biofuel, biofertilizer, and animal feed. Oleosin is a protein fraction present in glandless cottonseed meal (GCSM) and is responsible for the emulsifying properties in GCSM. In this work, hydrolyzed agro-industrial wastes from chili,	Food & Fiber / Value-added

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		sugarcane bagasse, and GCSM are used as liquid culture mediums to grow the modified yeast <i>Yarrowia lipolytica</i> to express oleosin from glandless cottonseed protein. We observed that GCSM produces the highest density of yeast at around 20 grams per liter at 96 hours of inoculation. Also, a high number of oil bodies were observed under confocal microscopy after being stained with Red Nile dye compared with the other agro-industrial food wastes. The use of hydrolyzed food waste is an economical and sustainable alternative to be employed as a culture medium and add-value to Agroindustrial byproducts. The proposed technology is also useful in obtaining specific heterologous proteins, single-cell proteins, and single-cell oils derived from the yeast.	
2.	Effect of cover crop on-farm profitability and risk in the Southern High Plains	Farming practices that involve leaving land fallow for extended periods (nine to thirteen months), rising aridity, and heavy wind increase soil erosion (23.64 tons/acre) and reduce soil fertility. It costs New Mexico more than \$31.00/acre annually. Cover cropping enhances soil health by reducing erosion, weed density, soil compaction, and increasing soil organic matter, water retention, and nitrogen. However, because of the high cost of cover cropping, growers are reluctant to adopt the technology. An NMSU study shows that a \$50.00/acre subsidy through the 'Healthy Soil Program' would make cover cropping profitable and enhance sustainability.	Food & Fiber
3.	Addressing Food In-Security and Economic Development Challenges in New Mexico	Much of rural New Mexico struggles with food insecurity and economic development challenges. In response, CES along with a special legislative appropriation has launched an agribusiness accelerator pilot project in northeastern New Mexico, anchored by a three-acre demonstration and training farm. Project goals include increasing the supply, accessibility, and consumption of locally produced food, increasing value-added agribusiness activity and fostering entrepreneurship, business growth, and job creation in the region. Lessons learned from the project will inform future economic development efforts across the state.	Food & Fiber
4.	Genomics-assisted breeding for chile pepper improvement in New Mexico	Chile peppers ( <i>Capsicum</i> spp.) are considered a major crop in New Mexico, with the state question itself being "Red or Green?", pertaining to these valuable crops. Recently, total production in New Mexico has been decreasing due to the presence of pests and diseases, different weather patterns, and costs associated with labor, consequently affecting farmers and producers. Novel genomics tools	Food & Fiber

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		are currently being implemented at the NMSU Chile Pepper Breeding and Genetics program to drive genetic improvement. Recently, DNA sequencing discovered ~66,000 high-quality DNA markers in a population comprised of 235 diverse chile pepper lines. Diversity analysis using DNA markers revealed the genetic relationships among varieties previously released by the NMSU chile pepper breeding program. Information from DNA sequences will enable the selection and development of chile pepper varieties with improved characteristics for farmers and consumers.	
5.	New Mexico Soil Health and Environmental Quality	Field demonstrations found that bioenergy crops could be successfully grown with saline wastewater. Researchers also found that edible produce grown in the Animas River watershed is generally safe to consume, helping to restore confidence in our agricultural markets. A greenhouse study demonstrated that hemp, sunflower, and canola (all bioenergy crops), are capable of extracting uranium and radium from contaminated mine soils and may be effectively used in phytoremediation efforts and a far reduced cost compared to traditional cleanup methods. Another study showed that adding duckweed ( <i>Limna minor</i> L.) to iron-contaminated water helped lower the concentration of the metal, probably by surface absorption and physical removal. COVID restrictions in 2020 limited field and lab access, slowing down collection and analyses of samples and restricting our ability to meet various milestones.	Food & Fiber
6.	Increasing Farm Safety during COVID	CES partnered with the Southwest Border Food Protection and Emergency Preparedness Center, NMSU School of Public Health, NM Farm Bureau, and NMDA to provide information to frontline workers in agriculture. The collaboration developed the "Essential Produce Worker Protocol" to assist produce farmers with OSHA and CDC guidelines for agriculture workers. CES and the NMDA developed extension articles addressing the needs of NM growers while working closely with the NM Livestock Board to provide online producer education.	Food & Fiber
7.	Early Arginine	Poor nutrition can reduce vascular growth during early pregnancy but can be stimulated by dietary arginine and may improve fetal development. Heifers were fed maintenance or 70% below maintenance and within treatments were provided arginine or no arginine. Supplements that provide nutrients to enhance vascularization will improve the nutritional status of the dam and enhance fetal	Food & Fiber



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		development. NMSU researchers have not observed any differences in gross fetal measurements across treatments; more lab analysis is required. The impact of this work will be that rangeland nutritional deficiencies can be prevented by arginine to ensure proper fetal development and proper growth later in life.	
8.	Horn Fly Repellent	Pasture-based cow-calf operations common throughout the Southwest are continuously searching for profitable and sustainable management options to overcome a variety of environmental challenges. Horn flies constitute one such threat that requires managerial intervention to avoid economic losses which are estimated to exceed \$1 billion annually. Recently, the Veterinary Entomology Research Laboratory at NMSU established a unique method to evaluate and determine efficacies of natural products used as repellents against biting flies. Utilization of these techniques will contribute to the development of non-insecticidal management approaches for cattle growers in the region and throughout the United States.	Food & Fiber
9.	Understanding the Impact of COVID on the Dairy Industry	NMSU Dairy Extension and UT Health School of Public Health partnered to deliver a training program addressing COVID-19 in the U.S. Dairy industry. COVID-19 training was delivered to dairy owners, managers, and workers representing large-herd farms in the Texas-New Mexico border region and Idaho, two of the largest milk-producing regions. Training materials are delivered in both synchronous and asynchronous formats, using live webinars, on-farm presentations, as well as recorded videos.	Food & Fiber
10.	Increasing Dairy Safety and Animal Handling	CES Dairy Specialist provided safety awareness training to about one-third of the NM dairy workforce. Approximately 3,500 employees have been trained on dairy safety and animal handling. Translated training materials were developed to respond to the needs of all employees (English, Spanish, or K'iche). The Idaho Dairymen's Association (IDA) adopted the program with a significant processor and co-op support. Due to processor and customer demands, National Milk Producers Federation (NMPF) created a Workforce Development Task Force (2017), which developed a Dairy Safety Reference Manual in English and Spanish (2019), co-authored by CES Dairy Specialist. NMSU's dairy workforce development program is now considered a leading example, with program details being utilized on some of the largest dairy operations in the U.S.	Food & Fiber
11.	Dairy Industry and Workforce Development	There is a decline in resources with a growing need to teach young dairy professionals modern dairy management. For the past 12 years, NMSU Dairy	Food & Fiber

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		<p>Extension has led a consortium of universities to provide practical dairy management. The six-week intensive summer program is held in Clovis, NM. Program accomplishments include:</p> <ul style="list-style-type: none"> <li>▪ Hosted 528 students from 52 universities</li> <li>▪ 4 out of 5 past program participants employed in agriculture</li> <li>▪ 2 out of 3 past program participants employed in the dairy industry</li> <li>▪ 1 out of 3 past program participants are working on or managing a dairy</li> <li>▪ 2017 Dairy Sustainability Award in Community Partnerships</li> <li>▪ 2019 Western Extension Directors Association Award of Excellence</li> </ul>	
<p><b>12.</b></p>	<p>Value creation of byproduct streams obtained from food and dairy industry</p>	<p>The dairy industry struggles to find new lactose uses. Traditional uses of concentrated and purified lactose are insufficient to accommodate the recovered lactose from manufacturing operations. As a result, the dairy industry faces a surplus challenge with limited options at its disposal. In this research, an insoluble catalyst was used to synthesize a sweetening syrup (a mixture of six sweeteners) from lactose entirely. More importantly, the synthesis was performed at conditions where enzymatic methods for the production of sweeteners cannot be operated. Overall, the outcomes of this investigation provide the foundation for exploring a new avenue for lactose utilization. The development and use of insoluble catalysts to synthesize rare carbohydrates (D-tagatose, D-Allulose, and others) will be a central piece of future research. Another relevant work performed in the area of value-added is the utilization of phospholipids from dairy streams. The consumption of milk phospholipids has been associated with many health benefits. However, direct extraction of milk phospholipids from byproduct streams has not been economically viable in the past due to multiple steps involved within the extraction process. Here milk phospholipids were directly extracted from byproduct streams with switchable solvents. This new class of solvents change from hydrophobic to hydrophilic in the presence of carbon dioxide, allowing the extraction and further separation. Remarkably, 99% of milk phospholipids were extracted with switchable solvents, offering a new methodology for the isolation of valuable compounds. In this area, research efforts will aim at developing sustainable extraction methods, where different CO<sub>2</sub>-responsive species will be studied.</p>	<p>Food &amp; Fiber/ Value-Added</p>

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13.	Developing heifers on native range or delayed gain feeding systems may be more beneficial to fertility than drylot systems.	Female fertility is thought to be programmed at birth, based on the number of follicles present within the ovaries. Large follicle counts referred to as the ovarian reserve can be linked to increased fertility. Recent research has demonstrated it may be possible through nutritional management to influence the number of follicles in the ovaries of beef. Differences in diet between native range and drylot developed heifers positively influenced mechanisms controlling follicle activation and may improve reproductive success. Developing heifers on a stair-step compensatory growth nutritional program resulted in a larger ovarian reserve, which may increase reproductive longevity.	Food & Fiber
14.	Beefing Up: Planning for the impact of COVID	NMSU CES Beef Specialist facilitated a three-part webinar series designed to address beef markets and COVID-19. The series, attended by 330 beef producers, focused on the economic impact of COVID-19 on the beef industry. Extension conducted a workshop evaluation after the completion of the series. The evaluations found that 100% of respondents agreed Extension programming increased their knowledge relative to COVID's impacts on the beef industry.	Food & Fiber
15.	Increasing awareness and competitiveness of NM seedstock	New Mexico rangelands are a harsh environment, and the genetics of the bulls must match the environment. Numerous seedstock ranches raise bulls to match the extreme conditions but New Mexico seedstock producers face increasing competition from out-of-state markets. As a part of the SW Sustainable Beef Project, NMSU Extension and collaborators conducted a statewide survey of ranchers to identify important characteristics for bull selection and purchase by NM ranches. A total of 78 respondents completed the survey, representing nearly 2 million acres of rangeland and over 20,000 head of cattle. A notable finding indicated over 50% of bulls were purchased out of state, which if translated to the NM bull battery, would equal 9,500 bulls purchased outside of NM every 4-5 years. Survey results identified key physical and genetic traits that are important to New Mexico ranchers. Producers reported that their average purchase price for a bull was \$4,000 indicating that NM seedstock producers are losing \$38 million in bull sales to out-of-state competitors. Results from the survey data will help NM seedstock producers target the needs of their clientele and retain more of the \$38 million lost to out-of-state bull purchases.	Food & Fiber
16.	Understanding the impact of drought on NM beef producers	As COVID wreaked havoc on the beef industry, NM beef producers also faced worsening drought conditions. CES responded by hosting a series of drought webinars (3) to provide ranch management options during drought, approximately 270 people attended. Post-event evaluations showed that training	Food & Fiber

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		and consultations with producers resulted in 100% of respondents indicating they obtained knowledge that could be utilized in their operations or decision planning.	
17.	Pueblo of Santa Ana: Vocation, Heritage, and Conservation	The Tamaya Resort and Santa Ana Pueblo aim to supply their resort and restaurants with estate wines to create sustainable vocations, teach indigenous cultural heritage and conserve their land. Viticulture Extension Specialist collaborated with Tamaya Ventures and the Department of Natural Resources along with vineyard technicians and managers to assess potential wine grape vineyard sites within Pueblo of Santa Ana (Sandoval County, NM). Site parameters, techniques, and on-site tools for vineyard success were introduced and explained. The Pueblo community-identified vineyard sites and lands to remain dedicated to wildlife and soil conservation. Future collaboration includes soil and water analyses, land modification and amendments, cultivar and rootstock selection, GPS mapping for vineyard layout and design in cooperation with Pueblo cartographers and land managers. An extension publication, including land conservation considerations, for establishment of vineyard plantings will be developed and incorporated into an online NMSU CES viticulture class.	Food & Fiber
18.	Expanding supply chain for small-scale growers	New Mexico generates \$6 billion in revenue through agriculture when food processing is included, \$11 billion. Small growers are looking to get a share of the market. NMSU CES proposed programming and activities to facilitate intelligent supply chains for fresh produce that would allow demand aggregation (at the origin) and disaggregation (at the destination) to make it possible for small growers to directly serve distant markets. These supply chains would be highly flexible, market-responsive, and driven by an analytical engine built in an integrated information environment. The proposed environment encompasses supply chain planning, information, and technology-based tools anticipated to help level the playing field for small and micro-growers as they compete with large, vertically integrated enterprises who have access to efficient information and supply chain planning systems.	Food & Fiber
19.	Northern NM Corn Planting	Corn planting date and plant density evaluation is very important under changing climate conditions. It provides local growers, extension workers, and seed industry personnel with accurate, up-to-date information on planting window and optimum plant population under local conditions for avoiding crop failure and improving resource use efficiency. Given that corn and corn products are an important commodity in northern New Mexico, information regarding the corn planting window and optimum plant population are helpful for growers to	Food & Fiber

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		increase corn yields, improve water productivity, and obtain the maximum economic returns from their corn production. An NMSU study shows that corn could be planted as early as April 20 until May 25 under the optimum plant population of 36,000 plants per acre (88,900 plants per hectare). Planting after May 25 puts the plant at risk of early fall frost that reduces yield and the quality of the product.	
20.	Alternative crop solution: Jujube	Late frost is constantly challenging fruit production in central and northern New Mexico. Jujube ( <i>Ziziphus jujuba</i> Mill.), also called Chinese date, originated from China and has been cultivated for more than 4,000 years. Jujubes trees are scattered across New Mexico growing and producing well. Growers and consumers demand more diversity in jujube cultivars for different purposes. The CES Fruit Specialist is evaluating alternative and reliable crops. The NMSU Alcalde Center imported 30+ cultivars from China, collected cultivars from across the country (60 cultivars), and set up Jujube cultivar trails (2015 and 2017). Since 2010, CES has hosted jujube workshops on growing habits and pruning, flowering and fruiting habits, and fruit tasting. The program utilizes cultivar performance publications (ornamental cultivars, fresh-eating cultivars, and drying and multipurpose cultivars) and three jujube extension publications. The peer-reviewed publications recommend 8-10 different kinds of cultivars pertinent for each region in New Mexico. Workshops, publications, and media coverage have influenced growers in New Mexico and nationwide. Newer jujube cultivars and pruning techniques will increase yield and revenue by \$1-2/lb. Thousands of home gardeners nationwide are planting jujube trees in their orchard which will improve their food composition and nutritional conditions.	Food & Fiber
<b>Water Use &amp; Conservation</b>			
21.	Rio Grande Basin aquifer protection policy analysis	North America's Rio Grande Basin, is cited as the most climate stressed river system in the US, for whom people who rely on the river system are among the nation's poorest. A recent NIFA project had the goal to develop and apply an economic analysis to investigate the impacts of new policies, such as changes in costs of aquifer protection in a conjunctive use system, the Middle Rio Grande Basin of North America. The importance of this work is demonstrated by permitting policy experimentation for numerous groups of regional water stakeholders, including agriculture, government agencies, environmental, and social justice interests.	Water Use & Conservation

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<p><b>22.</b></p>	<p>Brackish groundwater and RO concentrate reuse for agriculture</p>	<p>New Mexico is under continued drought and surface water availability for irrigation is getting limited. This is forcing growers to increase the use of groundwater to supplement the irrigation shortfalls. In New Mexico, groundwater aquifers are not contiguous and are of variable salinity. Water even if saline must be used for irrigation to sustain agriculture in the valley. Brackish water can be treated using reverse osmosis (RO), however, the process generates a highly saline concentrate. The reuse of RO concentrate for irrigation can increase the irrigation water portfolio. Therefore, salinity tolerance of different crops of southern NM need to be established and available irrigation water across salinity gradient should be applied across a cropping pattern that includes food and forage crops including halophytes. NMSU has started research in greenhouses and tested a suite of crops grown in NM. These crops include chile peppers, tomato, pecan, and alfalfa. Halophytes or salt-tolerant crops tested are switchgrass, triticale, barley, mesa pepperwort, fourwing saltbush, and inland saltgrass. Research demonstrated that pecan and tomatoes are very sensitive to salinity and continuous irrigation would severely affect yields. Saline water irrigation increased the number of flowers in chile peppers but overtime yields decreased with increasing salinity. Saline irrigation increased total soluble sugar content in tomatoes but with increasing salinity yield decreased. The research established triticale as a halophyte, not a marginal as reported in the literature, and showed that under highly saline conditions it can be grown in place of alfalfa. Overall, a novel irrigation scheduling is needed that is based on managing twin abiotic stresses of water and salinity.</p>	<p>Water Use &amp; Conservation</p>
<p><b>23.</b></p>	<p>New Mexico's Drought Climatology</p>	<p>NM's agricultural sector contributes about \$2.5 billion annually to the state economy with Livestock accounting for 81% of the production value. Droughts have caused major economic setbacks to the state's economy with a cost of about \$100-250 Million per each of the 12 drought events that occurred in NM since 2000 that mostly affected the agricultural sector. This research accomplished an important aspect of drought climatology by providing decision-makers with a general idea of what kind of drought impacts might occur with the different drought severity levels. This information can help in developing drought response and risk management strategies.</p>	<p>Water Use &amp; Conservation</p>
<p><b>24.</b></p>	<p>Development of Natural Attenuation Methods</p>	<p>Groundwater contamination cleanup is needed to sustain our water use, but treatment commonly requires subsurface delivery of oxidant reagents, which is limited by subsurface hydraulic accessibility. Subsurface delivery of oxidants, such as aqueous ozone (O3) and persulfate (PS) for in situ chemical oxidation of groundwater contaminants, is naturally attenuated by oxidant demand and</p>	<p>Water Use &amp; Conservation</p>

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		<p>reactivity. A “Monitored Natural Attenuation” assessment approach typically used for contaminant remediation feasibility assessment was developed for remediation-reagent delivery assessment. An NMSU research group evaluated subsurface delivery, attenuation, and effectiveness for the destruction of the emerging and recalcitrant groundwater contaminant. They discovered that aqueous oxidant decomposition and oxidant delivery attenuation can be predictable upon characterization of the sediment oxidant demand and dispersion, and the results will enable optimization of subsurface contaminant remediation reagent delivery, which will increase our ability to clean up contaminated groundwater.</p>	
25.	Water Intake Monitoring System	<p>Frequent droughts have resulted in significant herd reductions for many producers in the desert Southwest. For producers to remain profitable under these difficult circumstances, they must utilize animals that are efficient in both feed and water use. A long-term collaboration with Extension Animal Sciences and Natural Resources and the NMSU’s Klipsch School of Electrical and Computer Engineering are developing a water intake monitoring system that can collect novel data in remote locations throughout New Mexico. Information gathered from this system will be disseminated to producers to help them make improved natural resource management decisions related to water.</p>	Water Use & Conservation
26.	Identifying nutritional and medicinal value in crop varieties	<p>An NMSU research proposal addresses the program area priority, Foundational Knowledge of Plant Products, specifically secondary metabolites for use in foods, pharmaceuticals, and other natural products. Alternative, saline water sources for crops can augment declining freshwater supplies. Salinity is an undervalued property that may, in turn, add value to appropriate crops, particularly salt-tolerant halophytes that possess hidden traits for human health. The goal of this project is to better understand the potential for brackish water to increase the production of beneficial human health-promoting secondary metabolites by native halophytes as medicinal plants, to provide dietary supplements and functional food additives. Researchers have selected three native halophytes for study: fourwing saltbush, big saltbush, and mesa pepperwort. The species will be irrigated in a greenhouse for 90 days with three different solutions: a non-saline control (1.6 dS/m), local brackish groundwater (5 dS/m), and reverse osmosis concentrate from desalination of the brackish groundwater (8 dS/m). After 90 days, they will assess biomass production, salt uptake and partitioning, secondary metabolite accumulation and bioavailability, antioxidant activity, and toxins in leaves and roots. Findings will support the U.S. greenhouse and nursery industry in the production of crops for human health needs and in the sustainable,</p>	Water Use & Conservation

		beneficial use of brackish water supplies. Experimental results will be integrated into a framework to launch our long-term goals of expanding the study to more native halophyte species to provide new plant products with increased nutritional and medicinal value.	
<b>ACES Family Development and Health of New Mexicans</b>			
27.	Using Diet Modification to Help Manage Diabetes	According to the Centers for Disease Control and Prevention, just over one in ten American adults have diabetes. Diabetes and prediabetes cost an estimated \$2 billion in NM each year. Diet modifications help manage diabetes. CES partnered with the NM Department of Health Diabetes Prevention and Control Program and 22 other organizations to provide 21 Kitchen Creations diabetes cooking schools ( <a href="http://kitchencreations.nmsu.edu/">http://kitchencreations.nmsu.edu/</a> ). Over 300 adults have participated in online cooking schools, representing 21 counties. Continued programming will increase awareness, diagnosis, and management of diabetes and associated cardiovascular risks. Over 98% of participants reported increased understanding and knowledge of strategies to plan and prepare healthy meals as a result of class participation. This period of Kitchen Creations programming has a potential cost savings of over \$224,000 per year. Kitchen Creation received a grant from the American Diabetes Association to provide new education materials and resources to over 1,000 adults with type 2 diabetes during 2021.	ACES Family Development and Health of New Mexicans
28.	Chronic Disease Self-Management Education Program	CES and the NM Department of Health Diabetes Prevention and Control partnered to deliver the Chronic Disease Self-Management Education Program (CDSMEP) to increase participation in, access to, reach, and effectiveness of evidence-based programs in our communities (offered in English and Spanish). Nationally, the CDSMEP has shown a \$714 per person savings in emergency room visits and hospital utilization. This equates to a \$364 per person net savings after considering estimated program costs of \$350 per participant. CDSMEP has been improving lives since 2011, graduating approximately 1,100 participants for a potential economic impact of \$785,400 in reduced health care costs.	ACES Family Development and Health of New Mexicans
29.	Examining the impact of COVID-19 on food security and food access in New Mexico	In March 2020, COVID-19 negatively impacted health and the economy and disrupted food systems throughout New Mexico. Rural areas and places with large Native American populations, in particular, struggle with food access. Food insecurity, which is driven in part by food access problems, is associated with higher rates of diabetes, heart disease, hypertension, and other chronic diseases. Nationally, NM has the 4th highest rate of food insecurity in the country. Over 15% of New Mexicans are food insecure and 1 in 4 children experience food insecurity. Researchers at NMSU conducted a state-wide survey to understand	ACES Family Development and Health of New Mexicans



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		<p>the impacts of COVID-19 on food access and food insecurity in May and June 2020. 1,438 New Mexicans completed the survey and findings showed that while food insecurity had not increased during the early months of the pandemic, 30% of respondents reported experiencing food insecurity. Further, food insecurity was higher among households with children, larger households, female respondents, and people of color. One survey respondent said: “due to an increase in SNAP benefits, I don’t have to worry if I will have enough money for food. For the first time in a long time, my pantry is full. Although I was receiving SNAP benefits prior to COVID, my allotment barely paid for my meats for the month.” After analyzing the initial results, 10 New Mexico agencies and community organizations were provided with research briefs. The survey findings received press on KFOX, an NMSU new release, the Las Cruces Sun News, and in the College of ACES’ quarterly magazine. The findings of this study support the current use of waivers in food assistance programs and expanded food assistance at the state and federal level, which can reduce food insecurity rates state-wide in the long-term.</p>	
30.	Increasing School Enrichment and Reducing Food Insecurity	<p>The NMSU Extension and Research Youth Agricultural Science Center has played an important role in supporting youth academic achievement through school enrichment programs and reducing community food insecurity in partnership with the 100% Community initiative. The 4-H Youth Development Specialist organized STEM trunks for Extension educators to facilitate statewide 4-H school enrichment and special interest activities. As a result of programming, 75% of students could correctly identify the steps of the scientific method, 80% correctly identified temperature and precipitation changes were contributing to environmental issues, 59% correctly identified greenhouse gasses, and 89.8% correctly identified the impacts of drought on plant growth. Climate science curriculum and related journal articles are being used to support programming. Along with providing experiential learning, Extension serves as a long-standing community partner, actively decreasing food security by donating fresh food to Las Vegas food banks (excess of 1000 pounds), donating over 800 fruit and vegetable plants in the community, and expanding food production capacity by 10%.</p>	ACES Family Development and Health of New Mexicans
31.	Vaccinate with Confidence	<p>NMSU Cooperative Extension Service is entering a new partnership with the CDC. This system-wide engagement is with the CDC’s <i>Vaccinate with Confidence</i> communication campaign. NMSU Extension is applying for funding to promote COVID-19 vaccinations through relevant messaging and innovative models for community action. The priority audience is rural and other hard-to-</p>	ACES Family Development and Health of New Mexicans

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		reach audiences. A team is being formed to guide this statewide initiative and work on the program application with funding available in April. The team is comprised of extension agents and specialists, 4-H health ambassadors, producers, various industry representatives, and Tribal Nations.	
32.	Nutrition and workforce development	Ideas for Cooking and Nutrition (ICAN) is a CES program funded by federal grants to provide nutrition education to SNAP-eligible audiences in New Mexico. ICAN serves diverse SNAP-eligible audiences, with 58% of clients being Hispanic, and another 22% Native American. Prior to COVID, ICAN met with over 50,000 New Mexicans at 159 community sites around the state. In response to current needs, the program added 2,000+ virtual clients. In addition, 1,817 clients participated in a virtual food gardening course, <i>ICAN Seed to Supper</i> . ICAN operates in 22 counties across New Mexico, providing 55+ job opportunities to local residents and contributing \$1.8 million to the state's economy in salary and benefits. In 2020, ICAN established over 160 partnerships with community leaders, schools, and non-profits. Nutrition education programming resulted in healthier food and lifestyle choices among participants. SNAP-Ed clients improved diet practices (95%), improved their ability to choose and prepare healthy foods (91%), and increased their physical activity behaviors (78%). SNAP-Ed families save an average of \$30 on their month-to-month grocery budget.	ACES Family Development and Health of New Mexicans
33.	Stress management during the pandemic	As a result of the COVID-19 pandemic, individuals and families are experiencing significant amounts of stress which can negatively affect social, emotional, and physical health and wellness. To help alleviate increased stress, CES educators developed a four-part weekly webinar series to increase knowledge and use of stress management and resilience strategies. Workshop topics emphasized building family resilience, how stress impacts the brain and body, tools to positively leverage stress, and the importance of self-care. All sessions were recorded and posted on the NMSU ACES COVID-19 Response website. Post-event evaluations showed the series was useful (96%) and knowledge of stress management and resilience strategies increased (94%). Most of the respondents increased their knowledge of stress management and resilience and intended to do things differently as a result of participation in the webinar series.	ACES Family Development and Health of New Mexicans
34.	Embracing Aging	The COVID-19 pandemic is significantly affecting older adults. According to the CDC, 78% of the people who died from Coronavirus were 65 years and older (May-August 2020). New Mexico has a greater percentage of adults aged 65 and older at 18%, compared to the national percentage of 16.5% (U.S. Census, 2019 estimates). By taking precautions to avoid COVID-19, New Mexico's seniors are experiencing isolation which can negatively affect social, emotional, and physical	ACES Family Development and Health of New Mexicans

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		<p>health and wellness. In response to a concern for seniors in isolation, NMSU CES Extension professionals delivered an online six-part series, “12 Keys to Embracing Aging” to introduce and reinforce healthy habits for optimal aging (139 participants). The adapted curriculum was developed by Extension at K-State, University of Kentucky, and the University of Arkansas. Webinars topics included attitude, nutrition, physical activity, brain health, social activity, technology, safety, medical literacy, stress management, financial security, sleep, and taking time for yourself. All sessions were recorded and posted on an NMSU 12 Keys to Embracing Aging website. At least 97% of program participants indicated an increased understanding of how choices made today affect health and well-being in the future, could promote independence, well-being, and a longer healthier life.</p>	
35.	<p>Financially Navigating the COVID-19 Outbreak</p>	<p>In response to emerging concerns for the financial well-being of NM families, NMSU CES facilitated a workshop series to help individuals and families navigate the COVID-19 outbreak from a financial standpoint, access resources, and adapt household budget and practices, as effectively as possible. The four-part series was offered weekly and through Zoom (163 participants). <i>Financially Navigating the COVID-19 Outbreak</i> program participants increased their understanding of financial options and resources available to them during the pandemic (88%) while increasing confidence (96%) and decreasing stress (96%) related to finances. Participants found the material to be very useful (94%) and continued using resources three months following the series (42%) and shared information with others.</p>	<p>ACES Family Development and Health of New Mexicans</p>
36.	<p>Aggie Next Step program, <i>Take it to the Next Level: Skills for Student Success Series</i></p>	<p>Over the past four years, New Mexico schools have ranked last by National Kids Count. Academic success is challenging for many students in traditional school settings, the ongoing pandemic has increased the challenges facing our education system and students. Academic success is vital for continuing education and pursuing a career. Learning the skills directly linked to improved academic performance is key for student success and persistence throughout their academic career. NMSU 4-H and Youth Development Aggie Next Step program, <i>Take it to the Next Level: Skills for Student Success Series</i> provided a series of five 30-minute virtual workshops focused on skills important for academic success. After the series, 65% of students reported an increase in identifying learning styles and a 50% increase in understanding goal time frames and recognizing sources of responsibility.</p>	<p>ACES Family Development and Health of New Mexicans</p>

<b>Environmental Stewardship</b>			
<b>37.</b>	Soil Health Management for Agricultural Productivity	Soil health issues have become increasingly prominent in New Mexico, with many degraded farmlands. An integrated research and extension program was developed to address soil health issues in cropping systems of New Mexico. Two major workshops (over 2000 participants, 15 counties) were conducted in the past year with participants both within and outside the state. Over 80% of participants indicated increased knowledge on how to use various soil health practices after the training events. About 50% of land managers have indicated willingness to adopt soil health management practices for improving their land. Soil health awareness created by this extension program and other state entities led to the passing of the Healthy Soil Act during the NM legislative session in 2019.	Environmental Stewardship
<b>38.</b>	New practices and management to help in turfgrass water conservation.	Authorities and municipalities increasingly require to limit water for turfgrass irrigation in arid and semi-arid areas of the US have become increasingly apparent and strategies that help in water conservation have to be investigated. New Mexico State University’s turfgrass researchers study the possibility of using chemical products to maintain acceptable turf quality under reduced irrigation and to improve soil physical characteristics such as an infiltration rate under irrigation with low-quality water. These products include surfactants, plant growth regulators, and products that affect the chemical quality of irrigation water. Research has been conducted to compare these products against an untreated control at varying drought levels to quantify their irrigation conservation potential and the potential to improve soil properties.	Environmental Stewardship
<b>39.</b>	Rabbit Hemorrhagic Disease	Understanding impacts of RHDV2: In early 2020, Rabbit Hemorrhagic Disease Virus (Type 2; RHDV2), a pathogen somehow was introduced into the southwestern US. The pathogen rapidly spread, causing critical concerns for the domestic rabbit (pets and farmed rabbits raised for food) trade. Further, the pathogen spilled-over into native cottontails and jackrabbits, causing well-publicized mass mortality events. NMSU researchers have been working closely with colleagues at state and federal agencies to understand the impacts of RHDV2 emergence on native rabbit species, and to discern how the virus will spread and how it will affect the broader ecosystem.	Environmental Stewardship
<b>40.</b>	Reforestation Strategy for the 2020 New Mexico Forest Action Plan	NMSU research and promotion of active reforestation on post-fire landscapes has an immeasurable value on all communities of the greater southwestern US. Planting trees on these disturbed forests provides major benefits to critical resources such as water (agricultural and municipal), carbon, timber, wildlife, and	Environmental Stewardship

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		<p>recreation. A lack of action would result in a loss of billions of dollars connected to all the ecosystem services that these forests provide to the southwestern US. Thus, the New Mexico Reforestation Center and all reforestation activities are vital for reducing future risks of catastrophic fires, enhancing ecosystem services, mitigating climate change, and restoring post-fire landscapes that will benefit all communities of southwestern US.</p> <p>As a result of this new Reforestation Strategy, state legislators and forestry professionals from around the state are proposing the development of the New Mexico Reforestation Center. The mission of the New Mexico Reforestation Center shall be to meet current and future reforestation needs in NM through its comprehensive seed bank, nursery, and planting operations combined with research, education, and outreach activities.</p>	
41.	Urban Entomology	<p>NMSU lacked a research program on urban entomology that addressed the growing numbers of urban pests in New Mexico. In 2020, an NMSU researcher took the lead to have consolidated an urban entomology research program that responds to the needs of stakeholders with useful information about effective control methods for various urban pests. This research has impact the way bed bugs, ants, cockroaches, kissing bugs are managed by pest control professionals. These pests have a significant effect on human health as well as the economy. Impact of this knowledge is measured by talks presented at regional, national, and international meetings; and various peer-reviewed publications.</p>	Environmental Stewardship
42.	Soil Carbon Sequestration and Greenhouse Gas Mitigation during Irrigated to Dryland Transition	<p>The Ogallala Aquifer region of the US Great Plains produces 30% of total crop and animal products in the country. Agricultural intensification using irrigation water from the Ogallala Aquifer has increased land production values by more than \$12 billion annually. The saturated thickness of the Aquifer has declined by 50% in the last four decades, leading to a rapid transition to drylands. An NMSU researcher and their cropping systems team evaluated crop and soil management strategies to improve the resilience of agroecosystems by increasing soil organic carbon (SOC) and mitigating greenhouse gas emissions. Their study showed a 14% and 13% reduction in SOC and total nitrogen from 0-30 cm depth during the first 15 years of transition from irrigated to dryland cropping systems. Adopting conservation systems such as cover cropping increased SOC up to 15% and grassland restoration up to 51% in the lands transitioning from irrigation to dryland. Grassland restoration also reduced nitrous oxide (N<sub>2</sub>O) emissions. If conservation strategies are promoted in the 5.5 million ha area of the Ogallala Aquifer region, cover cropping alone can store 32 million metric tons of additional SOC in 0-30 cm depth. Grassland restoration could restore additional 126 million</p>	Environmental Stewardship

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		metric tons of SOC in 24% of the area that is projected to be not suitable for dryland crop production.	
43.	Importance of soil in human health and ecosystems	<p>Soil, the fascinating three-dimensional body of loose mineral and organic matter at the earth's surface, is foundational to human societies. We derive 90% of our food and all of our fiber from the soil. We build our houses and roads on the soil. The soil directly influences human health and nutrition. The soil also moderates climate, purifies water, stores plant available water and nutrients and affects the biodegradation of pollutants. The essential role that soil plays in human health and functioning ecosystems is beginning to be recognized both nationally and globally.</p> <p>NMSU research is currently focused on 1) methodological improvements to pedometric techniques and 2) utilizing gridded soil information to infer soil use and management ratings. Specifically, this research has developed a cell-phone-based method that can reduce the complexity and time needed to measure soil bulk density. This research has also developed a method to infer soil use and management ratings for hydrology, agriculture, and engineering applications from gridded soil property data.</p>	Environmental Stewardship
44.	Freshwater Fish Management	<p>An NMSU study is focused on the management and conservation of freshwater fish in North America. The value of freshwater fishes is difficult to estimate; however, recent evaluations suggest recreational fishing generates roughly \$125 billion annually in North America. In addition to their economic value, freshwater fishes have important ecological, societal, and cultural significance.</p> <p>Unfortunately, aquatic systems are one of the most threatened ecosystems worldwide. Threats to aquatic biodiversity are varied but include habitat loss, invasive species, and overexploitation. This research is primarily focused on addressing the influence of these threats on fish populations, is national in scope, and often involves collaboration with state and federal natural resource management agencies. This project has partnerships in Idaho, Utah, Mississippi, Georgia, Florida, Kansas, Washington, Wyoming, and New Mexico. Through these scientific partnerships, the researcher has assisted natural resource agencies to develop practicable solutions to effectively manage and conserve freshwater fish populations. Some of the solutions that this research has directly influenced include invasive species control (Washington, Wyoming, New Mexico, Kansas, Idaho), native species habitat restoration (Utah, Idaho), and harvest management (Idaho, Kansas). In addition to direct applications in fisheries management and conservation, the study contributes to the understanding of fish ecology as</p>	Environmental Stewardship

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		evidenced by peer-reviewed. Collectively, this research directly affects the conservation of North American freshwater fishes and contributes to a deeper understanding of the ecological processes influencing fish populations.	
45.	Weed Science Program Trainings	NMSU CES <i>Weed Science Program</i> developed Zoom trainings (552 views), free of charge to persons in need of CEUs during 2020. An end-of-session evaluation determined 87% of participants stated they are likely to modify a plant management practice and 82% will likely change a current applicator practice. Considering the average salary of a pesticide applicator (\$34,570), the training on best management practices for weeds, the overall value of the information provided, and the resulting services of weed management to the communities of New Mexico, was approximately \$22,090,230 during 2020.	Environmental Stewardship
46.	Importance of Turfgrass and Natural Green Space in Promoting Health and Well-being during COVID-19 Pandemic	Many turfgrass managers and people in the turfgrass industry faced economic uncertainty during the public health crisis and economic recession caused by COVID-19. Industry professionals were forced to re-evaluate or pause maintenance on public parks and golf courses to extended closures and significant loss of revenue. NMSU CES Turfgrass Specialist in partnership with Extension specialists from seven other land grant universities published two papers outlining the critical role of turfgrass and natural green space in promoting health and well-being during the pandemic and how to maintain green spaces with limited resources due to closures. By adopting minimal maintenance practices throughout closures, public golf courses were ready for reopening in May.	Environmental Stewardship
47.	New Mexico Prescribed Fire Act	Fire is a natural process that can be harnessed through prescribed burning. Creating a burning culture in New Mexico will ease the grip wildfire has on society. NMSU CES facilitates the Prescribed Fire Training and Certification Program. The program has trained 245 participants, burned 725 acres, on 12 NM ranches. NMSU CES, working with the House Memorial 42 Working Group, reported concerns to the NM Legislature. The NM Legislature listened and drafted the first of its kind, The New Mexico Prescribed Fire Act!	Environmental Stewardship