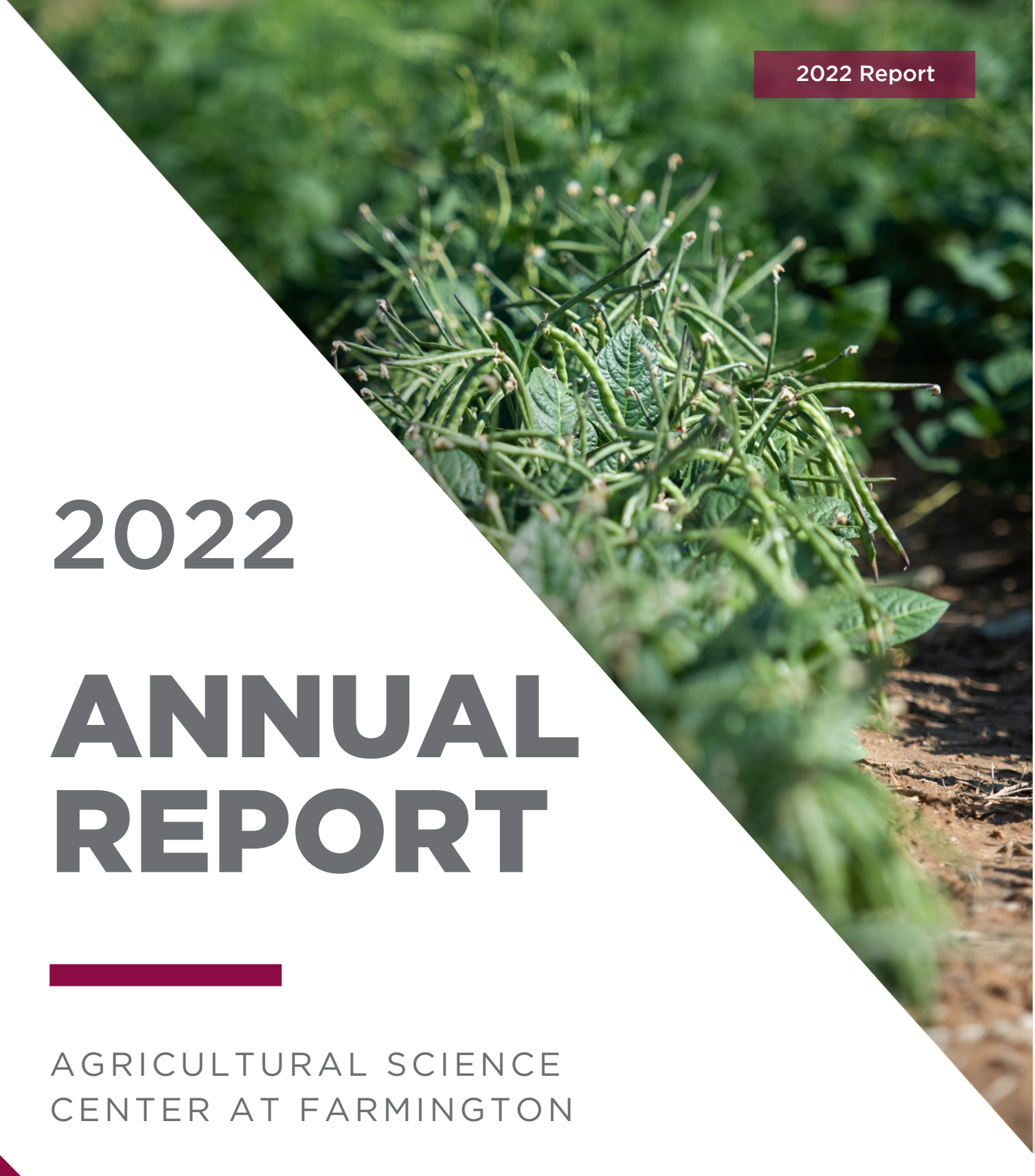
2022 Report



2022 ANNUAL REPORT

AGRICULTURAL SCIENCE CENTER AT FARMINGTON

The NMSU Agricultural Experiment Station supports research that addresses real-world problems. Research is at the core of NMSU's mission to improve the lives of people globally.

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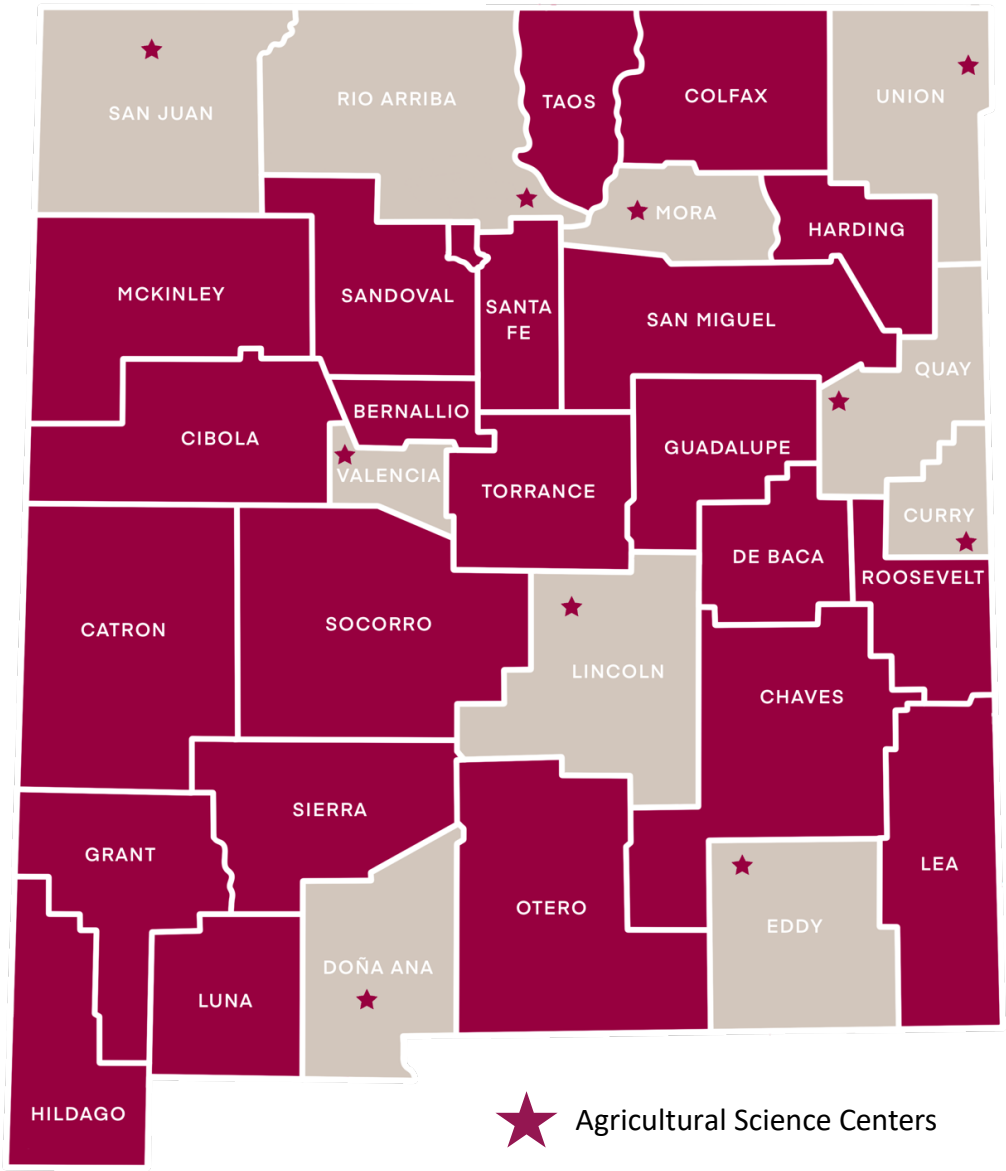
Notice to Users of this Report

This report has been prepared to aid Science Center staff in analyzing the results of various research projects from the past year and to record data for future reference. These are not formal Agricultural Experiment Station Report research results. The reader is cautioned against drawing conclusions or making recommendations as a result of the data in this report. In many instances, data represents only one of several years' results that will ultimately 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 are authorized for release or publication without the written prior approval of the New Mexico Agricultural Experiment Station.

Any reference in this report to any person, organization, activities, products, or services related to such person or organization is solely for informational purposes and does not constitute or imply the endorsement or recommendation of New Mexico State University or any of its employees or contractors. NMSU is dedicated to providing equal opportunities in areas of employment and academics without regard to age, ancestry, color, disability, gender identity, genetic information, national origin, race, religion, serious medical condition, sex, sexual orientation, spousal affiliation, or protected veteran status as outlined in federal and state anti-discrimination statutes. The College of Agricultural, Consumer, and Environmental Sciences is an engine for economic and community development in New Mexico. ACES academic programs help students discover new knowledge and become leaders in environmental stewardship, food and fiber production, water use and conservation, and improving the health of all New Mexicans. The College's research and extension outreach arms reach every county in the state and provide research-based knowledge and programs to improve the lives of all New Mexicans.

Agricultural Science Center Locations Map



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Executive Summary

The mission of the New Mexico State University Agricultural Science Center at Farmington is to conduct research, demonstration, and educational programs that will best fill the needs of the Agricultural community of San Juan County and the Navajo Nation in particular, and the State of New Mexico, Four Corners Region, and Nation in general. Projects reported here are in response to requests for research-based information and technical assistance. ASC Farmington is aligning research activities under NMSU's College of Agricultural, Consumer & Environmental Sciences (ACES) Four Pillars: Water Use and Conservation, Family Development and Health of New Mexicans, Environmental Stewardship, and Foundational Education and Training (https://aces.nmsu.edu/about/pillars.html). Within our service area, we are also aligning with NMSU LEADS 2025: to enhance student success, elevate research, amplify outreach, and build a robust university system (https://leads2025.nmsu.edu/).

Operational and salary support was funded in part through the Hatch Act of 1887, which established funding to "conduct agricultural research programs at State Agricultural Experiment Stations in the 50 states, the District of Columbia, and the U.S. insular areas" and the Morrill Act of 1862, "an Act donating Public Lands to the several States and Territories which may provide Colleges for the Benefit of Agriculture and the Mechanic Arts" (land-grant system). Funding from the New Mexico Legislature is helping to make capital improvements to the facility and purchase new equipment (including a plot combine – purchased in 2022), and other machines and implements to conduct high-quality agricultural research.

Additional funding for projects conducted in 2022 was obtained through state and federal competitive grants from the National Science Foundation, USDA, and the New Mexico Department of Agriculture, in addition to public/private partnerships. These projects are multi-institutional and cross-disciplinary and include collaborators listed in section 7 such as Navajo Agricultural Products Industry, Diné College, Fred Hutchinson Cancer Research Center/the University of Washington, University of Minnesota, U.S. Potato Genebank, Navajo Mesa Farms, Pivot Bio, the Land Institute, Navajo EthnoAg, the Transformation Network, Indian Resources Development (for intern funding), breeders (for things like alfalfa, corn, and cereal grains), San Juan, Animas, and LaPlata irrigators, and regional communities among others.

This report consists of project overviews related to daily weather collection, examining agronomic and specialty crop adaptability to the Four Corners Region, cropping systems, diabetes risk reduction through the act of gardening and healthy eating, and farmland soil quality and health monitoring. New projects funded include two Organic Research and Education Initiative awards through the USDA.

I would like to acknowledge the NMSU-ASC Farmington faculty and staff, undergraduate and graduate students, and all other collaborators and funding mechanisms for making the efforts reported herein happen.

Thank you for your continued support and we look forward to continuing to improve our communities, state, and nation.

Sincerely,
Kevin A. Lombard, Ph.D.
Professor, Horticulture
Superintendent, NMSU ASC Farmington

Research Projects:

Field evaluation and marketability of eight table grape varieties for New Mexico – Investigators: K. Lombard W. Giese, S. Yao, and J. Peterson

Field evaluation grafted and non-grafted winegrape cultivars for the Four Corners Region of New Mexico – Investigators: K. Lombard and W. Giese

Corn response to nitrogen fertilizer following five-year alfalfa production – Investigators: K. Djaman, M.M. West, D. Begay, Chad Begay, and F.J. Thomas

Performance evaluation of three Landrace Blue Corn genotypes under transitional organic farming practices – Investigators: K. Djaman, D. Begay, F.J. Thomas, J. Joe, K. Lombard, T. Vos, and R. Pratt

Chip and table potato genotype evaluation and cropping systems – Investigators: K. Djaman, M.M. West, S.C. Allen, D. Begay, and F.J. Thomas

Effects of irrigation and nitrogen management on potato growth, yield, quality, and water and nitrogen use efficiencies – Investigators: B. Shrestha, K. Djaman, K. Lombard, D. Begay, J. Thomas, C. Begay, and J. Joe

Precision and smart irrigation: soil moisture sensors for irrigation scheduling – Investigators: K. Djaman, K. Lombard, D. Begay

Performance evaluation of six triticale and twenty-three wheat genotypes – Investigators: K. Djaman, D. Begay, J. Thomas, C. Begay, and J. Joe

Pivot bio: a solution for reducing nitrogen fertilizer applied rate in corn – Investigators: K. Djaman, D. Begay, J. Thomas

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Soil Organic Carbon (SOC) measurements of various annual and perennial agricultural cropping systems at the ASC Farmington – Kevin Lombard, Rajan Ghimire, and others

Perennial intermediate wheatgrass (Thinopyrum intermedium/Kernza®) for specialty grain – Investigators: K. Lombard, D. Begay, and F.J. Thomas

Winter malted barley and other specialty grains for craft brewing – Investigators: K. Lombard, F.J. Thomas, and S.C. Allen

Engaging Navajo elementary schools in randomized controlled trial of Yéego! Healthy Eating and Gardening – Investigators: Shirley A.A. Beresford, India J. Ornelas, Mark C. Bauer, Geraldine A. Garrity, Sonia K. Bishop, Brandon Francis, Eileen Rillamas-Sun, Linda V. Garcia, Filiberto S.A. Vecenti, Kevin A. Lombard

Field evaluation and marketability of eight table grape varieties for New Mexico

Investigators: K. Lombard (klombard@nmsu.edu), W. Giese, S. Yao, and J. Peterson

Project Overview: NMSU viticulture established table grape vineyards at Los Lunas, Alcalde, and Farmington ASCs as well as Santa Ana Pueblo. Varieties being tested include Reliance, Marquis, Glenora, and Interlaken (industry standards), and Compassion, Neptune, Hope, Faith, Joy, Gratitude, Swenson Red, and Everest Seedless. Initial results and successful production techniques were shared at all three ASC grower field days. Student involvement has included a consumer sensory panel evaluation by Kirtland high school and NMSU students, a video by San Juan College students (Farmington, NM), and a trellis assembly at ASCF by summer interns.

Meeting the Needs of New Mexico: The work is evaluating potential table grape varieties for fresh market sales and consumption. These plantings are used to evaluate table grape production and varieties to diversify crop options for farmers, homeowners, and community/school gardens and can increase the healthfulness of locally sourced diets.

Impact: This project is generating knowledge on cold hardiness, insect/phylloxera and disease tolerance, and staggered ripening times in addition to consumer-preferred berry taste/aroma/texture traits that can also improve healthy dietary choices.

Collaborating Agricultural Science Center: Agriculture Science Center at Alcalde, Agricultural Science Center at Los Lunas

Funding Acknowledgement: New Mexico Department of Agriculture Specialty Crop Block Grant Program

Field evaluation grafted and non-grafted winegrape cultivars for the Four Corners Region of New Mexico

Investigators: K. Lombard (klombard@nmsu.edu) and W. Giese

Project Overview: The grafted trial examines rootstock influence on scion mortality, vine development, vegetative growth, yield components, and berry composition in the high elevation (>5,600 ft), semi-arid climate of northwest New Mexico. This long-term study evaluates nine rootstock entries (*Vitis berlandieri, riparia,* or *rupestris*) and two Vitis vinifera winegrapes (Refosco and Gewurztraminer) entries that were planted in a completely randomized design with six replications and four vines per plot in 2008. A 2022 Rosé style wine was vinted by Wines of the San Juan from Refosco, demonstrating value-added potential. Non-grafted hybrid varietals are also examined in the experimental vineyard.

Meeting the Needs of New Mexico: The work is helping to support northwest New Mexico wineries, which have a significant economic impact on New Mexico's service and tourism industries. The work supports site-specific varietal recommendations for vineyards having high frost risk in low-lying river valleys, and viniferous cultivars for irrigated upland mesa sites. Results have been reported at the national meeting of the American Society of Enology and Viticulture and are planned for formatting into an Extension Guide.

Impact: Rootstock influences scion phenological development, leaf senescence, the timing of dormancy, vegetative growth, and berry maturation. Understanding how rootstock selection can affect scion performance in non-traditional wine-growing regions is of practical importance to local growers and provides a useful comparison to vine performance in more established wine regions.

Corn response to nitrogen fertilizer following five-year alfalfa production

Investigators: K. Djaman (kdjaman@nmsu.edu), M.M. West, D. Begay, Chad Begay, and F.J. Thomas

Project Overview: The main objective of this research is to establish the first and second-year optimum nitrogen fertilizer application rate of corn after a 3 to 5-year irrigated alfalfa production in northwest New Mexico. A field of 2014 and 2018-planted alfalfa were terminated in December 2019 and 2020 and planted in corn in 2020, 2021, and 2022 growing seasons. Nitrogen fertilizer (urea) rates at 0, 75, 120, and 160 kg N /ha were applied to plots a month after planting. The results showed that the effectiveness of the applied nitrogen fertilizer occurred during the second year of field corn production following alfalfa termination. The applied nitrogen impacted crop growth and yield parameters during the second year of corn production. The study indicated a rate as low as 75 kg N/ha might be applied to corn the first year after 3-5 years of alfalfa. For the second year of continuous corn production after alfalfa, producers are requested to use the N recommendation of corn based on the soil testing results of each individual farm.

Meeting the Needs of New Mexico: Alfalfa and corn are important crops grown in rotation in New Mexico and the US. The beneficial effects of growing legumes in rotation with cereals have been proven for providing considerable amounts of nitrogen credit to the subsequent cereal crop, improving soil organic matter, weed control, break up diseases and pest cycles, etc. However, growers need to understand the difference between the nitrogen fertilizer rate applied to grain corn as a sole continuous crop vs. the rate applied in a rotation scenario following alfalfa or sweet corn.

Impact: This study aims to develop nitrogen fertilizer recommendations for corn in rotation with alfalfa. The outcome of this research holds the potential to increase corn growers' net economic returns as well as reduce contamination of soil and groundwater from applied nitrates.

Performance evaluation of three Landrace Blue Corn Genotypes under transitional organic farming practices

Investigators: K. Djaman (kdjaman@nmsu.edu), D. Begay, F.J. Thomas, J. Joe, K. Lombard, T. Vos, and R. Pratt

Project Overview: The nutritional value of landrace blue corn (higher protein and oil content) is quite high, and its starch digestibility confers the low glycemic index of blue corn compared to white and yellow corn. Blue corn is used in different ceremonies among Natives American communities and there is a need to identify genotypes adapted to local climates. A three-year field evaluation of three genotypes at NMSU ASC Farmington showed superior performance by variety GRIN: P1608602- CRC48 in terms of its adaptation to Farmington climate and elevation, growth and yield performance, grain color and minimal damage by insects and fungi.

Meeting the Needs of New Mexico: The Southwest Grain Collaboration project is evaluating different blue corn germplasms across New Mexico for their adaptation to local climatic conditions, relative maturity date, color intensity, susceptibility to Fusarium ear rot, lodging, marketable grain yield and the quality of the processed product using a participative phenotyping approach.

Impact: Native to the American Southwest, blue corn is a high-value crop that is in demand due to its cultural heritage, unique taste profile, and high nutritional value. The present research selects the best performing and the most adapted cultivar of blue corn for the Navajo Nation and other Indigenous tribes across the Four Corners region for local food and ceremonial products.

Chip and table potato genotype evaluation and cropping systems

Investigators: K. Djaman (kdjaman@nmsu.edu), M.M. West, S.C. Allen, D. Begay, and F.J. Thomas

Project Overview: The 2021 Potato trial consisted of 14 chip potato cultivars and 20 table potato cultivars planted within four replications on April 30, 2021. Potatoes were harvested on September 27-29, 2021, and processed on November 19, 2021, at Navajo Mesa Farms (NMF) laboratory. Center pivot irrigation was scheduled according to the site evapotranspiration rate. The fertilization rate was 180 pounds N, 120 pounds P2O5, and 300 pounds K2O per acre. Potato psyllids (*Bactericera cockerelli*) were monitored weekly. Specific gravity is good at Farmington compared to lower elevation-producing areas. Thus, this area is a valuable supply source for processing plants in TX, AZ, and CA. Sugars, fry defects, and chip color were monitored regularly during the post-harvest nine-month storage season to determine long-term storage quality. The chip potato research data is entered into the Potatoes USA database for use by all growers, processors, and breeders.

Meeting the Needs of New Mexico: The Four Corners region has a very favorable climate for potato production. Navajo Agricultural Products Industry (NAPI) and Navajo Mesa Farms (NMF) are large-acreage potato producers in the region and the present study selected the high-yielding and adapted potato cultivars for the growers to improve their production system profitability in a sound environment.

Impact: Chip and Table potato varietal research is necessary to find the locally adapted and high-yielding cultivars of better storage quality for potato growers of the Four Corners region.

Effects of irrigation and nitrogen management on potato growth, yield, quality, and water and nitrogen use efficiencies

Investigators: B. Shrestha, K. Djaman (kdjaman@nmsu.edu), K. Lombard, D. Begay, J. Thomas, C. Begay, and J. Joe

Project Overview: Irrigation and nitrogen management is crucial for potato growth, yield, and quality. A field experiment is conducted to evaluate the performance of two chip potato varieties under different irrigation regimes and nitrogen rates. Plots were kept week free with hand weeding. Crop growth and yield parameters were impacted by nitrogen rates and irrigation regimes. Water saving strategy at 20% combined with 60 kg N/ha maximized total and marketable tuber yields, and water and nitrogen use efficiencies.

Meeting the Needs of New Mexico: The present study helps new Mexican potato producers cope with the recurrent drought across the state. Using the nitrogen-potato production function increased the net revenue while reducing production costs and protecting the environment.

Impact: This study aims to develop nitrogen fertilizer production functions for potatoes under full and water-saving strategies. The outcome of this research holds the potential to increase potato growers' net economic returns as well as reduce contamination of soil and groundwater by nitrates by applying optimum nitrogen fertilizer rate under 80% of crop water requirements.

Precision and smart irrigation: soil moisture sensors for irrigation scheduling

Investigators: K. Djaman (kdjaman@nmsu.edu), K. Lombard, D. Begay

Project Overview: The world's agricultural and water resource enterprises are facing challenges in terms of optimizing crop yields by reducing water inputs while minimizing environmental degradation. ASC Farmington has acquired soil moisture sensors and other technology to study their applications in soil moisture monitoring, irrigation scheduling, and overall crop health monitoring. For more information, contact Koffi Djaman at kdjaman@nmsu.edu.

Meeting the Needs of New Mexico: Under the increasing drought conditions across New Mexico, precision water management strategies using high-efficiency irrigation management tools such as soil moisture sensors have the potential to reduce crop water use, maintain yield, increase crop water productivity, and reduce environmental impact.

Impact: Efficient use of water is no longer an option but a requirement in crop production; hence long-term research on various crops and water use strategies is essential.

Performance evaluation of six triticale and twenty-three wheat genotypes

Investigators: K. Djaman (kdjaman@nmsu.edu), D. Begay, J. Thomas, C. Begay, and J. Joe

Project Overview: The NMSU ASC Farmington has a long-standing history of small grain and wheat varietal testing. Plots are typically fall-sown and harvested the following summer. In 2021, six cultivars of triticale and twenty-three cultivars of wheat were evaluated for their winter hardness, heading, and grain yield under sprinkler irrigation. The cultivars were organized in a randomized complete block design with four replications and planted on September 28, 2021, at a plant density of 1.2 million seeds per acre.

Meeting the Needs of New Mexico: The winter wheat and triticale performance tests are essential to provide local growers, extension workers, and seed industry personnel with accurate, up-to-date information on wheat/triticale varietal health and performance under local conditions.

Impact: Given that wheat, triticale, and products are important commodities in northern New Mexico, information from performance testing is helpful for growers who wish to increase yields and make the most of production and harvest costs. For more information, contact Koffi Djaman at kdjaman@nmsu.edu.

Collaborators: Colorado State University, Navajo Agricultural Products Industry

Pivot bio: a solution for reducing nitrogen fertilizer applied rate in corn

Investigators: K. Djaman (kdjaman@nmsu.edu), D. Begay, J. Thomas

Project Overview: Pivot Bio microbes are specially designed to work on cereal crops, some of the most nitrogen-hungry crops grown in the US. Corn, wheat, and rice account for about half of the applied synthetic nitrogen globally. Pivot Bio Proven 40 is Pivot Bio's newest commercial product designed to replace up to 40 pounds per acre of synthetic nitrogen. Half of the 13-acre pivot was planted with corn at the plant density of 36,000 plants per acre. After emergence, the plot was split into two; one half representing a quarter of the pivot receiving the Pivot Bio product through the irrigation system, and the subplot was disked a day after application. The other half of the plot receives nothing as a source of nitrogen. Both subplots were management equations as needed. Six sub-sub-plots were harvested from each subplot and the yields were compared after adjustment to a standard moisture content of 15.5%%. Pivot Bio provides a clean alternative to synthetic nitrogen to the crop daily.

Meeting the Needs of New Mexico: Corn and wheat are part of the main crops produced in New Mexico and Pivot Bio microbes meet the need of NM cereal growers when the nitrogen fertilizer price is on the rise. NM farmers can replace synthetic nitrogen fertilizer with microbes with confidence. This product provides a clean alternative to synthetic nitrogen to the crop daily.

Impact: This study aims to use microbes to improve nitrogen fixation by cereal crops like corn, wheat, and barley. The outcome of this research holds the potential to increase corn growers' net economic returns as well as reduce contamination of soil and groundwater from applied nitrogen fertilizers. This product provides a clean alternative to synthetic nitrogen to the crop daily. With microbes as a source of nutrition for crops, there is no harm to the soil; nitrous oxide emissions, a highly potent GHG; or nitrates into waterways. Pivot Bio microbes empower the world's farmers to be more productive, profitable, and sustainable: better nitrogen, stronger farm economics, clean air and water, and sustainable crops.

Incorporation of different cover crops into the cropping systems for improving soil health

Investigators: K. Djaman (kdjaman@nmsu.edu), K. Lombard, D. Begay, J. Thomas

Project Overview: Grasses as well as leguminous and non-leguminous broadleaves are the major categories of commonly grown cover crops worldwide. We have adopted different cover crop species in rotation with field crops to increase carbon sequestration and improve our sandy loam health. Cover crop species used solely or in mixtures are *Brassica juncea* (disked as a green manure and biofumigant preceding potato production), Cowpea, black eye pea, winter pea, soybean, black bean, hairy vetch, clover, millet, sorghum-sudan.

Soil Organic Carbon (SOC) measurements of various annual and perennial agricultural cropping systems at the ASC Farmington

Investigators: Kevin Lombard (klombard@nmsu.edu), Rajan Ghimire, and others.

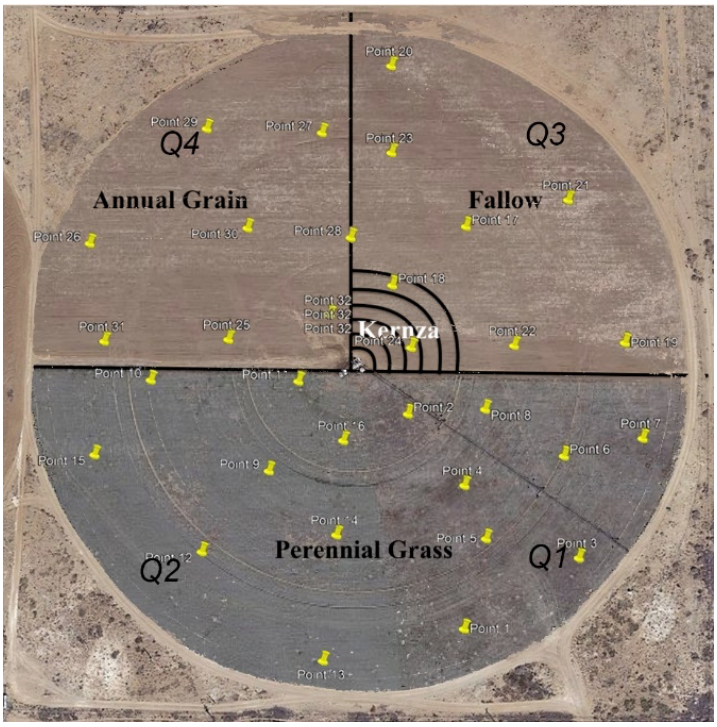
Project Overview: Sections of the ASC-Farmington have been screened for soil organic carbon (SOC) to determine cropping system influence on SOC as part of a statewide assessment of soil carbon sequestration potential. In 2023, center pivot #4 was divided into 4 quadrants and sampled (Figure). Quadrant (Q)1 and Q2 were under a perennial grass cover for decades; Q3 was a combination of fallow and planted in 2021 with perennial intermediate wheatgrass trademarked as Kernza; Q4 was under an annual barley study. SOC was highest in perennial grass, followed by Kernza/fallow. Lowest SOC was in annual planted barley.

Meeting the Needs of New Mexico: These studies are part of a larger effort to characterize different agricultural/landscape systems and soil organic carbon (SOC) across New Mexico as part of a comprehensive soil health improvement strategy.

Impact: Perennial cropping systems tentatively show higher SOC compared to annual cropping systems. “Sequestering carbon in SOC has been suggested as one way to mitigate climate change by reducing atmospheric carbon dioxide. The argument is that small increases of SOC over very large areas in agricultural and pastoral lands will significantly reduce atmospheric carbon dioxide” https://www.agric.wa.gov.au/measuring-and-assessing-soils/what-soil-organic-carbon .

Collaborating Agricultural Science Centers: Clovis, Los Lunas, Farmington, Mora, Las Cruces, and others.

Funding Acknowledgement: Indian Resources Development for support of summer interns. Hatch appropriations for supporting lab incidentals.



Perennial intermediate wheatgrass (*Thinopyrum intermedium*/Kernza®) for specialty grain

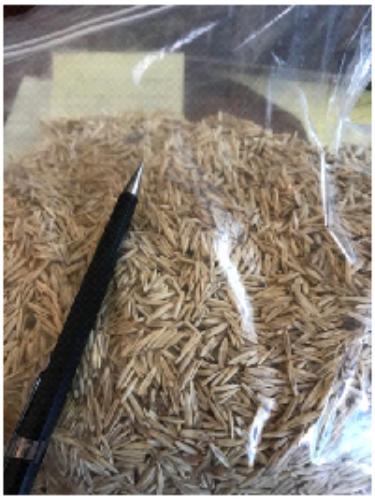
Investigators: K. Lombard (klombard@nmsu.edu), D. Begay, and F.J. Thomas

Project Overview: Intermediate wheatgrass (*Thinopyrum intermedium*) is a perennial grass related to wheat. Perennial crops offer soil health advantages and dual benefits for value-added small grains (like in brewing and baking) in addition to forage for animals. Breeding programs at The Land Institute and the University of Minnesota have used the species to develop a promising new perennial grain crop trademarked as Kernza®. Three experimental breeding lines were planted alongside a commercially available line at the seeding rate of 10 lbs/acre. In 2022, Russian thistle was the most challenging weed due to weak stand establishment and the low Kernza planting density. In 2023, plots were combined for grain potential. Additional information can be found at kernza.org and https://landinstitute.org/our-%20work/perennial-crops/kernza/.

Meeting the Needs of New Mexico: Little is known as to Kernza's performance in northwest New Mexico, so research on this crop can help shed light on the potential for perennial grain crops.

Impact: Dual-purpose perennial wheatgrass offers opportunities to reduce tillage while providing a value-added grain crop and forage potential. Future studies should examine increasing planting densities and optimizing cultural practices to reduce weed pressure at the time of establishment.

Funding Acknowledgement: Hatch Appropriations with seed support from Land Institute



Winter malted barley and other specialty grains for craft brewing

Investigators: K. Lombard (klombard@nmsu.edu), F.J. Thomas, and S.C. Allen

Project Overview: The Winter Malted Barley (WMB) a multi-state trial administered through the University of Minnesota with cultivars from public and private breeders, consists of two-row and six-row barley varieties. Heritage and Ancient grains are also planted for consumer interest as specialty grain. Planting occurs in the late summer/early fall before irrigation water is turned off. The crop overwinters provided there is ample winter soil moisture and heads up/is harvested by July. Evaluations include winter survival, lodging, disease, and yield.

Meeting the Needs of New Mexico: The objectives of these trials are to support growing interest by craft brewers and distilleries to obtain locally- sourced malted barley and to evaluate small grain options for Northwest New Mexico growers that might fit into a diversified crop rotation. The project also cooperates with the Central New Mexico Community College Beverage Production and Management Program

Impact: New Mexico has 100 breweries that produced 138,500 barrels in 2020, with an economic impact that grew to $391 million. Production of craft distillates also continues to see market growth in New Mexico.

Collaborating Agricultural Science Centers: Tucumcari Agricultural Science Center

Funding Acknowledgement: Hatch appropriations for supporting lab incidentals

Engaging Navajo elementary schools in randomized controlled trial of Yéego! Healthy Eating and Gardening

Investigators: Kevin A. Lombard (*1*; klombard@nmsu.edu) Shirley A.A. Beresford (*2)*, India J. Ornelas (*2*), Mark C. Bauer (*3*), Geraldine A. Garrity (*3*), Sonia K. Bishop (*2*), Brandon Francis (*1*), Eileen Rillamas-Sun (*2*), Linda V. Garcia (*3*), Filiberto S.A. Vecenti (*3*),

1 *Agricultural Science Center at Farmington, New Mexico State University, Farmington, New Mexico;*
2 *University of Washington/Fred Hutchinson Cancer Research Center, Seattle, Washington;*
3 *Diné College, Tsaile, Arizona*

Project Overview: Few healthy eating, school-based interventions have been rigorously evaluated in American Indian communities. Gardening and healthy eating are priorities in the Navajo Nation. Collaborations between researchers and local partners supported the implementation of this project. Shiprock and Tsaile/Chinle areas in the Navajo Nation were selected. Elementary schools were screened for eligibility. All students in third and fourth grades were invited to participate in the assessments. The intervention was efficacious in improving self-efficacy for eating fruits and vegetables among students over a school year. The findings warrant further evaluation of the intervention in larger-group randomized trials with schools in Navajo communities.

Meeting the Needs of New Mexico: Type-2 diabetes is a serious issue on the Navajo Nation. School garden projects offer an opportunity to reduce the risk of diabetes and improve the quality of life in Navajo communities.

Impact: Students in the intervention schools had self-efficacy scores for eating fruits and vegetables that were significantly higher than those in the comparison schools. The self-efficacy to grow fruits and vegetables in the school garden increased among those in the intervention schools. Any increase in serving consumption is impactful, with potential for lifetime health benefits if sustained. For more information, contact Kevin Lombard at klombard@nmsu.edu. The full report can be found in the American Journal for Preventative Medicine https://www.ajpmfocus.org/article/S2773-0654(22)00031-1/fulltext

Funding Acknowledgement: Partnership for the Advancement of Cancer Research, supported in part by NCI grants U54 CA132383 (NMSU) and U54 CA132381 (Fred Hutch).

Grants and Contracts

Awarded in 2022

- Pratt, R. C. (Principal), Djaman, K. (Co-Principal), Lombard, K. A. (Co-Principal), Patrick, M. M. (Co-Principal), Schutte, B. J. (Co-Principal), Prime Grant, "Bridging Traditional Agriculture and Climate-Adaptive Organic Agriculture in the Southwest", Sponsoring Organization: USDA/National Institute of Food and Agriculture NIFA, Sponsoring Organization Is: Federal, Research, Total Award: $744,971.00, Current Status: Active.
- Fernald, Alexender (Principal), Maxwell, C. (Co-Principal), Lombard, K. (Co-Principal), Guzman, I. (Co-Principal), Lilywhite, J. (Co-Principal), Heyduck, R. (Co-Principal)., "Expanding Organic Systems to Reduce Water Demand and Increase Agricultural Resilience in the Southwest," Sponsoring Organization: USDA/National Institute of Food and Agriculture NIFA, Total Award: $750,000.00, Current Status: Funded.
- Lombard, Kevin (Co-Principal) and Bonnie Hopkins (Co-Principal). “Northwest New Mexico Agriculture Restoration Project," New Mexico Office of the Attorney General”, $930,402.00, Current Status: Funded.
- Lombard, Kevin (Principal under NMSU subcontract). “New Beginnings for Navajo Nation Students" USDA, $500,000.00, Description: $140,088 under sub-award from Diné College. Current Status: Funded.
- Ghimire, R. (Principal), Angadi, S. (Co-Principal), Brewer, C. E. (Co-Principal), Burney, O. T. (Co-Principal), Cox, S. H. (Co-Principal), Cram, D. S. (Co-Principal), Geli, H. M. E. (Co-Principal), Hanan, N. P. (Co-Principal), Hurd, B. H. (Co-Principal), Idowu, J. J. (Co-Principal), Leinauer, B. (Co-Principal), Lombard, K. A. (Co-Principal), Prihodko, L. (Co-Principal), Smallidge, S. T. (Co-Principal), Spackman, C. (Co-Principal), Cooperative Agreement, "Improving Climate Resilience Through Carbon Management and Soil Health Research, Outreach, and Education Activities", Sponsoring Organization: USDA/Natural Resources Conservation Service, Sponsoring Organization Is: Federal, Research Credit: $3.00, PI Total Award: $995,000.00, Current Status: Active.
- Djaman, K. (Principal), Lombard, K. A. (Co-Principal), Prime Contract, "Potatoes USA SNAC Trial at NMSU", Sponsoring Organization: Potatoes USA, Sponsoring Organization Is: Foundation, Research Credit: $30.00, PI Total Award: $23,500.00, Current Status: Active.

Ongoing in 2022

- Lombard, K. A. (Principal), Sponsored Research, "SRS RN: Transforming Rural-Urban Systems: Trajectories for Sustainability in the lntermountain West", Sponsoring Organization: University of New Mexico, Sponsoring Organization Is: Other, Research Credit: $280,181.00, PI Total Award: $280,181.00, Current Status: Active.

Ended in 2022

- "Chip potato cultivars evaluation," POTATOES USA, $23,000.00, Status: Active, Effective Start Date: July 2021, Effective End Date: June 2022.
- "Field Evaluation and Marketability of 15 Table Grape Varieties for New Mexico," New Mexico Department of Agriculture, $52,818.00, Effective End Date: September 29, 2022
- "Northwest New Mexico New Farmer Network: Connecting Beginning Farmers to Land and Resources," New Mexico Department of Agriculture, $158,870.39, Description: Bonnie Hopkins (PI); Lombard (CO-I), Effective End Date: September 29, 2022

Research Publications

- Beresford, S. A.A., Ornelas, I., Bauer, M. C., Garrity, G. A., Bishop, S. K., Francis, B., Rillamus-Sun, E., Garcia, L. V., Vecenti, F. S.A., Lombard, K. A. (2022). Group Randomized Trial of Healthy Eating and Gardening Intervention in Navajo Elementary Schools (Yéego!). American Journal of Preventative Medicine (AJPM) Focus, 1(2), 1-11. https://www.ajpmfocus.org/action/showPdf?pii=S2773-0654%2822%2900031-1
- Darapuneni, M.K., L.M. Lauriault, G. Martinez, J.O. Idowu, K. Djaman. 2022. Yield potential and water use efficiency of alternate rotation crops in the semiarid environment of southwestern USA. Applied Engineering in Agriculture 38(6):845-851. https://doi.org/10.13031/aea.15030.
- Djaman K., K. Koudahe. 2022. Discussion of "Effects of Biochar and Residual Plastic Film on Soil Properties and Root of Flue-Cured Tobacco" by Chao Gao, Xiaohou Shao, Xu Yang, Xiuneng Li, and Wenbo Wu. Journal of Irrigation and Drainage Engineering (December 2022) https://ascelibrary.org/doi/abs/10.1061/JIDEDH.IRENG-9919.
- Djaman K., K. Koudahe. 2022. Discussion of "Soil moisture or ET-based smart irrigation scheduling: a comparison for sweet Corn with sap flow measurements" by Gadson Asiimwe, Hadi Jaafar, Mustapha Haidar, and Roya Mourad. Journal of Irrigation and Drainage Engineering 2023, 149(2): 07022027. https://doi.org/10.1061/(ASCE)IR.1943-4774.0001738.
- Djaman K., K. Koudahe, A.T. Mohammed. 2022. Dynamics of Monthly and Seasonal Crop Evapotranspiration of Four Major Crops for Planning on a Large Commercial Farm: Case of the Navajo Agricultural Products Industry, New Mexico (USA). Agronomy 12(11), 2629; https://doi.org/10.3390/agronomy12112629.
- Djaman, K. 2022. Corrigendum to 'Critical review of the impact of cover crops on soil properties'. International Soil and Water Conservation Research. https://doi.org/10.1016/j.iswcr.2022.09.002.
- Djaman, K., K. Koudahe, A. Saibou, M. Darapuneni, C. Higgins, S. Irmak. 2022. Soil Water Dynamics, Effective Rooting Zone, and Evapotranspiration of Sprinkler Irrigated Potato in a Sandy Loam Soil. Agronomy 12(4), 864. https://doi.org/10.3390/agronomy12040864.
- Djaman K., K. Koudahe, H.D. Koubodana, A. Saibou, S. Essah. 2022. Tillage Practices in Potato (*Solanum tuberosum* L.) Production: A Review. American Journal of Potato Research. 99:1–12. https://doi.org/10.1007/s12230-021-09860-1.
- Djaman, K., S. Allen, D.S. Djaman, K. Koudahe, S. Irmak, N. Puppala, M.K. Darapuneni, S.V. Angadi. 2022. Planting date and plant density effects on maize growth, yield, and water use efficiency. Environmental Challenges, 6, 100417. https://doi.org/10.1016/j.envc.2021.100417.
- Koudahe K., S.C. Allen, K. Djaman. 2022. Critical review of the impact of cover crops on soil properties. International Soil and Water Conservation Research, 10 (2022):343-354. https://doi.org/10.1016/j.iswcr.2022.03.003.
- Irmak S., D. Brar, M.S. Kukal, L. Odhiambo, K. Djaman. 2022. Automated real-time irrigation analytics inform diversity in regional irrigator behavior and water withdrawal and use characteristics. Agricultural Water Management 272 (2022) 107837. https://doi.org/10.1016/j.agwat.2022.107837.

Cooperators and Collaborators

- Basin Cooperative, Durango, CO
- Colorado State University, San Luis Valley Research Center, Center, CO
- Colorado State University Soil and Crop Sciences, Fort Collins, CO
- Colorado State University, Southwestern Colorado Research Center, Yellow Jacket, CO
- Diné College, Shiprock, NM/Tsaile, AZ
- Dream Diné Charter School, Shiprock, NM
- Fort Lewis College, Durango, CO
- Higgins Farms, Inc., Farmington, NM
- Land Institute, Salina, KS
- Navajo Agricultural Products Industry (NAPI), Farmington, NM
- Navajo Ethno-Agriculture, Nenahnezad, NM
- Navajo Mesa Farms, Farmington, NM
- Navajo Nation Human Research Review Board, Window Rock, AZ
- Navajo Technical University, Crownpoint, NM
- New Mexico Department of Agriculture, Las Cruces, NM
- NMSU Agricultural Experiment Station (AES) and Science Centers (Statewide)
- NMSU College of Agricultural, Consumer, and Environmental Sciences (ACES), Las Cruces, NM
- NMSU College of Engineering, Las Cruces, NM
- NMSU San Juan County Cooperative Extension Service, Aztec, NM
- Northern Arizona University, Center for Ecosystem Science and Society, Flagstaff, AZ
- Pivot Bio, Berkeley, CA
- Potatoes USA, Denver, CO
- Quality Irrigation Solutions, Cortez, CO
- Rocky Mountain Seed Alliance, Mancos, CO
- San Juan River Farm Board, San Juan County, NM
- San Juan County Cooperative Extension, Aztec, NM
- San Juan Soil and Water Conservation District, Aztec, NM
- Second Nature Research, LLC, Yuma, AZ
- Shiprock Area Food Access Coalition, Shiprock, NM
- University of Arizona, Native FEWS Alliance, Tucson, AZ
- University of Minnesota Department of Agronomy and Plant Genetics, St. Paul, MN
- University of New Mexico, Intermountain Transformation Network, Albuquerque, NM
- University of Washington School of Public Health/Fred Hutchinson Cancer Research Center, Seattle, WA
- USDA Agricultural Research Service, U.S. Potato Genebank, Sturgeon Bay, WI
- USDA NRCS, New Mexico, San Juan County Soil and Water Conservation District 1, Aztec, NM
- Utah State University, San Juan County Cooperative Extension Service, Monticello, UT
- Valley Irrigation (Valmont Industries), Valley, NE
- Wilbur-Ellis, Farmington, NM

Outreach Activities

- Dream Diné Charter School. Guest lecture on food and health", Scope: Local (April 2022)
- Native American Producer Success Project - NAPS Webinar Series, Native American Producer Success Project - NAPS, Virtual, "Irrigation Methods: Irrigation with Drip", Scope: Regional, Invited or Accepted? Invited. (May 11, 2022).
- Sustainable Food, Energy, and Water Community Outreach. Workshop/Field Day 120 participants, NSF Transformation Network including NMSU ASC Farmington, Shiprock, Navajo Nation, NM. (June 7, 2022).
- NMSU-ASC Farmington 2022 In-Person Field Day. 130 participants. NMSU-ASC Farmington Field Day, NMSU-ASC Farmington, Farmington, NM, NM. In-person presentations and Instagram video films produced in 2021 were repurposed (July 15, 2022).
- Post WRRI Conference Tour: NMSU ASC Farmington and Navajo Agricultural Products Industry, NMSU/WRRI, Farmington, NM, NM. Bus tour of NMSU ASC Farmington and Navajo Agricultural Products Industry hoop houses and Region 2 scales/store. (June 10, 2022)
- NMSU Grants Campus hoophouse construction project. Workshop, NMSU Grants, NM, Grants, NM. (September 2, 2022).
- Kirtland Highschool Grape Sensory Evaluation. Thirty-three high school students participated in sampling grapes grown from the NMSU-ASC Farmington experimental table grape study and compared to store-bought table grapes, NM. Funding was through NMDA. (September 13, 2022).
- Navajo Preparatory Highschool Tour of ASC Farmington. Thirty-eight high school students participated in a tour of the ASC Farmington, NM. Navajo Preparatory students toured the ASC Farmington. The students were from two science classes. (September 20, 2022).
- Native American Producer Success Project - NAPS Webinar Series, Native American Producer Success Project - NAPS, Virtual, "Composting", Scope: Regional (October 5, 2022).
- Nenahnezad Chapter House Farmers Monthly Meeting, Nenahnezad Chapter House, Navajo Nation, Nenahnezad Chapter House, Navajo Nation, "Soil Sampling Techniques and Interpreting Soil Sample Test Results", Scope: Local (December 15, 2022).
- Several individual producer visits

Advisory Committee

- Dave Zeller (Navajo Agricultural Products Industry; NIIP canal)
- Renae Pablo (Navajo Agricultural Products Industry; NIIP canal)
- Roselyn Yazie (Navajo Agricultural Products Industry; NIIP canal)
- Nonabah Lane (Navajo Ethno Agriculture, Fruitland canal, in remembrance)
- Gloria Lane (Navajo Ethno Agriculture, Fruitland Canal)
- Bart Wilsey (Farmington Museum, Stacey Ditch; Wilsey Vineyard)
- Dave Arnold (Turley Manzanarez ditch; Wines of the San Juan)
- Carol Cloer (Hammond Ditch; Cloer Hay)
- Gary Hathorn (Farm Bureau)
- Vikki Lake (Shiprock High School; Waterflow)
- Bonnie Hopkins (NMSU San Juan County Cooperative Extension)
- San Juan County Soil and Water Conservation District
- Tracey Raymond (President, San Juan River Irrigation Board, Nenahnezad Chapter)
- Elbert Hamblin, La Plata
- Amber Crotty, Sheep Springs

Personnel

Faculty and Staff

- Kevin Lombard, Professor of Horticulture and Superintendent
- Koffi Djaman, Assistant Professor, Agronomy
- Franklin Jason Thomas, Farm and Ranch Supervisor
- Dallen Begay, Farm Manager
- Margaret West, Associate Research Scientist
- Sam Allen (Until Sept. 2022), Associate Research Scientist
- Chad Begah, Agricultural Experiment Station Laborer
- Jonah Joe, Agricultural Experiment Station Laborer

Graduate and Undergraduate Students

- Brandon Francis, NMSU Graduate Research Assistant
- Audrey Harvey, Northern Arizona University
- Emiliano McLane, NMSU Graduate Research Assistant
- Bhimsen Shrestha, NMSU Graduate Research Assistant

Undergraduate Students and Interns

- Korbin Nakai, Kirtland High School
- Monique Russel, NMSU