Agricultural Water Use in New Mexico

Initial Analysis Results and Potential Use Cases of an Agricultural Water Use Quantification Tool

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Prepared for the Thornburg Foundation by

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Introduction

The Thornburg Foundation's Water Initiative and Land & Agriculture Initiative are focused on creating more resilient water and food systems in New Mexico. To support these programs, the Foundation identified a need to better understand agricultural water use patterns throughout the state, using consistent data sources and replicable methods; and to disseminate this analysis along with information on federal funding sources for improving the resilience of the state's agricultural and water sectors. Thornburg retained CK Blueshift, LLC, to build a geospatial analysis tool that combines newly available, satellite-derived data quantifying consumptive water use with precipitation and cropland data. This tool can support quantification of annual trends in total agricultural water use state-wide; estimation of total consumptive water use by crop, region, or irrigation district; and evaluation of water savings potential from existing or proposed conservation programs. Once this work was complete, the Foundation engaged a variety of New Mexico stakeholders to review the tool, obtain suggestions on how it could be used, and identify aspects of the tool that may need further verification or refinement.

This report summarizes the work generated through this project. The first section describes the data sources used, including their uncertainties and limitations; the methods used to assemble the data; and the analytical approach used to analyze the datasets. Results are summarized in the second section. The report's third section offers a summary of stakeholder feedback, including possible applications of the tool, and next steps to increase its utility. Appendix A provides a summary of new federal funding opportunities associated with the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act, with a particular focus on agricultural water conservation and how the tool might assist water users in accessing this funding.

Methods

Data Sources

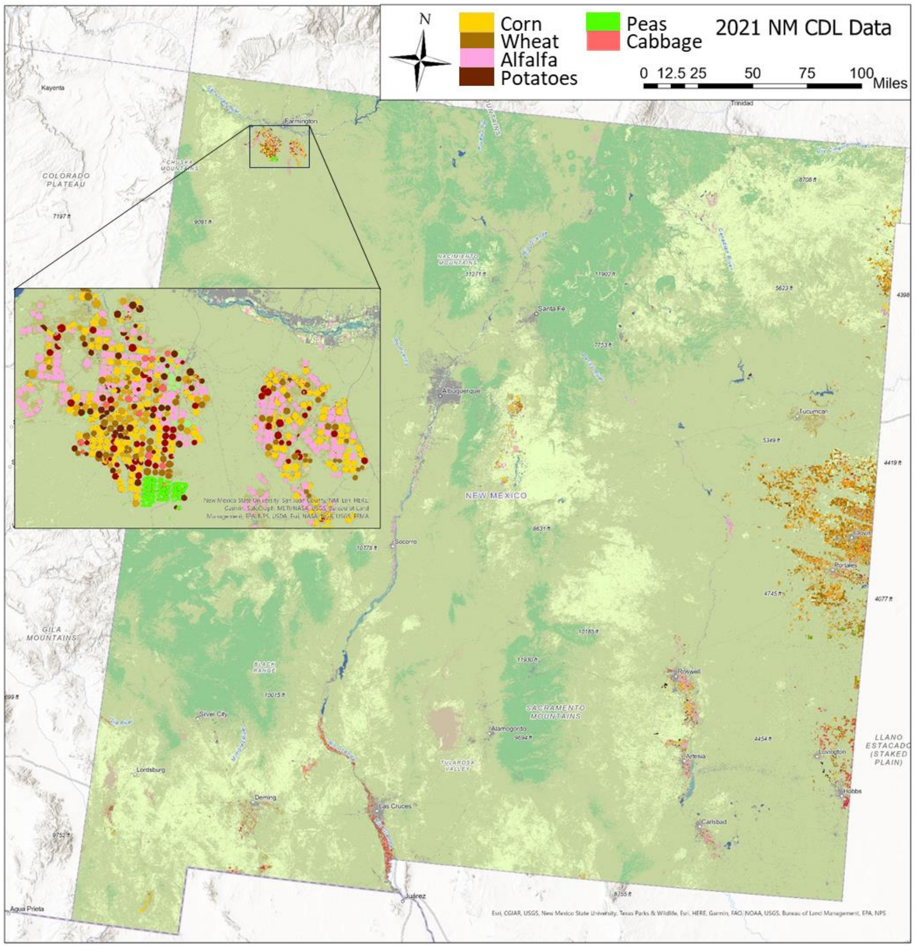
The analysis relies on three data sources, each of which provide spatially continuous data for the state of New Mexico between 2016 and 2021. These datasets include crop type information from the US Department of Agriculture (USDA) Cropland Data Layer (CDL), satellite-derived evapotranspiration data estimated from OpenET, and precipitation data from the PRISM Climate group at Oregon State University. The tool uses annual data from both OpenET and PRISM, so that all water balance calculations reported here are on an annualized basis.

Cultivated Fields: USDA Cropland Data Layer (CDL)

The USDA Cropland Data Layer (CDL) is a satellite-derived geospatial layer that classifies all the agricultural lands in the United States by crop type (Boryan et al., 2011; Han et al., 2012). The CDL is developed annually by the National Agricultural Statistics Service (NASS) of the USDA, using multiple sets of satellite imagery and a set of decision tree algorithms that classify each pixel by crop type.

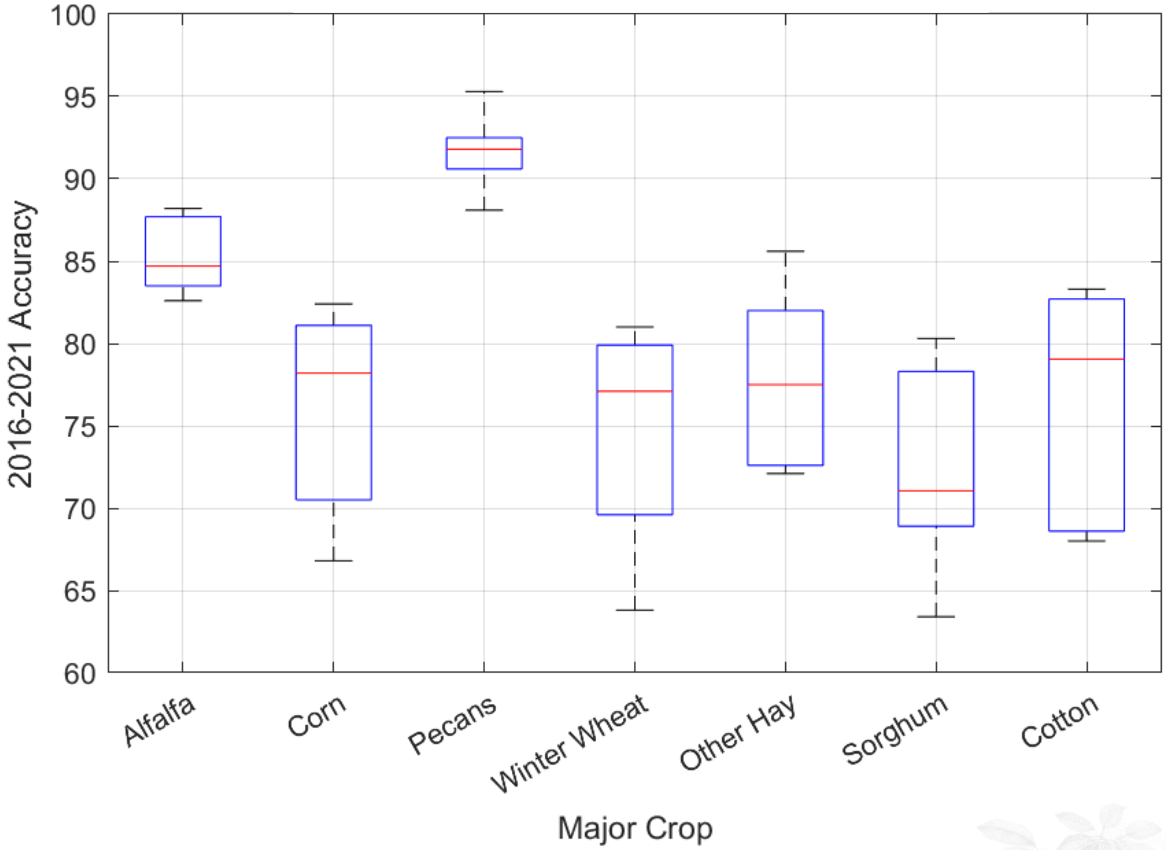
Each year, the CDL is compared to ground truth data collected by the USDA Farm Service Agency, which allows NASS to develop statistics regarding product accuracy to accompany each product release (Boryan et al., 2011). These accuracy reports are developed for each state and each year that the CDL is released. An example of the 2021 CDL data for New Mexico is shown in **Figure 1**, including a detail highlighting some of the major crops being grown in the upper San Juan basin in northwestern New Mexico. The accuracy statistics for the major crops described in this report are shown in **Figure 2**. As shown, classification accuracy is generally between 70-90% for the major New Mexico crops over the six years analyzed, with relatively higher classification accuracy (80-90%) for pecans and alfalfa, and relatively lower classification accuracy (65-80%) for sorghum, corn, and winter wheat.

Figure 1. 2021 cropland data layer (CDL) for New Mexico. Inset shows center pivot irrigation fields in upper San Juan basin. Legend highlights some of the major crops in this region.



This analysis used six years of CDL data from 2016-2021, downloaded at a 30-meter spatial resolution for the state of New Mexico. Additional details on the Cropland Data Layer can be found in (Boryan et al., 2011), (Han et al., 2012), and at the USDA NASS site:
https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php.

Figure 2. Boxplot illustrating USDA reported classification accuracy for the CDL for seven major crops in New Mexico. Red line = median accuracy value over six years of data.



Evapotranspiration Data: OpenET

The OpenET dataset provides a suite of satellite-derived evapotranspiration (ET) estimates, which are geo-referenced at a 30-meter resolution over the western United States. The six individual algorithms used to estimate ET on the OpenET platform are widely used by government and water management agencies across the United States and internationally. These algorithms use a combination of visible and thermal bands from satellite data to calculate evapotranspiration using energy balance or reflectance-based approaches (Melton et al., 2022). In addition to the six individual models, OpenET provides an ensemble mean value, which minimizes the potential for outliers to affect the ET estimates. All of the OpenET data are available at: https://openetdata.org/.

The OpenET team completed an intercomparison and accuracy assessment by comparing the ET calculated from each of the individual models and the ensemble mean to ground-based measurements. This assessment showed that ET estimates have lower error at longer timesteps (e.g., seasonal or monthly) compared to shorter timesteps (e.g., daily), and that the accuracy of the ensemble mean is higher than for any of the individual models (Melton et al., 2022). Comparisons between measured monthly ET measured at flux towers and the ensemble mean of the OpenET models for croplands consistently had r^2 values above 0.9, with mean absolute errors of between 15-17% (Melton et al., 2022; Volk et al., 2024). On a water year basis (as reported in this study) the ensemble mean ET value was shown to be within 5% of ground truth data from flux tower measurements (Melton et al., 2022).

This project used only annual data from the OpenET ensemble to calculate water use across New Mexico. At the time this project began, OpenET data were available for the period 2016-2021, so those six years form the foundation of the results reported here. **Figure 3** shows an example of the OpenET data for New Mexico for the 2021 calendar year.

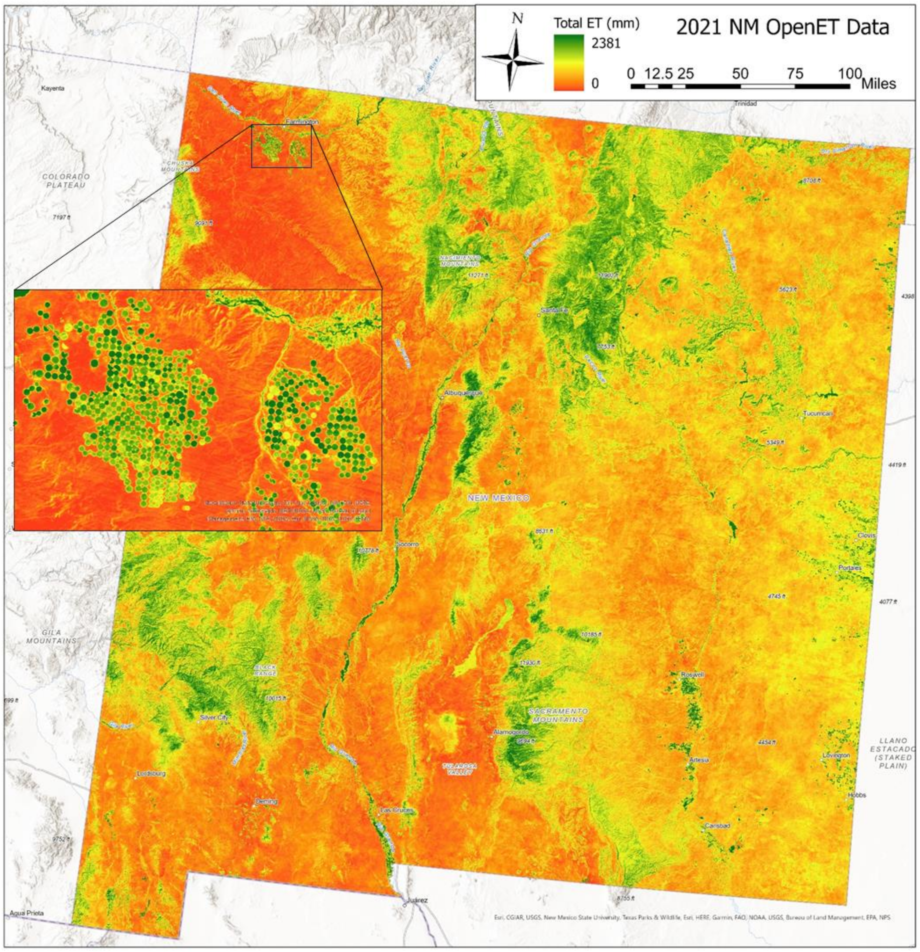


Figure 3. 2021 OpenET data for the state of New Mexico. Inset shows annual ET values in the upper San Juan basin, for comparison with crop types shown in Figure 1.

PRISM

The PRISM dataset summarizes historical precipitation and temperature across the conterminous United States (Daly et al., 2000; Gibson et al., 2002). PRISM is built from a combination of station observations and a statistical model that accounts for the elevation and aspect of the landscape. The PRISM product is available on a continuous grid at a 4-kilometer spatial resolution at monthly to annual timesteps. Accuracy assessments conducted on the PRISM precipitation data for the Western United States demonstrate a mean absolute error of 17%, and a bias of approximately 3.5% (Daly et al., 1994). The raw data are available at: https://prism.oregonstate.edu/.

This project used the annual PRISM precipitation data for the state of New Mexico between 2016-2021. **Figure 4** shows an example of the PRISM dataset for New Mexico for 2021.

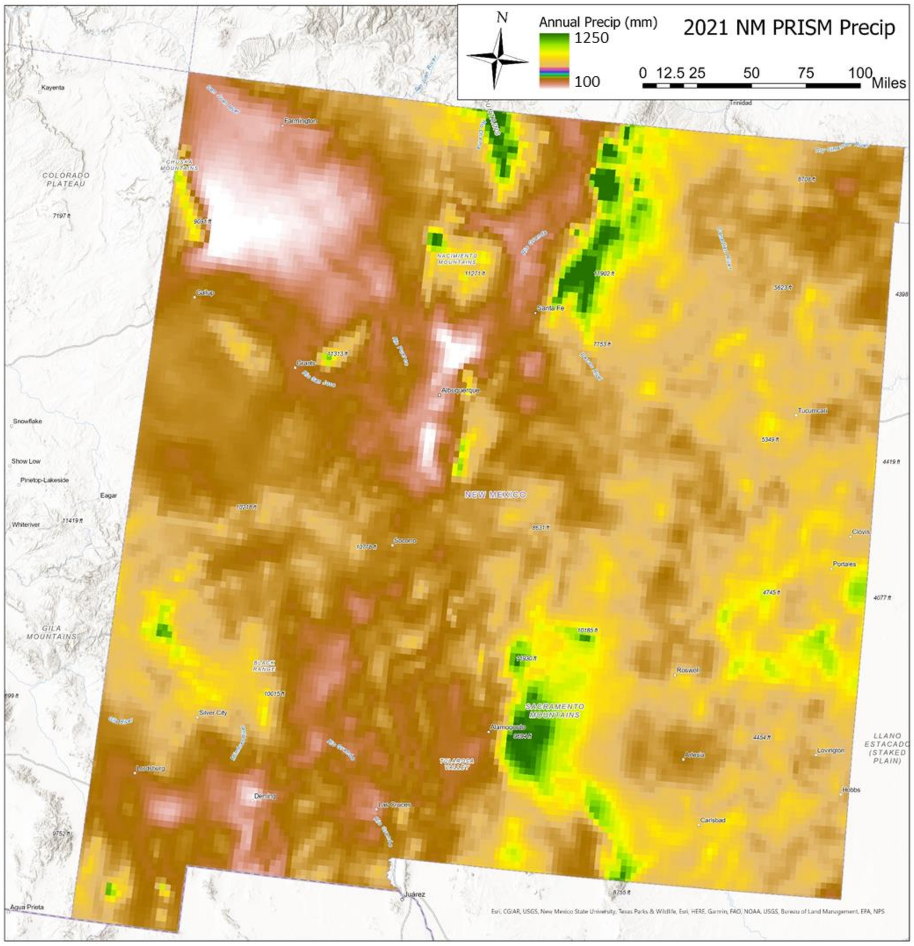


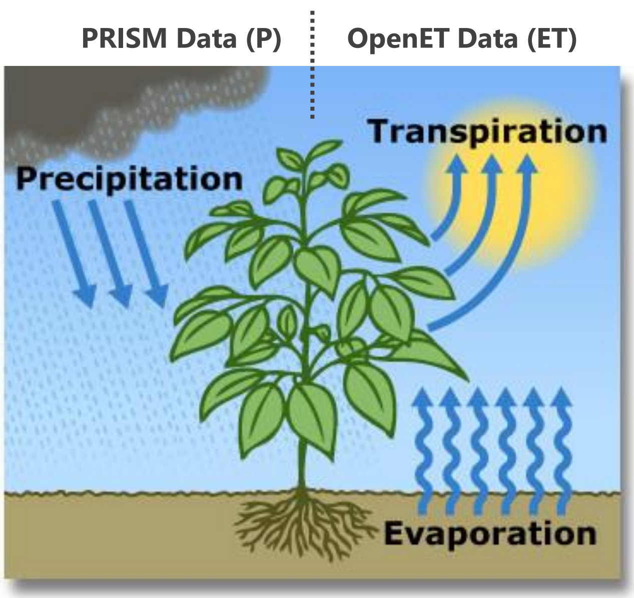
Figure 4. 2021 PRISM precipitation data for the state of New Mexico.

Data Processing

The first step in the analysis was to create a common data frame for the CDL, OpenET, and PRISM datasets, putting the crop type, precipitation, and ET data on a common grid. All three datasets were re-gridded and re-projected to an Albers projection with a NAD83 datum and a 30m pixel resolution. The raw CDL and OpenET data were already gridded at 30m, so these datasets required minimal scale adjustment; the PRISM data were downsampled and reprojected from a 4km to a 30m resolution to match the other two datasets. All the geospatial data processing was done using ESRI ArcGIS software. Once all the data were assembled onto a common reference frame, the datasets were exported as GeoTIFF files for further analysis. Six sets of GeoTIFF files were created, one for each of the years between 2016 and 2021. Each set of GeoTIFFs consisted of one crop layer, one OpenET layer, and one PRISM precipitation layer.

The remaining data processing was done using scripts written in MATLAB technical computing software. For each year of data, the MATLAB scripts first calculated the total acreage of each crop in the state from the CDL. For each crop, the scripts then identified all the pixels cultivated with that crop in that year and extracted the precipitation and ET data from each of those pixels. ET exceeds precipitation across most cultivated lands in New Mexico; the difference between total annual ET and precipitation (P) for each crop is a proxy for the additional irrigation required to meet that crop's annual water demand. The scripts calculate (ET-P) at each pixel to estimate the water deficit for each 30x30m plot of land (**Figure 5**). To maintain focus on major crops in New Mexico, this state-wide analysis was limited to crops with at least 5,000 acres in cultivation. Each pixel-scale estimate of ET-P was retained for each crop, resulting in tens to hundreds of thousands of individual estimates of the net irrigation requirement for each crop and each year.

From these raw data, the scripts generate plots illustrating the full distribution of net irrigation requirements by crop. For each crop and each year, the total acreage state-wide and the mean irrigation requirement were also calculated, enabling an evaluation of trends in both total water use and crop acreage over the 6-year analysis period.



https://www.usgs.gov/media/images/evapotranspiration-sum-plant-transpiration-and-evaporation

Figure 5. Schematic illustrating the water balance calculation conducted at each pixel for each crop. Precipitation is approximated by the PRISM data and the sum of evaporation and transpiration is approximated by the OpenET data. The difference between the two is a proxy for the net irrigation requirement at that pixel.

Results

Water Consumption by Crop

Figure 6 shows the raw water use calculations for all crops in New Mexico with >5,000 acres in cultivation in 2021. These data summarize the differences between ET and precipitation calculated at each individual 30m pixel in the state for each crop, a proxy for each crop's net irrigation requirement. Each of the box and whisker plots summarizes thousands to hundreds of thousands of individual observations, depending on the number of pixels classified under each crop category. As illustrated by the horizontal red lines in **Figure 6**, the majority of the crops in cultivation in 2021 had median irrigation requirements between 400-1000mm (~16-40 inches). The crops with the highest median irrigation requirements in 2021 were pecans, alfalfa, corn, and fields that were double cropped with corn and other grains.

Figure 6. Box and whisker plots showing net water deficit by crop, for all crops with >5000 acres in cultivation in 2021.

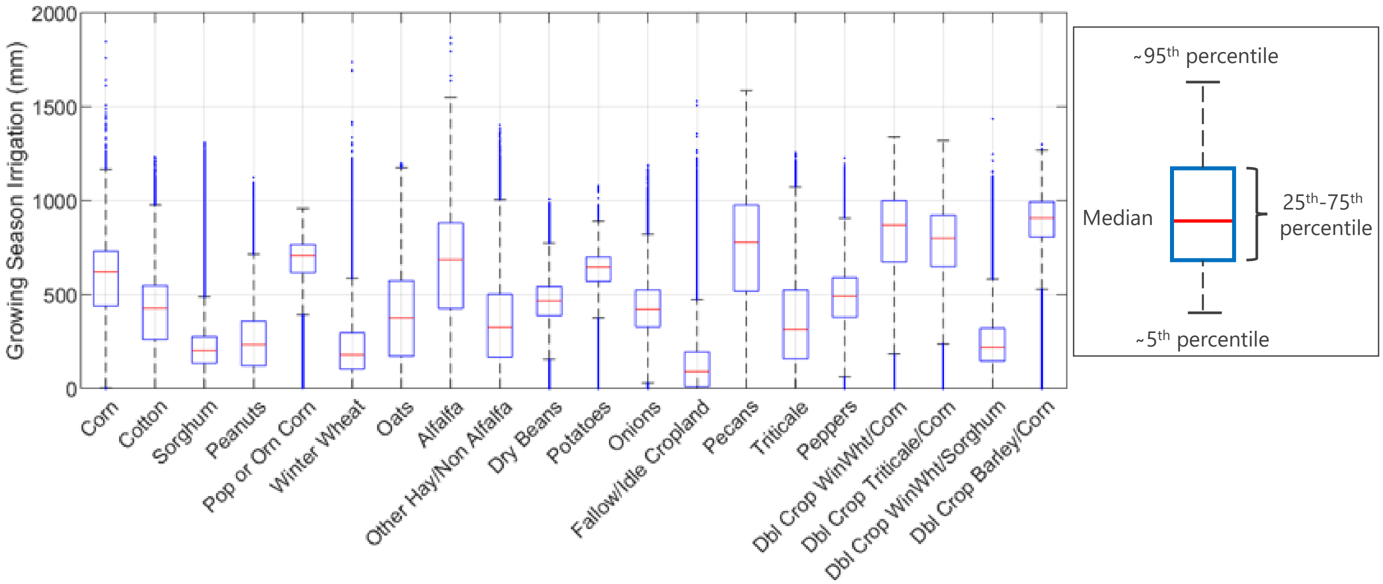


Figure 6 also shows that the difference between ET and P is often positive – although generally small –for many of the pixels classified by USDA as "fallow/idle cropland." This means that on an annual basis, fallowed fields remain a net consumer of water (i.e., the amount of water lost to evapotranspiration is greater than the amount of water falling on those fields as precipitation). There are three possible explanations for this result. First, it is possible that the USDA CDL mis-classified some of these "fallowed" fields when they are actually cultivated and/or irrigated for part of the year. The USDA reported accuracy for fields classified as "fallow/idle cropland" is typically around 70%, so this misclassification may explain some, but not all, of these results. Second, uncertainty in the OpenET and/or PRISM data could result in errors in either the ET or the precipitation values. However, because reported errors on both OpenET and PRISM data are relatively low (5-17%) this is also unlikely to fully explain this result.

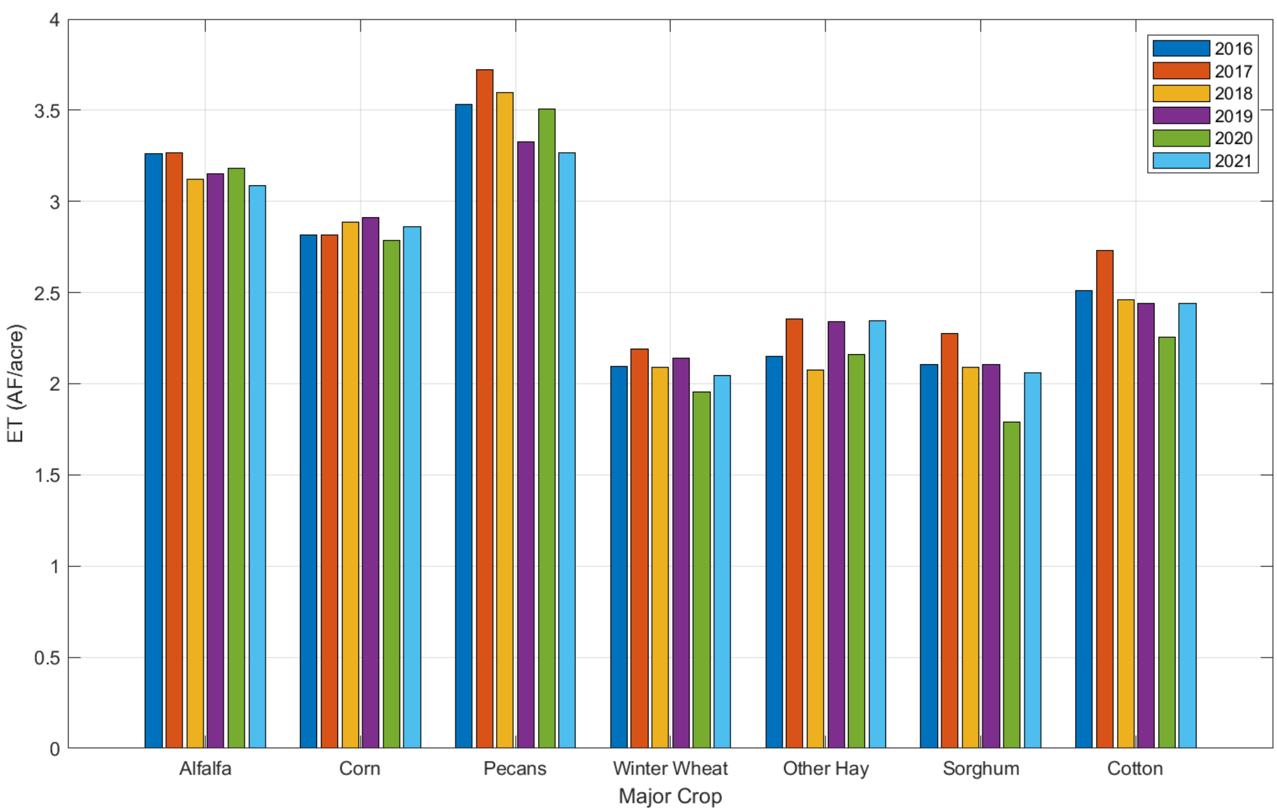
The third, and most likely, explanation for this result is that the vegetation and exposed soil on fallowed fields, while not typically receiving direct water inputs from irrigation, can still access soil moisture and shallow groundwater that can be lost to evapotranspiration. This is particularly likely in lowland areas near rivers, irrigation canals, and other potential sources of moisture. If true, this finding would imply that depending on how fallowed fields are managed they can actually remain a net consumer of water, so that taking fields out of cultivation does not completely eliminate consumptive water use in those areas.

State-Wide Agricultural Water Use

The state-wide analyses looked at trends in ET, net irrigation requirement, cultivated acreage, and total water use for seven major crops in New Mexico between 2016 and 2021. These state-wide summary data highlight the effects of climate on irrigation, as well as the combined impacts of climate and cropping patterns on state-wide water use for irrigated agriculture.

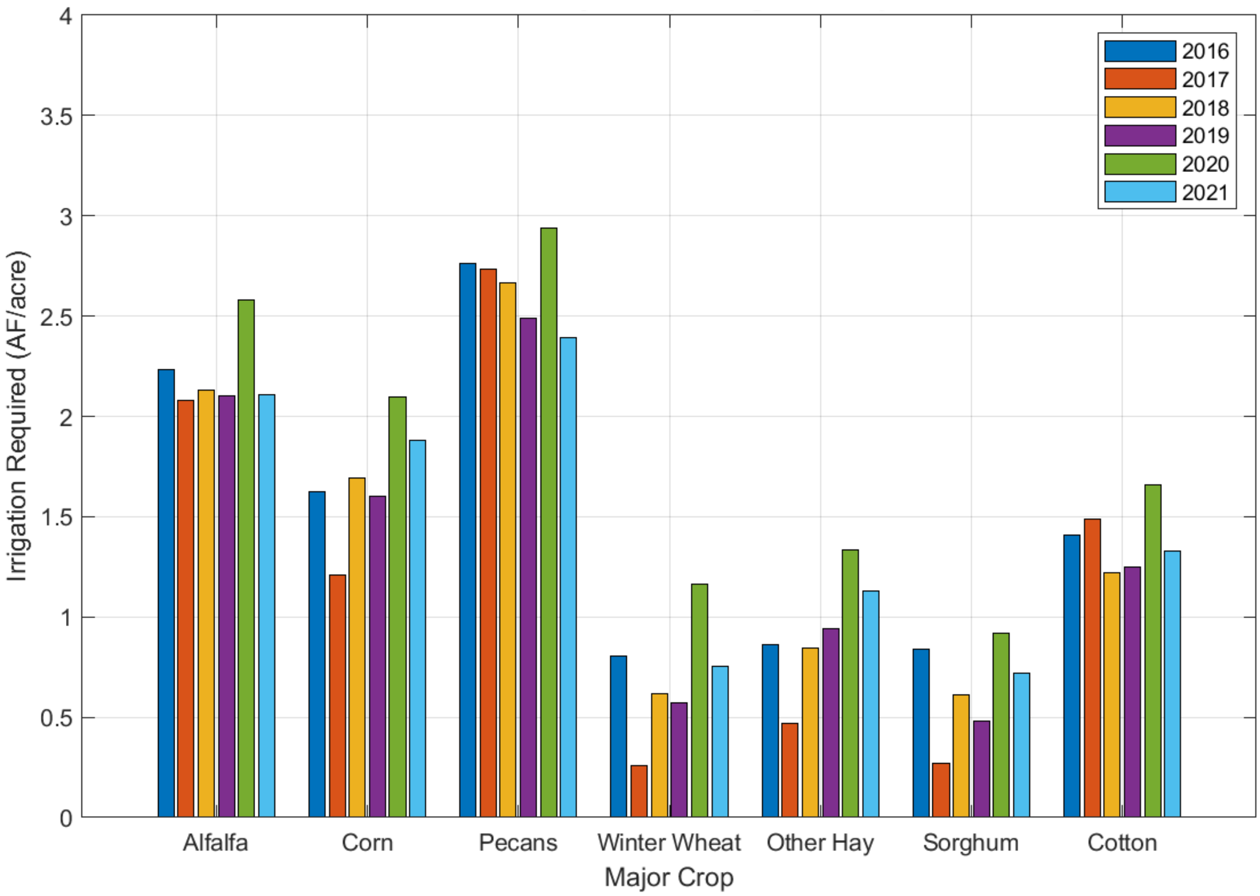
Figure 7 summarizes the average annual ET in acre-feet (AF) per acre for each of seven major crops in New Mexico over the six years analyzed (2016-2021). As shown in **Figure 7**, the average annual ET for these crops ranges from a high of approximately 3.5 AF/acre for pecans to a low of approximately 2 AF/acre for winter wheat, sorghum, and other hay. Figure 7 also shows that while there is some year over year variability in ET within crops, this variability is relatively small compared to the differences in ET between crops. For example, the average annual ET for alfalfa and corn varies by less than 5% year over year, and there are only two instances (cotton in 2017 and sorghum in 2020) where ET from any crop varies by more than 10% from its long-term mean. In other words, the total consumptive water demand for all seven of the major crops analyzed is relatively stable over the six years evaluated.

Figure 7. Summary of average (mean) annual ET between 2016-2021 for each of seven major crops in New Mexico.



In contrast to the total ET, the net irrigation requirement (ET-P) for many crops varies significantly year over year. **Figure 8** summarizes the average annual difference between ET and precipitation (also in AF/acre) for the same seven major crops in New Mexico. Variations in the average irrigation requirement by crop primarily reflect inter-annual variability in state-wide precipitation. For example, the PRISM data indicate that 2017 was the wettest of the six years analyzed state-wide (approximately 30% wetter than the average of the six years) and 2020 was the driest year (approximately 30% drier than average). This climate signal is reflected in the net irrigation requirements for nearly all crops, with total irrigation required in 2017 nearly always lower than in the other years, and the total irrigation required in 2020 nearly always higher than in the other years.

Figure 8. Summary of the average (mean) annual difference between ET and precipitation between 2016-2021 for seven major crops in New Mexico.



Estimating total annual water use by crop requires a combination of total acreage and net irrigation requirement for each crop. **Figure 9** shows the total cultivated acreage by year for each of the seven major crops analyzed. As shown, the cultivated acreages of some crops (e.g., alfalfa and pecans) were relatively stable between 2016-2021; while other crops had either decreasing (e.g., winter wheat) or increasing (e.g., sorghum) trends over the six-year period. The net irrigation requirements summarized in **Figure 8** were then combined with the acreage summaries in **Figure 9** to estimate the total water required, state-wide, for each crop in each year in the analysis. **Figure 10** shows these results, and illustrates that alfalfa was the highest net water user in nearly all years, followed by winter wheat, sorghum, and corn. Water use from the latter three crops was substantially more variable over the six years analyzed, reflecting a combination of changes in cultivated acres (**Figure 9**) and changes in irrigation requirements (**Figure 8**) due to variations in precipitation and temperature.

Figure 9. Trends in total irrigated acreage between 2016-2021 for seven major crops in New Mexico.

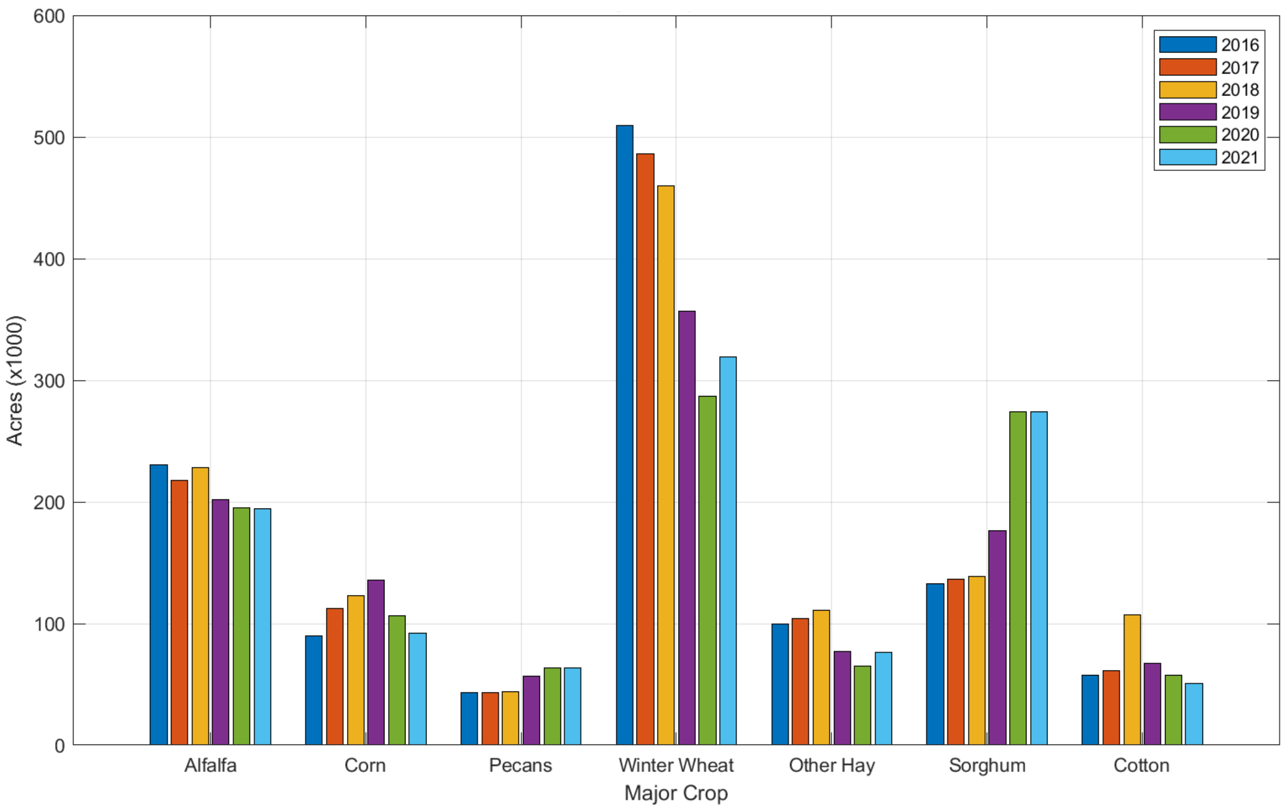
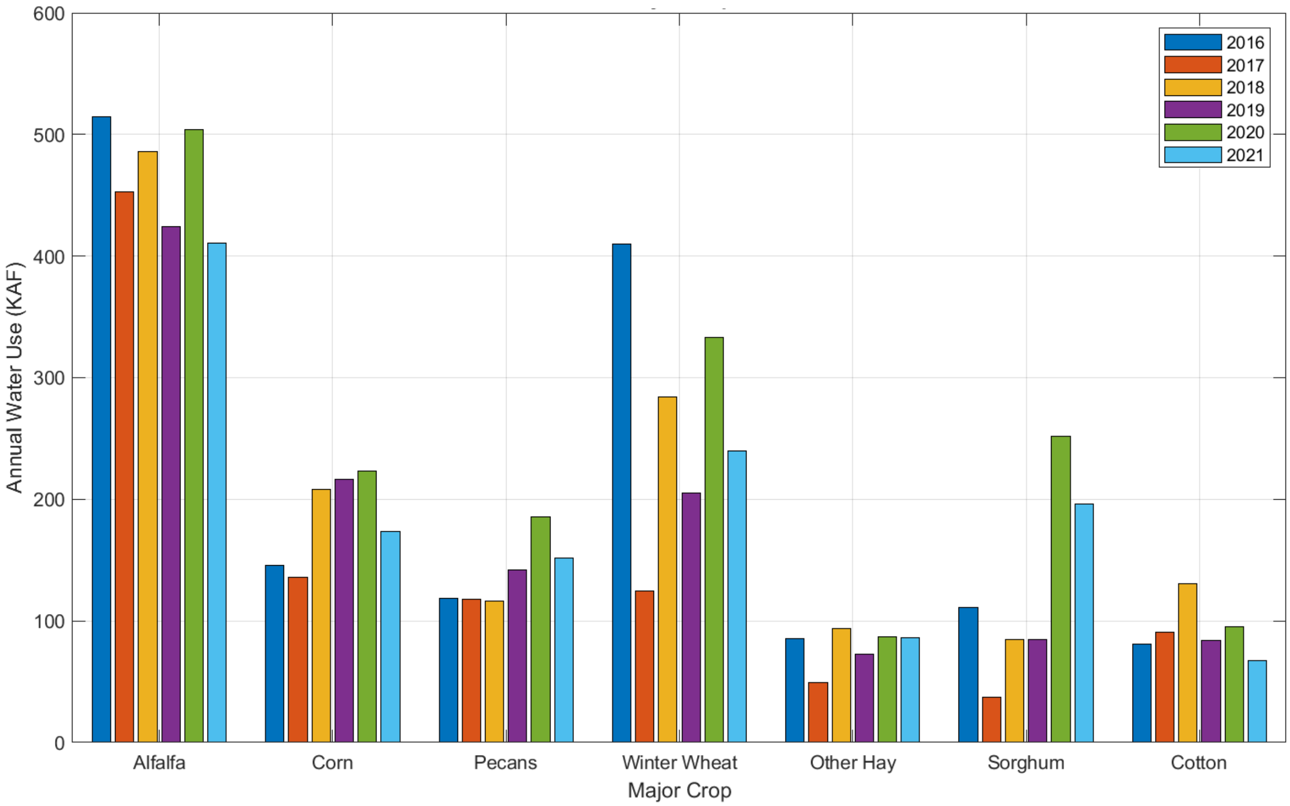


Figure 10. Estimated total annual water use between 2016-2021 for seven major crops in New Mexico.



Water Use by Region

Figure 11 compares net consumptive water use (ET-P) for seven key crops within the three major irrigation districts in the San Juan and Rio Grande basins. As shown, pecans dominate net water use in the Elephant Butte Irrigation District (EBID); corn and alfalfa consume nearly 80% of all water used in the Upper San Juan/Navajo Indian Irrigation Project (NAPI); and alfalfa alone consumes nearly 75% of all water in Middle Rio Grande Conservancy District (MRGCD). The total water use for these seven crops is highest in EBID, followed by the Upper San Juan/NAPI and MRGCD.

However, the agricultural water used within these three irrigation districts typically accounts for less than half of the water use state-wide for the seven crops analyzed. Except for pecans, the net water used by all other crops is substantially higher in other parts of the state than in these three irrigation districts (**Figure 12**). Although a detailed analysis of the regions outside the Rio Grande and San Juan basins was outside the scope of this study, a qualitative review of cropping patterns from the cropland data layer suggests that the majority of the alfalfa grown outside of the Rio Grande and San Juan basins is in the Pecos Valley Conservancy and Fort Sumner Irrigation districts; the majority of sorghum is grown in a broad region of eastern New Mexico near the towns of Clovis and Portales; and the majority of cotton is grown in southeastern New Mexico near the towns of Lovington and Hobbs.

Figure 11. Annual net consumptive water use (ET-P) among 7 major crops in three major irrigation districts of New Mexico, based on 2021 OpenET and CDL data. Size of each pie is approximately scaled to the total water used for the 7 crops shown in each district.

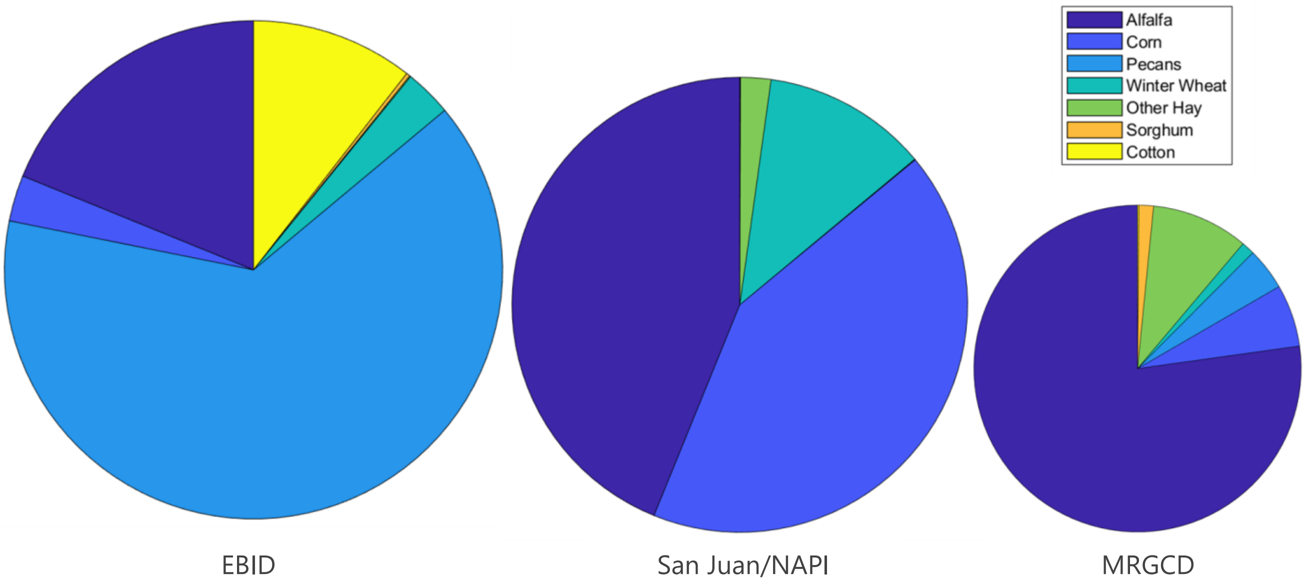
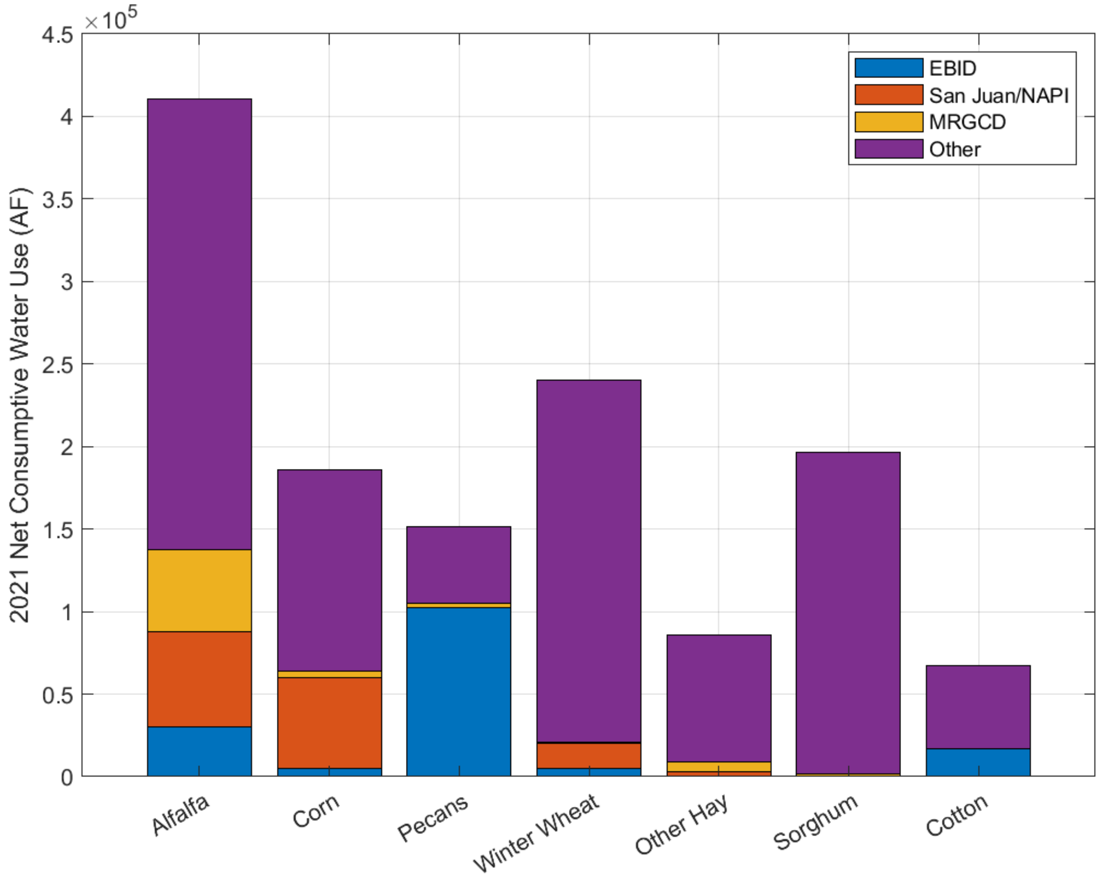


Figure 12. Comparison of total water use in San Juan and Rio Grande irrigation districts in 2021 vs the remainder of the state. Note that the majority of water use for most crops occurs outside of the San Juan and Rio Grande basins.



Stakeholder Summary: Recommendations and Potential Use Cases

The Thornburg Foundation engaged a wide range of New Mexico water interests to preview the tool developed by CK Blueshift, with a focus on identifying potential uses as well as verification and validation needs. Thornburg reached out to state and federal water and agricultural agency personnel, irrigation district representatives, representatives of the six Middle Rio Grande pueblos, conservation organization staff, and other interested parties for a series of webinars to demonstrate the tool and explore how it might be used, especially in water planning and water conservation efforts.

Potential Applications

New Mexico faces many water-related challenges. As the climate warms, the state is experiencing hotter, drier conditions, including extended droughts that have reduced surface water availability, stressed streams and rivers throughout the state, reduced reservoir storage, increased pressure on groundwater supplies, and triggered interstate litigation. New Mexicans, in some cases with federal partners, are rising to these challenges by increasing their focus on water planning at the watershed, regional, and state levels; investing in water conservation, efficiency, and improved stream flow; and exploring approaches to improving soil health.

The agricultural sector, particularly in the Rio Grande Basin, is under pressure to reduce use in the face of reduced water availability, the requirements to deliver water to Texas under the Rio Grande Compact and related litigation settlements, and the need to protect endangered fish and important riparian habitat. Like many other areas of the arid West, the challenge is to find approaches that allow irrigated agriculture to prosper and sustain livelihoods and local economies, even in the face of reduced water availability and a warming climate. An accurate picture of how water is used for agricultural irrigation and a cost-efficient, adaptable way of measuring the success of various water conservation measures are essential building blocks of a path to a sustainable, resilient agricultural economy for New Mexico.

The stakeholder discussions convened by Thornburg to review the tool identified several potential applications, including:

- Analyzing uses and trends in agricultural irrigation for purposes of water planning
- Designing and evaluating fallowing programs
- Evaluating potential water savings from crop switching; and
- Monitoring water-related benefits of soil health programs.

Water Planning

New Mexico has both a state water plan and 16 regional water plans. However, most of the regional plans are from 2016 or 2017 and are based on data that is even older. Most do not contain a detailed analysis of spatially explicit water use in irrigated agriculture. In 2023, the New Mexico Legislature enacted SB 337, the Water Security Planning Act. This Act is designed to bring more consistency and transparency to the planning process, and it gives the Interstate Stream Commission (ISC) authority to approve regional water plans. The Act provides direction to ISC on developing rules and guidelines for the new planning process, emphasizing use of sound science and hydrologic reality, while also authorizing it to make grants and loans to regional entities to support the planning work. The Act also requires that the plans "prioritize and evaluate solutions." Moreover, the Water Data Act of 2019 authorized the Bureau of Geology and Mineral Resources (NMBGMR) to develop, integrate, and distribute data and information to support water policy, planning, and management. NMBGMR will be working closely with ISC to support the newly authorized regional water planning process, including region-specific data and reports on water supply and demand.

Stakeholders and state agency personnel indicated that this tool could be useful for state and regional water planning, as it can be tailored to any specific geographic region, can provide estimates of agricultural consumptive use correlated to crops and weather, and can show trends that may assist in future demand projections. If the tool were further developed to be interactive, it could allow for quick and efficient updating to reflect new annual data as it becomes available. It could also be used to evaluate possible changes resulting from water conservation solutions.

The tool could similarly be used by the acequias, irrigation districts, and pueblos and other tribal nations, to assist their own planning and demand management efforts. For example, it could be used to explore whether a certain level of rotational fallowing or crop switching would be useful to water conservation efforts or to examine and document trends in water use and crop choice.

Finally, the tool may prove useful to the U.S. Bureau of Reclamation's Middle Rio Grande Basin Study, which is involving a wide range of stakeholders to assess water supply and demand, to better understand the implications of climate change, and to develop potential solutions to address the challenges identified. The Basin Study has an agricultural sectoral group, and use of the tool could contribute to their analytical work.

Fallowing

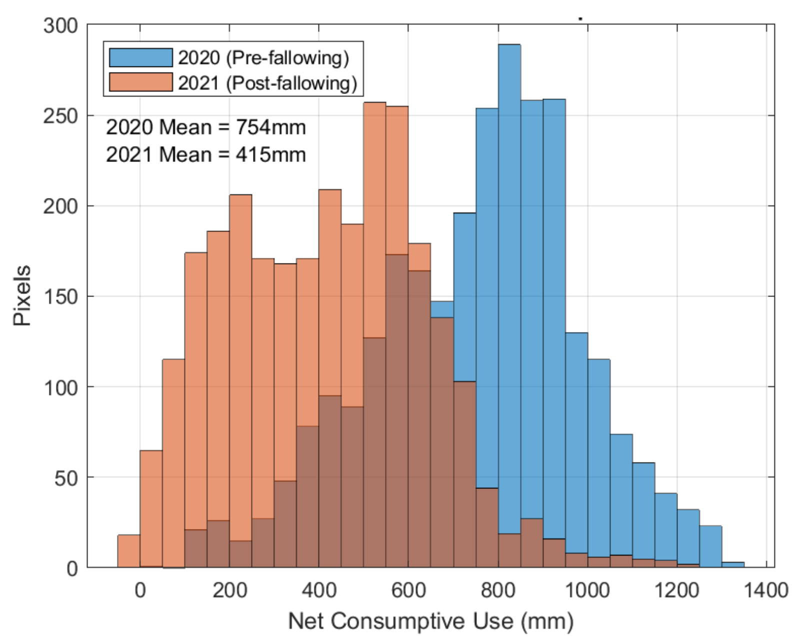
As water scarcity continues to be a challenge for New Mexico, whether related to a hotter and drier climate, interstate compact obligations, or competing demands for water, agricultural irrigators will face calls to conserve. Near-term options for achieving this conservation tend to focus on compensated, dynamic (rotational) temporary fallowing, even as irrigation districts and others look to more durable approaches such as storing stormwater, recharging groundwater, improving water delivery infrastructure, or crop switching.

Already, temporary rotational fallowing and water leasing for environmental flows has been explored in the Middle Rio Grande Conservancy District (MRGCD) and the Lower Rio Grande Valley. In 2023, the New Mexico Legislature appropriated $30 million for additional temporary fallowing. These programs may need to expand, depending on hydrological conditions and other factors and may, at times, need to be put in place in other areas of the state.

The tool can be used to help evaluate and design fallowing programs. First, it can help managers estimate how much water is conserved through fallowing because fallowed land is one of the classifications in the USDA cropland data layer, and differences in water use between irrigated crops and fallowed fields are evident in OpenET. Moreover, the OpenET data show that fallowed fields may still result in some consumptive use, depending on location (near canals or in areas with access to shallow groundwater), soil type, or other factors. The outputs from the tool could help managers determine with more precision the savings from a particular approach. As one preliminary example, **Figure 13** documents the reduction in net consumptive use across a suite of fields enrolled in a temporary fallowing program in New Mexico between 2020-2021.

The tool might also be used to design a fallowing program by evaluating past consumptive use on a 30m grid level, selecting fields that have a higher water use per acre for the same crop (possibly indicating more marginal land), and even estimating the water needs of establishing a cover crop to reduce weeds and dust. All these factors could allow managers to design temporary, compensated fallowing programs that efficiently use public resources, allow districts to avoid checkerboard fallowing patterns that impede district operations, and provide a transparent program design.

Figure 13. Distribution of net water consumption for all 30m pixels on fields enrolled in a temporary fallowing program in NM before (blue) and after implementation (red). The OpenET data document an average reduction in net water consumption of 339mm (approximately 13 inches) due to the program.



Crop Switching

The tool could be used to help evaluate and design crop switching programs aimed at water conservation (e.g., converting from lower value, high water-use crops to higher value, lower water-use crops). First, it could be used to see how water use has changed in districts where, i.e., peppers and onions have been replaced by alfalfa due to labor issues, and what might be saved if those crops could be returned to the field if the labor challenges could be addressed. It could also be used to evaluate water savings with pilot crop switching programs, where producers receive sufficient financial compensation and processing/marketing support to switch to lower water use crops.

Because alfalfa has a ready market and many growers are familiar with it, switching from this crop is not likely to be widespread in the short-term. However, over the mid- to long-term, it could be a promising water conservation strategy if producers were to receive the range of support needed to overcome technical challenges and market development barriers that often get in the way of crop switching.

Soil Health

The New Mexico Department of Agriculture is focused on healthy soils, including through a grant program for growers who want to implement water- and climate-smart healthy soils practices. There is emerging evidence that healthy soils practices (no till, cover crops, and similar practices) can conserve and increase soil moisture and thus reduce the need for applied irrigation water without sacrificing yield (Magdoff, 2021; Nichols, 2015). The irrigation analysis tool could potentially be used to evaluate these soil health efforts, at least on a case study basis, and demonstrate whether there are significant reductions in applied water associated with healthy soils practices. A positive result could spur additional investment and, most importantly, additional outreach to and support for producers to implement such practices. Given the mapping capabilities of the tool, it might also be used by managers to determine where to focus on improving soil health by determining whether geographically co-located lands growing the same crops have major differences in water consumption, which could be related to differences in soil health that could be remedied.

Verification Needs

Discussions with a variety of New Mexico stakeholders identified the need to test the tool against on-the-ground conditions, where possible. It was beyond the scope of this initial phase to complete these investigations, but these suggestions from stakeholders are included here as topics for future work that could improve the accuracy of the tool later. Some of these suggestions included:

- Comparing precipitation data from PRISM with that from local weather stations to evaluate how station-based precipitation information might influence estimates of net consumptive water use at a local level.
- Comparing ET estimates from the OpenET tool to data being collected by eddy covariance towers, where those towers exist (e.g., Melton et al., 2022; Volk et al., 2024).
- Using these observations to evaluate whether one of the algorithms used in the OpenET tool might be more reliable than the ensemble average for particular geographies or crops.
- Evaluating whether shading by pecan trees affects the OpenET values from that crop.

As described in the Methods section of this report, the accuracy of the OpenET data on a water year basis is on the order of 5%, and the bias on the PRISM dataset is on the order of 17%. This suggests that improvements in accuracy from any of these proposed activities are unlikely to exceed 20%. Depending on the desired future use of the tool, these potential improvements in accuracy may or may not be worth the investments required for gathering, quality controlling, and analyzing alternative input data streams.

Appendix I: Federal Funding

The water use tool summarized in this report can be used to provide rapid assessments of current water use, to assess changes in agricultural water use while considering climate variability, and to potentially quantify the outcomes of specific water conservation activities. Each function could provide critical information for requesting funding for water conservation activities or for documenting outcomes once funding is received.

Table 1 on the next page summarizes federal funding opportunities for implementing water savings activities in irrigated agriculture and how the tool might help access that funding. The focus is on federal opportunities, but there are many existing and new programs and appropriations at the state level in New Mexico that may also be available, either on their own or as match funding to leverage federal investment.

Table 1. Summary of federal funding opportunities for implementing water savings activities in irrigated agriculture and how the tool might help access that funding.

Strategy	*Funding Opportunities*	*Status*	*Potential Use of Agricultural Analysis Tool*
Design, implementation and monitoring of compensated dynamic fallowing in Rio Grande Basin.	Inflation Reduction Act drought mitigation funding	Expecting BOR announcement of IRA funding opportunity for Rio Grande in 2024.	Evaluate results of past pilot programs to develop water conservation estimates and design for new programs; employ the tool to evaluate results of new programs.
Multi-benefit water conservation/environmental improvement projects in Rio Grande Basin.	Inflation Reduction Act drought mitigation funding	Expecting BOR announcement of IRA funding opportunity for Rio Grande in 2024.	Evaluate results of past pilot programs to design new programs; employ the tool to evaluate results of new projects.
Drought response and/or environmental benefit projects for San Juan	Inflation Reduction Act drought mitigation funding	San Juan eligible under Upper CO River Basin funding opportunity, expected to be announced in 2024.	Evaluate results of past pilot programs to design new programs; employ the tool to evaluate results of new projects.
Irrigation decision-support tools for better water management (e.g. the irrigation analysis tool developed for this project)	BOR Water SMART Applied Science Grants	Funding up to $ 400K; 25% to 50% match required; 2023 proposals were due 10/17/2023; additional opportunity expected in second half of 2024.	Develop the tool into a more interactive format to be used in water management decision-making at irrigation district, pueblo, acequia, or other level.
Develop and/or update comprehensive drought plans and projects	BOR Drought Response Program	$5 million maximum; 50% match required; 2023 proposals due in November 2023; additional opportunity expected second half of 2024.	Develop the tool into a more interactive format to be used in water management decision-making at irrigation district, pueblo, acequia, or other level to predict water savings from various strategies.
Healthy Soils on-the-ground implementation	USDA Regional Conservation Partnership Program	Large-scale, multi-partner; linking to water conservation and carbon sequestration could have added appeal to agency; current round of proposals were due 8/18/2023, so would have to target 2024 funding opportunity. Match generally required.	Use of tool to evaluate past results of soil health pilots and to evaluate results of new program to quantify water savings.
Marginal lands/land repurposing/carbon sequestration	USDA Regional Conservation Partnership Program	Large-scale, multi-partner; linking to water conservation and carbon sequestration; current round of proposals were due 8/18/2023, so would have to target 2024 funding opportunity. Match generally required.	Historical analysis with tool to help identify possible marginal lands (e.g. higher water use for same crop in same area); estimate consumptive use for establishing cover crop or native grasses for sequestration.

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