2024

NEW MEXICO

INTRODUCTION

The Ogallala aquifer is the most economically important groundwater source in eastern NM and is the primary driver for crop production in the region. The six counties that overlie the Ogallala are responsible for over 1/3 of all agricultural cash receipts in New Mexico and over 25% of all crop cash receipts. The Ogallala aquifer is heavily pumped for irrigation of various agricultural crops that support farming and livestock industries, which, in turn, sustain the many small- to medium-sized cities dotted throughout eastern NM. Primary crops grown in the region are corn, sorghum, wheat/triticale, and alfalfa. Most of these crops are used as silage, hay, or grain to supply the large dairy industry in eastern NM and West TX. There are over 172,000 milk cows in the three major NM counties over the Ogallala Aquifer.

Like much of the Southern High Plains, water levels in the NM portion of the Ogallala have been in a long-term, serious decline for decades. Water usage is unsustainable, as extraction far exceeds the recharge into the aquifer.

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Agricultural producers are currently experiencing declining well pumping capacities at an alarming rate, particularly in the southern stretches of the aquifer in NM. In addition, decreased water levels in existing municipal wells have led to many wells being shifted from agricultural use to municipal usage in both Clovis and Portales areas to meet municipal water demands. Samplings from 2004-2007 to 2010-2015 of 121 wells in Curry and Roosevelt counties showed an estimated loss of close to 2M acre-feet in the aquifer during the time periods, with a 7-yr average loss of 277,586 acre-feet per year. Over the sampling period, 75% of the wells experienced a decline in water levels with a median well decline of 4.2 ft (Fig. 1). No significant surface water resources exist in the High Plains region of New Mexico.

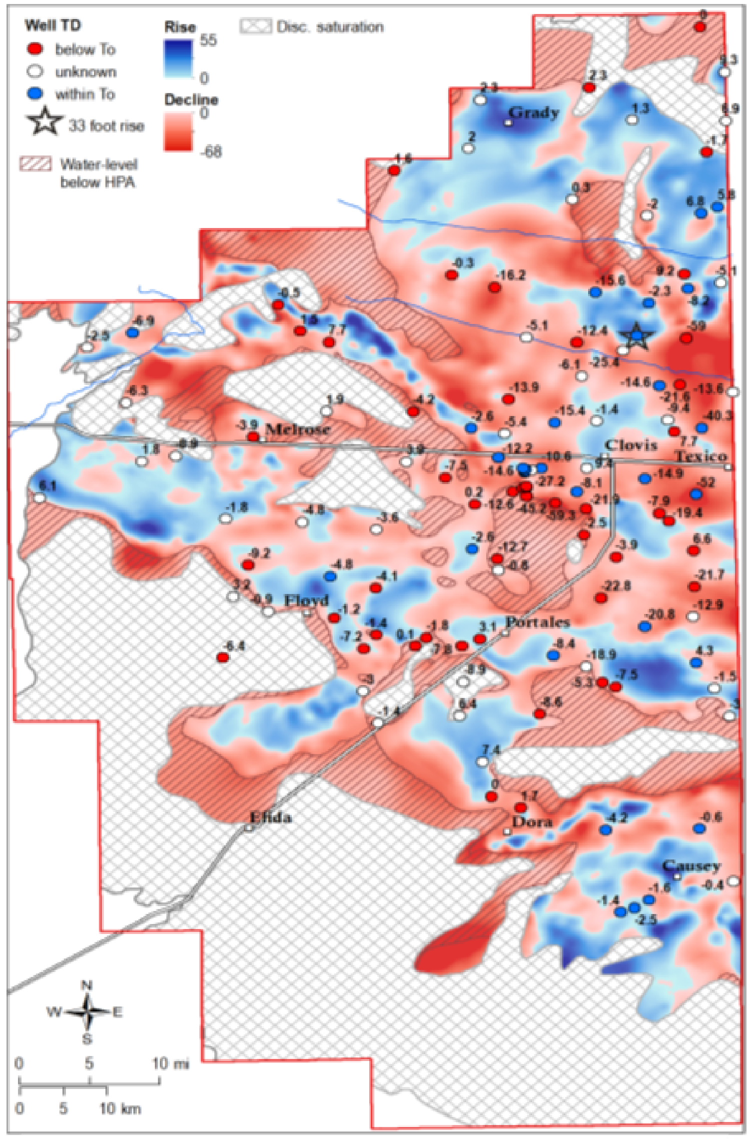

Fig. 1. Change of saturated thickness of the Ogallala Formation in Curry and Roosevelt Counties, NM, from 2004–2007 to 2010– 2015 (in feet). Source: Rawling, 2016.

Addressing Agricultural Challenges with New and Ongoing Research

The primary focus of the majority of research in the region to date has been finding low water-use cropping alternatives that sustain crop production and improve soil health status. Research conducted at New Mexico State University's Agricultural Science Center at Clovis has been evaluating alternative tillage methods, cover cropping, crop rotation, alternative crops, and perennial cropping opportunities in the region. Locally available dairy composts are also integrated into alternative farming systems to see if they enhance cropping effects on soil health and water conservation.

Well capacities are increasingly becoming less capable of supplying enough water to grow high water demand crops such as corn. Therefore, exploring various alternatives is expected to help farmers develop best management practices. Some of the alternatives tested in the region are described below.

Cover cropping: Crop diversification through cover cropping and legume integration in crop rotations has been tested for the last several years to harness soil health and water conservation benefits. Our previous and ongoing research shows that the benefits of cover crops on New Mexico agroecosystems will vary depending on irrigation availability for the cash crops being grown. In three independent research projects, we investigated the potential of cover cropping under hot, dry conditions of the Clovis Agricultural Experiment Station, New Mexico. These studies investigated the effects of cover crops on soil health, water use, weed suppression, and cash crop yields (corn, wheat, and sorghum in different rotations) grown under 1) dryland, 2) limited supplemental irrigation, and 3) fully irrigated conditions and compared those results with fields grown without cover crops.

Under all three water regimes (drylands, limited irrigation, full irrigation), soils were less prone to wind and water erosion due to improved soil structure and stability of the soil with cover cropping. Soil temperatures were also cooler on cover cropped fields than fallow fields, and they accumulated more organic matter, more residue on the surface, and better soil biological health.

Under limited irrigation and full irrigation, additional benefits were observed in cover cropped fields. Cover crops increased weed suppression; effectiveness increased with greater biomass production and ground coverage. With water available for irrigating cash crops, soil microbial diversity increased with more diverse cover crop species in the mixture. In addition, cover cropping increased the yields of fully irrigated corn and sorghum in all years. Cover cropping under no-tillage improved water-conservation efficiency in rotation with fully irrigated cash crops and increased subsequent corn and sorghum yield by 15 to 22%. Yields were the same in four out of five years for limited irrigation winter wheat and grain sorghum production with and without a cover crop, and sorghum yield was higher with a cover crop in one out of five years. Cash crop yields of corn and sorghum were either comparable or slightly lower under dryland conditions for covered cropped fields.

How much water is needed to maximize the benefit of the cover cropping system?

Farming with limited irrigation is a challenge, and producing crops in a strict dryland situation is a greater challenge. In these environments, cover crops are normally not grown to their full potential due to water limitations. In a 2-year irrigated silage sorghum study conducted in eastern New Mexico (Paye et al., 2022a), winter cover crops depleted 10–13 inches of soil moisture in the top 3 ft of soil depth during their growth (Figure 2). On the other hand, leaving the land in fallow resulted in 0.4–2 inches of soil water storage at the time of corn and sorghum planting. However, the cover crop produced a biomass of 2–3 tons of dry matter per acre (Ghimire et al., 2023), which allowed the plots with cover crops to store more water during the cash crop phase despite that initial water depletion. Therefore, when compared at the cropping systems level, cover cropped systems saved more water than those without cover cropping.

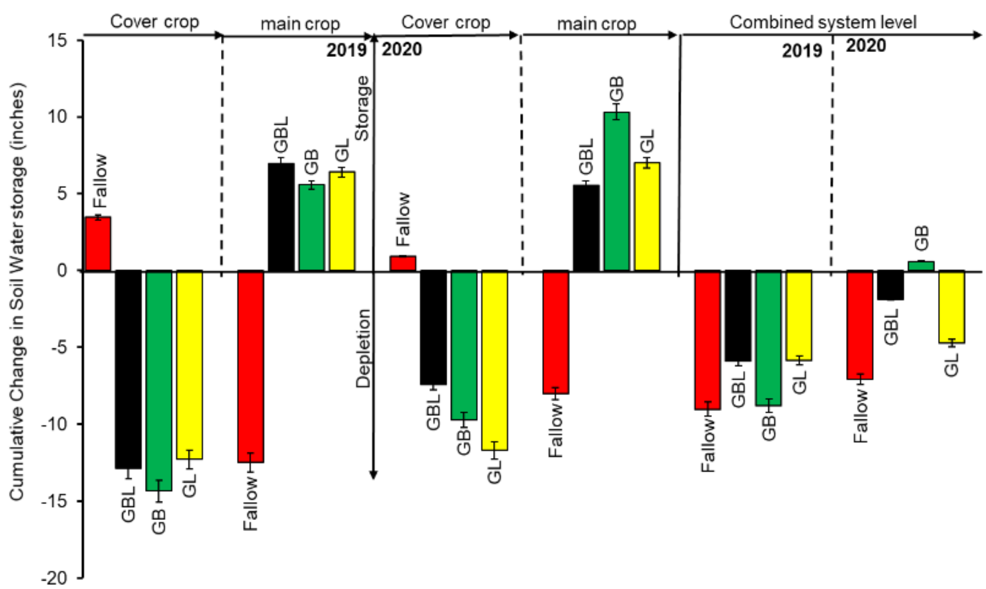

Figure 2. Cumulative soil water storage and depletion at 3-ft soil depth during fallow/cover crop periods and subsequent cash crop, and total soil water depletion at the cropping system level (combined) in 2019 and 2020 at Clovis, NM USA. Soil moisture was measured once every two weeks during the cover crop phase and once a week during the silage forage sorghum phase. The bars represent the net soil moisture (depleted or stored) under fallow and the different cover crop mixtures for each cropping phase. Positive bars within each cropping phase mean soil water storage, and negative bars mean soil water depletion as affected by fallow and the different cover crop moistures. Cover crop mixtures: GBL = grasses + brassicas + legumes, GB = grasses + brassicas, and GL = grasses + Legumes. Grasses used in this study were triticale and annual ryegrass; brassicas were turnip and Daikon radish; and legumes were Austrian winter pea and berseem clover (Ghimire et al., 2023).

Other alternative crops: Farming systems in eastern NM are dominated by a small handful of annual cereal crops with limited diversity. While corn silage remains a staple component of dairy feeding rations, research has shown that forage sorghums certainly fit into the high-energy diets of dairy cows while saving considerable amounts of water. Extensive testing on sorghum types, varieties, fertility management, and seeding rates has led to a much-improved understanding of the proper management of this crop and the soil and water conservation benefits and flexibility it provides.

Broadleaf alternative crops may be able to provide rotational benefits in continuous corn or sorghum production systems while stimulating economic impact in the region. Research conducted on winter canola has shown that irrigation may be reduced by as much as 40% (compared to winter wheat dual-purpose systems) while providing both grazing and high-value seed harvest options for producers. Forage quality of canola and other cover crops was comparable with forage corn or sorghum under irrigated conditions.

Perennial grain and forage crops: Perennial cropping is another alternative tested for water use, grain and forage production, forage quality, and soil health in fields with irrigation retirement. We have ongoing research on perennial crops, including the integration of low water use varieties of alfalfa with native perennial grasses and evaluating their impacts on soils, forage production potential, and forage quality. We learned that soil C and N mineralization is enhanced early on by adopting perennial cropping while maintaining good quality forage production. Further research will help assist farmers as they transition to farming systems that utilize less irrigation water and other crop inputs.

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Reducing tillage intensity and frequency: Many eastern New Mexico farms have already been converted into dryland production. Every drop counts in dryland crop production. Research on conventional tillage, strip-tillage, and no-tillage comparison in dryland situations showed the many benefits of reducing tillage. No-tillage in dryland corn-sorghum rotations increased soil water storage, reduced soil erosion, and maintained comparable crop yields. No-tillage increases soil organic matter storage and results in a net positive carbon balance of the system, while conventional tillage leads to a net loss of carbon and net negative ecosystem carbon balance. However, no-tillage has its challenges: compaction, low seed-to-soil contact and poor germination in extreme dry conditions, and low herbicide efficacy in dry environments. We asked a research question, "Is there any room for mixing residue and soils, or strategically-timed tillage in the continuous no-tillage system to maximize agronomic and environmental benefits?" and then established an occasional tillage study in 2019. We noticed light tillage (disking, stubble mulch tillage in >5 years of continuous no-tillage) helps in residue mixing with soil and possesses a minimum negative impact regarding soil carbon loss, aggregate breakdown, and soil erosion. It helps in residue redistribution in the soil profile and increases nutrient availability.

Soil amendment: Composted dairy manure is a major soil amendment used in eastern New Mexico and west Texas for forage production. Amending soil with compost has been a common practice for area producers. Biochar, a charcoal-like substance used to rejuvenate soil health, has not been tested yet in eastern New Mexico. Evaluating the effects of dairy manure, compost, and other amendments such as biochar would be beneficial for area producers because of the exceptional capacity of biochar and compost on soil water retention, soil health, and nutrient supply to crops. Research on compost and cover crop effects on soil health and ecosystem services is in progress. A new project will be established in 2024 at the ASC Clovis to study the comparative effects of compost and biochar on soil health and summer crop production.

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OPPORTUNITIES

Agricultural producers on the High Plains of New Mexico have always been a resilient group. Many have experienced and survived multiple year droughts, low commodity prices, and high input costs. Also, many irrigated farmers also practice dryland cropping in this hot, dry, windy environment. As such, farmers are always looking for new information on best management practices and ways to improve their operations under increasingly harsh growing conditions.

Water conservation techniques such as no-tillage and reduced tillage management, selection of short season, drought tolerant varieties of traditional crops, and planting alternative crops are all currently being integrated into the farming systems of the region. Each year, more and more producers are slowly integrating perennial forage crops that provide resiliency against extreme climate events while improving soil health.

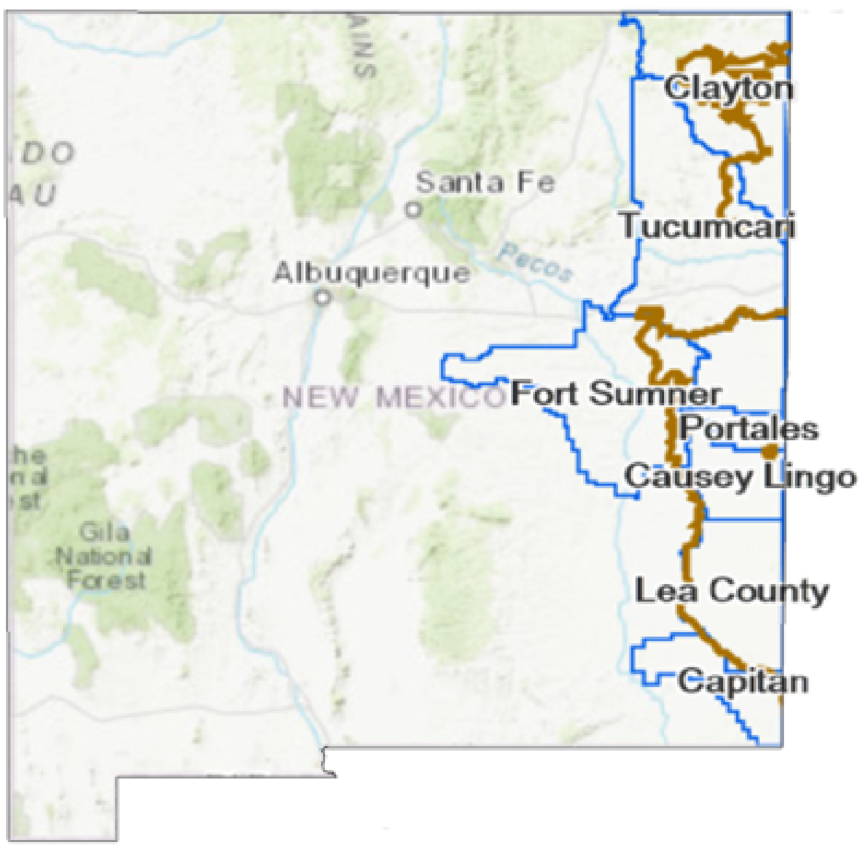

Fig. 3. Underground water basins in eastern New Mexico.
Source: NM Office of the State Engineer.

Efficient irrigation practices such as low energy precision application (LEPA) and low elevation spray application (LESA) on center pivot systems have been implemented, but subsurface drip irrigation acceptance has been limited, primarily due to initial installation costs and traditionally low-value crops. Therefore, finding adapted and acceptable alternatives has been a challenge and opportunity for researchers and innovative producers in the region. While the rotational benefits of canola have long been understood, acceptance was limited due to a lack of storage and/or processing facilities nearby. Some dairy farmers are integrating these into their cropping systems as alternative winter forage. The same opportunities exist for other cover crops and alternative crops that do not have local markets, and connection to other markets is limited. However, water use by these crops and their impact on subsequent cash crop production should be carefully considered while planning cover and alternative cropping.

Composted dairy manure has been the best and most accessible amendment for eastern New Mexico and has multiple soil health benefits. Research at ASC Clovis demonstrated the benefits of composting on microbial growth, organic matter storage, and crop nutrient availability. Attention is needed to not over-apply the manure or composted manure because of potential salt accumulation and P fixation in soils.

POLICY AND PARTNERSHIP

The Office of the State Engineer (OSE) has authority over the measurement, appropriation, and distribution of all surface and groundwater in New Mexico, including streams and rivers that cross state boundaries. New Mexico State laws govern the appropriation of groundwater and have been developed since the early 1930s. Beneficial use of water is the basic tenet for both surface water and groundwater statutes, with priority administration governing in times of shortage.

There are seven underground water basins that have been declared by the OSE in the Ogallala aquifer region (Fig.3). Groundwater rules have been developed that identify more specific details on the Administration of Groundwater. In addition, Basin Guidelines are used to ensure regional consistency for some of the more active Groundwater Basins located on the East side of the state. The Basin Guidelines are meant to help provide clear procedures for agency staff when reviewing water rights applications filed by farmers, ranchers, and municipalities.

There were approximately 29,000 wells drilled as of 2020 in the Ogallala aquifer and only 65% of the wells drilled were metered. All new and replacement wells drilled today are metered as part of an Application to change an element of a Water Right submitted to the agency by many of the existing wells are already dried.

In critical regions of a basin, The Office of the State Engineer has developed hydrological models to evaluate additional requests for appropriations. If a region is experiencing high levels of water withdrawals and thin saturated thickness within the underlying aquifer, then these areas are designated as Critical Management Areas (CMA's). Great lengths to protect these CMA's from additional water level declines are undertaken. When an application for appropriation is requested in a CMA, a regional assessment using the hydrological model is conducted. Any excessive drawdown and reduction of the saturated thickness of the Aquifer will result in the denial of the application or the reduction in the amount of water that can be withdrawn or diverted.

Researchers, state agencies, and private stakeholders are collaborating to conserve water and enhance water use efficiency. NMSU researchers are working with NRCS, the New Mexico Department of Agriculture, the Southwest Climate Hub, other university researchers, and USDA research facilities across the southern and central high plains to work on soil health, alternative crop and forage production, and dairy and livestock farming. Collaborative projects are underway to improve soil, crop, and water management, engaging producers and the general public in research and environmental outcomes. However, there is a need for more collaborative work to address regional challenges in dealing with limited water for irrigation and agricultural sustainability issues.

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REFERENCES

Rawling, G.C. 2016. A hydrologic investigation of Curry and Roosevelt Counties, New Mexico. Open-file Report 580. New Mexico Bureau of Geology and Mineral Resources. February, 2016.

Ghimire, R., W.S. Paye, M.A. Marsalis, and R. Sallenave. 2023. Using cover crops in New Mexico: Impacts on soil moisture and subsequent crop yield. NMSU Extension Circular 707. CR-707.pdf

Ghimire, R., R. Sallenave, and A. Smith Muise. 2022. Using cover crops in New Mexico: impacts and benefits of selecting the right crops. NMSU Extension Circular 704. CR704.pdf