Using Cover Crops in New Mexico: Effects on Soil Moisture and Subsequent Cash Crops

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Figure 1. **Cover crops study plots at the NMSU Agricultural Science Center at Clovis, NM, comparing soil health and water dynamics with and without cover crops in corn-sorghum production systems (photo by Rajan Ghimire, April 2019). Cover crop mixtures compared in this study were two grasses (triticale and annual rye grass), two legumes (Austrian winter pea and berseem clover), and two brassicas (daikon radish and turnip).**

Introduction

Livestock production and its inputs make up the largest share of New Mexico's agricultural economy. Corn, sorghum, wheat/triticale, and alfalfa are crops grown primarily to support the livestock industry's demand for high-quality forage. Most of these crops are grown as irrigated silage, hay, or grain needed for inclusion in livestock rations. Corn and sorghum silage—the two main feed sources for cattle—require a substantial input of nutrient and water resources. A highly nutritious silage corn and sorghum crop requires up to 770 mm (30.3 inches) of water input, far exceeding New Mexico's average annual precipitation of around 350 mm (13.8 inches), which

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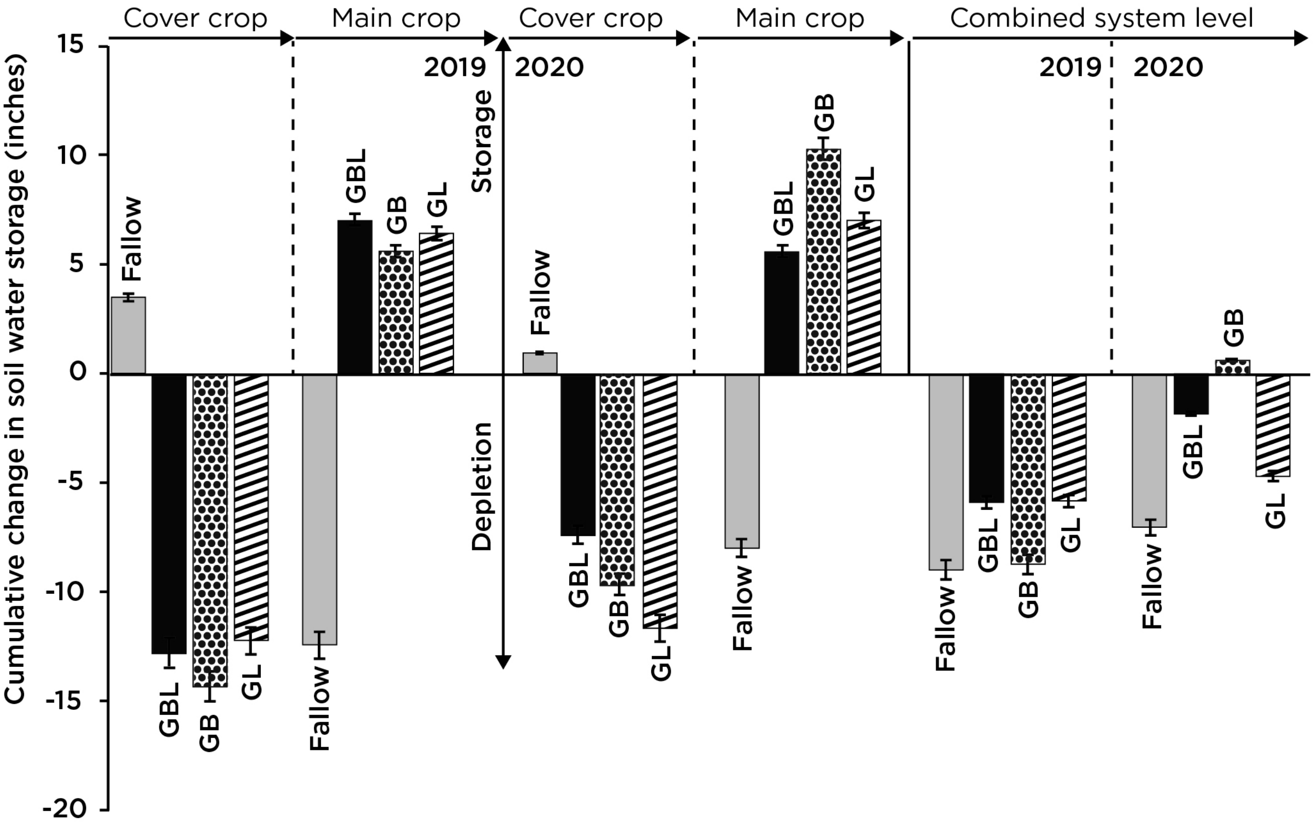

Figure 2. **Cumulative soil water storage and depletion in the top 3 feet of soil depth during fallow/cover crop periods and subsequent cash crop, and total soil water depletion at the cropping system level (combined) in 2019 and 2020 at Clovis, NM. Soil moisture was measured once every two weeks during the cover crop phase and once a week during the silage forage sorghum (cash crop) 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 mixtures. 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.**

can vary widely based on location (https://weather.nmsu.edu/). However, water availability for irrigated crop production is becoming a growing challenge because of declining water levels in streams, rivers, and underground aquifers. With increasing climate change and variability, water demand for crop production has further increased, while available water for irrigation has been decreasing more rapidly in recent years than in the past, threatening the survival of the agricultural industries in arid and semi-arid regions.

Cover cropping has been promoted for improving soil health and potential forage yield during lean periods of forage production. However, water use by cover crops, their potential to improve soil health, and their impacts on the subsequent cash crop yield should be carefully considered when planning cover crop integration in arid and semi-arid cropping systems.

Is cover cropping feasible in areas facing water scarcity for cash crop production?

Incorporating cover crops into cropping systems can bring many ecosystem benefits, such as improved soil health, better nutrient utilization, soil water conservation, soil aggregate stability, erosion control, and improved cash crop yields (Ghimire et al., 2019; Paye et al., 2022a, 2022b; Thapa et al., 2022). Typically, cover crops protect the soil with a living cover during the fallow period in between cash crops. In addition to soil benefits, they can also be used as alternative forage during the winter months when supply is limited (Paye et al., 2022a, 2022b). However, realizing these benefits under water-limited conditions is usually challenging compared to areas that receive more precipitation. This is because cover crops can deplete soil water storage by the time of subsequent cash crop planting, which may affect cash crop establishment. Without precipitation or irrigation, the low soil moisture after cover crop termination could make cash crop planting, germination, and establishment difficult in dry environments of New Mexico. In extremely dry years, this can ultimately reduce the subsequent cash crop yield.

A study comparing soil water storage and depletion with cover cropping in eastern New Mexico (Figure 1) showed that most of the winter cover crop water use—up to 80%—occurred during the last 50 days (late March through mid-April) before cover crop termination (Paye et al., 2022a, 2022b). Hence, grazing, haying, or terminating cover crops early on is strongly recommended in dry years in order to limit their water use. Although cover crops depleted soil moisture (as measured at the time of cash crop planting), the study also showed that land that was left fallow lost more soil moisture overall than land that was cover cropped at the combined cropping system levels. Therefore, cover cropping in irrigated forage production systems could be beneficial for crop-livestock integrated systems in New Mexico. However, dryland farmers should be cautious not to deplete too much soil moisture that the subsequent cash crop could use.

How much water will I need to apply to my cover crop for maximum benefit?

In semi-arid climates, cover crops are normally not grown to their full potential due to water limitations for crop production. The amount of irrigation water needed for cover crops is determined by many factors, including weather, irrigation water availability and amount, the cover crop species, and the purpose of the cover crop. In years with good fall and winter precipitation, irrigation requirements for cover crops will be lower than during years with dry falls and winters. Under water-limited conditions, it is critical to manage cover crops in ways that will limit their water usage. In a two-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 feet of soil depth during their growth (Figure 2). Leaving the land fallow, on the other hand, 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 (Paye et al., 2022a, 2022b), which allowed the plots with cover crops to store more water during the cash crop phase, despite the initial water depletion. Therefore, when compared at the cropping system level, cover-cropped systems saved more water than those without cover cropping.

How much cover crop biomass should be harvested, and how much should be left in the field?

The primary reason for growing cover crops is to provide cover for soils that would otherwise be left bare during off-season periods (Ghimire et al., 2019). For a complete description of which cover crops to grow in New Mexico and their benefits, refer to NMSU Extension Guide A-150, *Principles of Cover Cropping for Arid and Semi-arid Farming Systems* (https://pubs.nmsu.edu/_a/A150.pdf), and Circular 704, *Using Cover Crops in New Mexico: Impacts and Benefits of Selecting the Right Crops* (https://pubs.nmsu.edu/_circulars/CR704.pdf).

Some cover crops can be harvested as a forage crop for livestock. There is growing interest among livestock farmers in using cover crops as forage, but their soil benefits are highly dependent on the cover crops' ability to produce high amounts of good-quality biomass (Paye et al., 2022b). In hot and dry environments such as New Mexico, the *quantity* of biomass production is more important than the *quality* of biomass because our soils are limited in biomass input for microbial processing of organic matter. Finding a balance of how much cover crop biomass can be harvested without offsetting the soil and ecosystem benefits that cover crops provide is important. For instance, if enough biomass is produced, harvesting cover crops at 4 inches above the ground may leave a standing stubble of around 0.5 tons/acre, which could control erosion and conserve residue cover during subsequent crop production (Blanco-Canqui et al., 2020). In addition, the cover crops' root biomass—which can be up to 42% of the harvestable aboveground biomass—can continue providing critical ecosystem services even after the cover crop has been harvested (Ghimire et al., 2018). Hence, it is better not to harvest cover crops if biomass production is less than 0.5 tons/acre. Research at the NMSU Agricultural Science Center at Clovis shows that

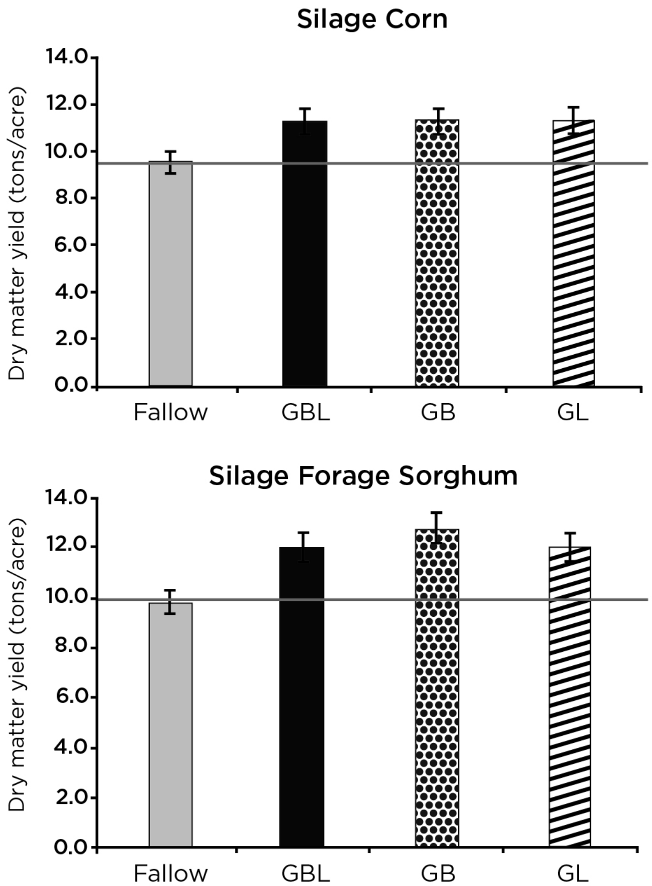

Figure 3. **Average two-year yield of forage sorghum and corn silage following either fallow or different cover crop treatments at Clovis, NM. Cover crop mixtures: GBL = grasses + brassicas + legumes, GB = grasses + brassicas, and GL = grasses + legumes.**

about 2 tons/acre of biomass are needed if the target is to increase soil organic matter storage in the soil (Ghimire et al., 2017).

Are the water-saving benefits of a cover crop enough to offset cover crop input costs?

Generally, growing cover crops brings additional expenses that producers must consider when making cover cropping decisions. Improving soil quality and protecting the soil from wind and water erosion are laudable goals of cover cropping. However, these goals are difficult to achieve if producers cannot directly link them to farm profitability. Expenses incurred in purchasing, planting, and terminating cover crops could reduce the immediate net farm profit in a given year compared to leaving the land fallow. However, growing cover crops can increase farm profit if enough biomass is produced to be grazed or harvested as hay or silage, which is unlikely in dry years but possible in wet years.

Better still, leaving the cover crop residue on the surface can significantly reduce irrigation water losses via evaporation and runoff (Paye et al., 2022a, 2022b). This improves soil water storage and makes more water available for the cash crop in irrigated systems. Less evaporation means less frequent irrigation is needed, which can reduce energy costs from pumping groundwater. Reduced evaporation by cover crops can also improve crop water productivity and cropping system water use efficiency. In eastern New Mexico, our two-year study (Paye et al., 2022a, 2022b) demonstrated that irrigated silage corn and forage sorghum yields following cover crop mixtures increased by 9–26% and 18–32%, respectively, compared to fallow (Figure 3). Such increases in forage yield were visible in the field (Figure 4) and can bring substantial financial incentives for producers.

Grazing the cover crops during winter or haying in spring could also offer economic benefits that could offset the cost of purchasing, planting, and terminating the cover crops (Acharya et al., 2019). However, cover crop grazing was not possible in the Paye et al. (2022a, 2022b) study, so we do not have data on the economics of cover crop grazing.

Finally—and perhaps most importantly—cover crops also bring ecosystem benefits, such as reduced soil erosion, increased soil organic matter, and better soil health, which cannot be quantified using financial metrics, at least in the near term.

Conclusion

Cover cropping can be beneficial to crop-livestock systems, including the dairy industry of eastern New Mexico and West Texas. The mulching effect of cover crop biomass can improve the cash crop water use efficiency, leading to greater forage yield in irrigated corn and forage sorghum silage, despite the initial depletion of available soil moisture by cover crops. Additional economic benefits can be achieved by using the cover crop biomass as alternative forage. In dry years, however, extreme water scarcity may affect yield of the subsequent cash crop if supplemental irrigation is not available.

For growers seeking to adopt dual-purpose cover cropping, mixtures with legumes are recommended for better forage quality. When cover crop biomass is harvested for forage, cutting 4 inches above the

Figure 4. **Visual contrast of sorghum growth at Clovis, NM, between a fallowed field on the right versus a cover-cropped field on the left five months after cover crop termination, with cover crop residue in the foreground.**

ground, or leaving about 0.5 tons/acre in addition to the root biomass, would be ideal for maintaining the soil protection and ecosystem benefits of cover crops. When growing winter cover crops to replace fallow after summer crops, it is good to plant early in the fall to allow sufficient time for the cover crop to establish before freezing winter temperatures. Despite the additional cost incurred by cover cropping, a 9–32% increase in corn or sorghum yield, in addition to grazing or haying the cover crops, can be sufficient to cover the cost of cover cropping.

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