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Exploring the soil health-water quality-ecosystems services nexus of long-term conservation tillage plots under intense irrigation

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Farmers and land managers are tasked with maintaining high productivity, planning for long-term intensification, and increasingly, making considerations for the impact of their management on ecosystem services. In particular, there has been increasing attention on the role that management practices have on soil health and water quality. Despite a wealth of literature connecting soil health and water quality theoretically or mechanistically, there is little empirical research connecting soil health to land management practices designed to improve water quality. Moreover, those projects that do connect soil health to water quality often do so on farms that meet their irrigation needs through rainfall inputs, potentially missing the impact that reliance on irrigation has on both soil health and runoff water quality.

A number of Best Management Practices (BMPs) have been developed to mitigate the impact of agricultural runoff to receiving water bodies, with conservation or reduced tillage proposed as a way to reduce the effluent loading of both nutrients and sediment. Additionally, reducing tillage intensity and frequency has been shown to improve soil health along a number of metrics and to sequester carbon for climate change mitigation. However, these concepts have rarely been empirically connected, and even less so in semi-arid environments characterized by high temperatures, low precipitation, and significant inputs. In-depth studies of multiple aspects of environmental health on conservation tillage plots, particularly those performed at farm-scale, can provide insights to inform farmer decision-making.

We examined soil health and water quality metrics on a long-term research conservation vs. conventional tillage comparison site using the Soil Management Assessment Framework (SMAF) and Edge-of-Field Monitoring (EoF) of water quality to elucidate the impact of reduced tillage on furrow-irrigated corn. The SMAF program aims to assign scores ranging from 0.0-1.0 to indicate the relative “healthiness” of a soil with a series of ten biological, chemical, physical, and nutritional measurements. Meanwhile, water quality is evaluated through EoF monitoring of a handful of key water quality analytes in irrigation runoff that pose an environmental problem in the region, and various approaches are used to connect effluent water quality to soil health measurements. These relationships, along with measurements of soil carbon fractionation, crop yield, and farm profitability, are used to evaluate conservation tillage in furrow-irrigated agriculture for a broad set

of ecosystem services. Our analysis suggests that conservation tillage provides a number of valuable ecosystem services and general benefits over conventional tillage, including improvements to physical and biological soil health indicators, reduced runoff of nutrients and sediment, reduced carbon intensity of production, and increased farm profitability. However, conservation tillage in furrow-irrigated agriculture is not without its challenges, namely control and management of irrigation water. Overall results are collectively presented to provide a broader comparison of conservation and conventional tillage through an interdisciplinary lens at farm scale and with attention paid to the ways in which farmers make decisions regarding land management.