

2019 USAFRI Research Project Objectives

Imaging Alfalfa to Predict Yield and Quality and Impacts of Water Deficits Using Innovative Overhead Irrigation Systems **University of California-Davis - Putnam**

Project Award: \$78,922

Justification:

- Yield is undoubtedly the most important profit-limiting factor for alfalfa growers. Yields are limited by many factors, including traffic, loss in stand, pests, variety, soil variation and irrigation practice. This proposed research project is aimed at increasing alfalfa forage yield and quality for alfalfa farmers and dairy producers through advanced overhead irrigation practices. Secondly, we will develop a field-diagnostic tool for analysis of yield in farmer's fields that will assist in management for maximum yield which is relevant to both irrigated and non-irrigated regions.

Improving Water Management Using Innovative Overhead Technology under Water Deficits. Approximately ½ of the nation's milk supply comes from western states in irrigated regions (NASS, 2018), and approximately 48% of US alfalfa is grown in western states. Note that several transition Midwestern states (e.g. NB, KS, SD) also have significant acreage of irrigated alfalfa, so irrigated alfalfa is likely to be greater than 50% of US production. Western states are subject to severe and debilitating periods of drought and it is challenging to cultivate alfalfa under water-scarce conditions. The challenges of drought and availability of surface and ground water supplies are universal across the West, whether restrictions on water extractions from the Colorado River basin in Arizona or the Ogallala Aquifer in Western Nebraska/Kansas, the Central Valley of California, or the water shortages in the Pacific Northwest. This has led to interest in 'deficit irrigation' strategies for alfalfa production (Cabot et al., 2017; Orloff et al., 2014; Putnam et al., 2018; Gull et al., 2018). Precision irrigation technologies using overhead sprinklers with low pressure nozzles at 30" spacing and low elevation configuration is known to increase water infiltration, reduce wind losses, reduce energy costs, and increase yields substantially. This requires a modest investment, but growers have shown that the return-on-investment is often recovered quickly (Neibling et al., 2009). Other technologies such as variable rate irrigation (Peters and Flury, 2017; Gaunt, 2017) and Mobile Drip Irrigation (Kisekka et al., 2017) hold promise for improved yields and reduction in water use. This project will combine and test the most promising precision technologies for mechanized overhead irrigation utilizing Low Elevation Sprinkler Application (LESA) and Mobile Drip Irrigation (MDI) methods. These will be combined with deficit irrigation strategies aim to save water costs under times of limited water supply and improve water productivity (defined as crop tonnage per unit of water). These techniques, along with 'deficit irrigation strategies' will provide tools for growers to conserve water and increase profitability.

Yield Mapping. Using aerial imagery to estimate yield and quality is a second goal of this research. This can be used for diagnosing field problems, as well as for timing of management practices such as irrigation. It is well established that plant height is a key variable (along with flowering) to predict quality as well as yield (Yuan et al., 2018). Estimation of forage yield and quality non-destructively using LiDAR (Light Detection and Ranging) and canopy reflectance is an important potential technology for making informed decisions under limiting water resources (Noland et al., 2018). This component of the research will focus on determining plant height, forage yield and quality non-destructively using both unmanned aerial vehicles (UAVs) and LiDAR. Proximal sensing using ultrasonic sensors has been successfully used to measure crop height in many agronomic and phenotyping/breeding studies (Yuan et al., 2018). The mapping of yield variation in fields can also be an important diagnostic tool for

farmers (independent of irrigation) to correct deficiencies and improve yields over time. We plan to test these image-yield maps on farmer's fields to test the practicality of this approach.

Objectives:

- The objectives of this project are to 1) determine effects of Low Elevation Spray Application (LESA), and Precision Mobile Drip Irrigation (MDI) on yield and quality of alfalfa under full and deficit irrigation regimes; and 2) develop field mapping tools that will predict yield and quality of alfalfa under full and deficit irrigation strategies to enable growers to maximize yield and profitability.