2021 USAFRI Research Project Objectives

Alfalfa Biomass, Nitrogen Accumulation, and Water Use-Efficiency in High-Yielding Irrigated Environments
Kansas State University - Lollato

Project Award: $50,000

Justification:

- Alfalfa hay yields in the U.S. have remained stagnant since the early 2000's. A potential cause for yield stagnation in commercial crops can be attributed to suboptimal management practices, which prevent growers from attaining higher yields and result in large yield gaps between potential and actual yields (Grassini et al., 2013). Previous research studies suggest that there is a two- to three-fold (3-5 tons dry biomass/acre) yield gap between average and top-tier alfalfa producers in the U.S. (Russelle, 2014). Thus, alfalfa yield stagnation is likely due to below-optimal management practices adopted by growers and research aimed at identifying limiting yield factors and best management practices can result in alfalfa yields improvements.

- The maximum alfalfa yield reported in the US is around 26 tons of dry matter per acre, while the average alfalfa yield lies around 4.5 tons/a (Undersander, 2021). What are the main growth characteristics of high-yielding irrigated alfalfa, and which management practices are limiting alfalfa hay yields? To answer this question, we will conduct a one-of-a-kind on-farm field sampling and survey to characterize alfalfa biomass and shoot N accumulation, as well as water use-efficiency, in high-yielding irrigated alfalfa fields in western Kansas. Typically, researchers attempt to answer this question with plot-level replicated trials, where different treatments are applied to the crop and yield and/or quality are measured using experimental equipment. However, using experimental plots has a few fundamental drawbacks: (i) researchers are only able to test few factors at a time, and (ii) the trials are performed in a limited number of locations and years. We propose that the sampling of commercial fields where historically high-yields have been achieved is a more "boots on the ground" alternative to characterizing alfalfa growth under near non-limiting conditions. For instance, van Roekel and Purcell (2014) sampled growers' fields to characterize soybean growth, N uptake, and radiation use-efficiency in a maximum yield environment. The authors concluded that the observed soybean characteristics were near or above the maximum values previously reported in the literature, providing empirical evidence for the potential of high soybean attainable yields and resource use-efficiency. This compelling example shows how on-farm sampling can be useful to improve local recommendations practices while overcoming limitations of small plot experiments.

- Beyond yield, on-farm surveys including field-specific management information, hay yield, and amount of water input (rainfall + irrigation) data can be used to calculate alfalfa's water use efficiency (WUE) in terms of biomass per unit of water supply. By sampling and interviewing a large number of growers managing irrigated alfalfa, the resulting database will have information to accurately compute the WUE of all surveyed fields. This new dataset will enable us to explore the underlying causes for which some fields or farmers have lower WUE relative to the most efficient fields from the survey, which will be used as a benchmark. For instance, Grassini et al. (2015) used grower data from irrigated and dryland fields to calculate a maximum WUE for soybeans, which was quantified as 3.8 bushels of soybean per inch of available water (Fig. 2). This benchmark value was used to calculate the difference in WUE of the other commercial fields and allowed the researchers to identify the main management practices associated with improved water use-efficiency.

- To our knowledge, there have been no attempts to perform an on-farm sampling and survey of management practices in irrigated commercial alfalfa production fields. While on-farm surveys do not substitute traditional replicated experimentation, one of the biggest advantages of on-farm surveys is the opportunity to investigate the impact of several independent management practices, which would be cost prohibitive in small plot experiments (Rattalino Edreira et al., 2017). The proposed survey will provide new opportunities for: (i) characterizing the growth, yield, and resource use-efficiency of high-yielding irrigated alfalfa; (ii) assessing current alfalfa on-farm management practices relative to recommended practices, (iii) discerning the yield limiting factors and the relative contribution of individual management and production factors at the level of commercial-scale fields (in contrast to small experimental plots), and (iv) quantifying field and regional water use efficiencies of irrigated alfalfa production environments.

Objectives:

- The overall objective of this research is to conduct on-farm field sampling of high-yield irrigated alfalfa fields, combined with a survey of farming practices adopted in these fields to improve alfalfa yield and water-use efficiency. The specific objectives are to use southwest Kansas as a case-study to: 1) provide a description of alfalfa growth and resource use-efficiency in high yielding fields; 2) describe current alfalfa management under these conditions, 3) calculate water-use efficiency in all fields included in the survey, and 4) identify major agronomic practices associated with increased hay yield and WUE.