FREP Concept Proposal

Project Title: Characterizing N Fertilizer Requirements of Crops Following Alfalfa

Project Location: Statewide: Intermountain Region, Sacramento Valley, San Joaquin Valley, and Imperial Valley

Project Duration: 3 Years

Project Leaders:

- Dan Putnam, Cooperative Extension Forage Specialist, University of California Department of Plant Sciences, One Shields Ave., 530-752-8982 dhputnam@ucdavis.edu;
- Stu Pettygrove, CE Soils Specialist, Department of Land Air and Water Resources, University of California, Davis, One Shields Ave. 530-752-2533 gspettygrove@ucdavis.edu**;**
- Khaled Bali, CE Farm Advisor, Imperial County. 1050 East Holton Road, Holtville, CA 92250. 760-352-9474. kmbali@ucdavis.edu**;**
- Steve Wright, CE Farm Advisor, Tulare County. 4437 Laspina St., Ste. B, Tulare, CA 93274. 559-684-3315 sdwright@ucdavis.edu
- Kent Brittan, CE Farm Advisor, Yolo County, 70 Cottonwood St., Woodland, CA 95695. 530-666-8733. klbrittan@ucdavis.edu
- Steve Orloff, CE Farm Advisor, Siskiyou County, 1655 South Main Street, Yreka, CA 96097. 530-842-2711 sborloff@ucdavis.edu

Target Audience: The target audience is: farmers, ranchers, CCAs and PCAs, Universities and companies who make recommendations for fertilizer use.

Objectives: To determine the impacts of rotation with alfalfa on the N fertilization needs of a non-legume crop, to develop an 'N credit' recommendation for management of N fertilizers in rotations.

Summary of problem to be addressed. Farmers of row and field crops (corn, small grains, tomato, cotton) in California have been under scrutiny from several quarters to more accurately match the needs of the crop with fertilizer applications. There are both economic and environmental incentives to better manage these resources, the primary of which is mineral N fertilizers. Environmental concerns include possible effects on groundwater with N fertilizers and manure used on agronomic crops (see Harter et al. report, March, 2012) and impacts on air quality. To better manage N, it is necessary to understand crop rotation effects. Alfalfa in California is commonly rotated with wheat, corn, oats, tomato, cotton, and sometimes specialty vegetables. A minimum of 200,000 acres are likely rotated from alfalfa each year. Farmers value both the soil tilth benefits of crop rotations with alfalfa, as well as the weed suppression and N benefits. However, little is known about the impacts on fertilizer N needs of subsequent crops in this rotation, and many growers do not take this into consideration when developing a fertilizer program. Under irrigation, a productive alfalfa crop fixes between 350 and 750 lbs of N per acre per year in California, totaling – 2,000 to 4,000 lbs N/acre over a 5 year alfalfa stand. While most of this N is presumably removed in the forage, a substantial portion of residual nitrogen remains in the soil, a portion of which may be available to subsequent crops. This is due to the stable

soil rhizosphere, the sloughing off of root and nodule pieces, root mass itself, and the deposition of high-N containing foliage to the soil. While there have been many studies conducted in the Midwest to quantify an 'N credit' for corn or grains following alfalfa, to our knowledge there have been no studies in California to characterize this rotational N benefit under irrigated conditions. Factors such as higher temperatures, the higher alfalfa and grain yields, soil type, as well as the presence of irrigation water create conditions in California which are likely to be distinct from Midwestern production systems. Additionally, the wide variety of conditions (from desert to Mediterranean and mountain conditions) within California creates challenges to develop a unified recommendation for an 'N credit' for crop rotations. This is a large gap in our technical knowledge that limits our ability to improve N fertilizer management in the state.

Approach: We propose to conduct field and laboratory experiments that will quantify the N-rotation benefits following alfalfa. Since a wide variety of factors (strength and duration of the alfalfa stand, weeds, weather, time between alfalfa destruction and planting, tillage, rotation crop, soil type, etc.) are likely to be important, we will attempt to obtain a wide range of sites, characterize those sites, and attempt to control at least several of these agronomic variables. We will choose 8 sites (farmer's fields) per year for two years, with a smaller number in year 3 depending upon success of the initial data: 2 in the intermountain area, 2 in the Sacramento Valley, 2 in the San Joaquin Valley, and 2 in the Imperial Valley. We will utilize wheat as the primary test crop across all sites, since it can be grown at all sites. Note: cotton, tomato and corn are also important rotation crops with high N needs, but we feel that quantification of N uptake and rotation effects should be feasible utilizing a single crop as a control across sites. Growers who are rotating from alfalfa to small grains will be chosen in each of the four regions. Characterization of the alfalfa stand, soil properties, amount of forage incorporated will be made. We will make every attempt to standardize the practices during the rotation period, e.g. method of stand removal, type and duration of land preparation for the rotation crop, time of seeding, agronomic practices for wheat. A replicated fertilizer N-rate study with 5 treatments (zero N to very high N rates in two applications) will be instituted at each site after establishment of the small grain, with crop above-ground biomass yield, agronomic traits and total plant N uptake measured at harvest. Comparing the optimum N fertilizer rate (the point of maximum yield) with the unfertilized control will give an indication of N credit for the legume from that study, which then can be characterized across sites. Comparison of crop N uptake with fertilization with non-fertilized controls will give an indication of the importance of residual N. At two sites, we plan on having a 'true control' – an N-rate study on a nearby field which has had continuous non-legume -- as a way of testing the rotational impact of alfalfa vs. non-legume. Additionally, researchers will sample the soils from the field with the alfalfa present, and a field nearby with at least two years of cereal or corn production, and measure the N mineralization potential of the soil using an aerobic laboratory incubation method. This will provide an important additional comparison of the legume rotation with a non-legume rotation. Such results from 8 sites in each of 2-3 years plus the two additional non-alfalfa rotation field sites and supporting soil incubation results will provide a powerful dataset from which to make recommendations; this data does not exist currently. Information on specific circumstances (stand, weeds, timing, soil type, location etc.) can be used to modify the recommendations for an N credit that depend upon those factors. This information would be welcomed by farmers looking to improve N management on their farms.