

2018 USAFRI Research Project Objectives

Maximizing Alfalfa's Yield Potential University of California - Brummer

Project Award: \$49,988

Justification:

- Yield is the bottom line for crop breeding programs. Even if one considers other traits of importance, such as nutritive value, the need for maximizing production given the constraints of the other trait(s) remains. Oddly, and somewhat inexplicably, yield improvement in alfalfa has stalled for the past ~25 years across the nation (Brummer and Casler, 2014); the graph of California on-farm yields based on USDA ag statistics shown below is typical, although other states, particularly in the Midwest have shown a plateau for somewhat longer. Trials from northern (Tulelake) and southern (El Centro) California show that yield improvement has been modest at best; as a percentage of standard cultivars Vernal in the north, yields have declined; as a percentage of CUF101 in the south, yields have improved, probably though better disease resistance packages. Based on these and other data, we can conclude that overall biomass production per hectare is more-or-less stagnant, with gains relative to older varieties likely to be due more to improved disease/pest resistance than to pushing the yield ceiling per se.

Does it matter that yields are not increasing, or at least, not increasing by much? I think the answer is yes. Higher production per unit area is necessary to accommodate the needs of a growing population desiring more animal products, to overcome the loss of agricultural land to urbanization, degradation, or other uses, and importantly, to remain competitive with other crops, such as corn silage, whose productivity is increasing. In addition to providing desirable nutritive value to ruminants, alfalfa also provides numerous positive environmental services to an agroecosystem (nitrogen fixation, perennial soil cover, improved soil organic carbon, to name three) (Olmstead and Brummer, 2008). Thus, ensuring it remains in cropping systems has both direct animal feeding benefits as well as indirect benefits to other crops in rotation.

The lack of yield progress can be ascribed to the perennial nature of alfalfa, to the harvesting of the entire plant (and hence, the inability to make gains in harvest index as in grain crops), and to the conflicting demands of long term persistence, higher nutritive value, better disease resistance, and incorporation of new traits all of which divert attention from direct yield selection. The first two reasons undoubtedly pose limitations relative to grain or oilseed crops, but there is no obvious physiological reason why yield improvement could not be made. However, the latter reason is a red herring, as every other crop faces similar conflicts among multiple traits – wheat, for instance, must maintain strict milling quality standards and yet wheat yields have been increasing despite that limitation. Although there are plausible reasons why alfalfa yield improvement could lag other crops, there's no reason that yield improvement (over and above defensive disease/insect resistances) shouldn't be possible.

Objectives:

- Our long term objectives are to demonstrate that genetic gain for yield is possible using these technologies singly or, especially, in combination. Objectives include: 1) Complete a second year of data collection on the existing GS selection evaluation experiment; 2) Develop, genotype, and begin phenotypic evaluation of half-sib breeding populations; and 3) Evaluate remote and/or proximal sensors to determine biomass yield in breeding populations.