

New Frontiers in Alfalfa Improvements

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Three statistics underline the depressing situation in which the alfalfa industry in the United States finds itself: (1) alfalfa production is now at its lowest level since 1952, (2) hectareage is at its lowest since 1948, and (3) hay yield per hectare has been essentially flat since 1978. The last statistic undoubtedly influences the preceding two, as yield gains in other major crops, especially maize silage, make them more desirable to grow (and require less management and labor as well). How can the research community – public and private – reverse these trends? Can we see a new horizon? Or is will it be obscured by silage corn (and in California, almond trees)?

I'd like to think alfalfa's here for the long-term and won't go the way of the dodo bird. Several avenues seem to exist to ensure the crop's future by targeting new/improved traits, new growing regions, and new uses. New traits could be incorporated using conventional selection, transformation, or gene editing, as we will hear in this session. A host of traits could conceivably be identified, selected, and commercialized, but identifying those that would have the largest market impact and that could increase the use of alfalfa is tricky. At base, increasing yield overall, and specifically, the yield of digestible nutrients, will be essential to profitable alfalfa production. Regionally important traits include the full gamut of needs, from drought and heat tolerance to winterhardiness to specific disease and insect resistances. One obvious region in the US that could expand the use of alfalfa is the southeastern USA. While other regions may not have substantial room to grow due to competition for land from other crops, alfalfa could be added into southeastern forage systems as a companion to bermudagrass or tall fescue, for example, which would not require diversion of existing land uses to alfalfa. Finally, new uses of alfalfa – ranging from the "old" new use in highly productive pasture systems to current possibilities such as protein for human consumption – could also keep alfalfa going.

Conventional evaluation and selection are the foundation of an alfalfa breeding program and will remain so. Various genomics methods and biotechnologies will augment that program, but without a strong foundation, they are unlikely to revolutionize alfalfa improvement (or that of any other crop, for that matter). Adding high throughput phenotyping and genomic predication and selection will accelerate genetic gain by making selection cycles faster, by expanding the effective number of genotypes that can be evaluated each cycle, or both. Incorporating desirable alleles using gene editing or transformation could have far-reaching positive consequences if the technologies are permitted not only in the USA but in our major export partner countries as well.

One area where too little research is focused, it seems to me, is in more fully understanding the phenology and plasticity of alfalfa plants through time, across harvest/regrowth cycles, and in the competitive spacing of a sward. If we knew more about plant development, could we do a better job of reconceptualizing alfalfa to make the crop easier to harvest, provide a better package of nutrition, and be better tailored to current management and equipment? We'll hear about crop modeling advances during the conference that address this topic. Building on those results could help us dissect the genetic basis of various traits, from stem number per plant and branching phenotypes, to leaf:stem ratios and phenotypic plasticity enabling a plant to expand into open areas that develop in the stand. Crop ideotypes can be a black hole, diverting attention to insignificant component traits and away from ultimate traits, like yield. But the exercise of understanding the plant better could help us radically revise how we grow and manage alfalfa, and in turn, in how we improve the crop using the genetics, genomics, and biotechnological tools at our disposal. This could have substantial implications for the future use of alfalfa in the USA and globally. Let's get on it.