Maximizing Alfalfa's Yield Potential

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Alfalfa on-farm hay yield has not increased over the past 30-40 years. Yield increases have been found in various experiments, but these can often be explained not by an increase in yield potential but by improved disease or insect resistance. While the latter is certainly desirable, improving the yield *per se* of alfalfa would help keep the crop competitive with annual oilseed and grain crops and with corn silage, all of which have seen large yield gains over the past 50 years. The lack of on-farm yield gain in alfalfa is mystifying in that breeding companies often indicate they have seen yield gains in their experimental germplasm when evaluated in their breeding trials, just as maize breeders (and breeders of most other crops) have seen. But unlike maize, where these experimentals become cultivars widely grown in farmers' fields and yield gains are seen in aggregate on-farm yield data, no similar increase is seen when experimental alfalfa cultivars transition to production conditions. Why?

Our alfalfa breeding program has looked at a number of ways to change breeding methods to improve yield. These include (1) evaluating yield early in the breeding program in high density sward plots reflecting commercial planting conditions, (2) adjusting yield data for spatial variation in breeding trials using various statistical programs now widely available, (3) using aerial drone-based sensors to predict yield, (4) the application of genomic prediction to aid the selection of desirable genotypes without requiring multi-year field data. These and other modifications of breeding methods could improve genetic gain by changing various parameters in the breeder's equation such as increasing selection intensity, improving heritability, or decreasing cycle time. Collectively, these changes could lead to better phenotypic data and more accurate selection, and in theory, higher genetic gain. For example, based on our genomic selection program, we estimate that one cycle of genomic selection (GS) can reach 80% that of phenotypic selection, but *much faster*, only requiring six months rather than 3-5 years. If multiple cycles of GS can be effectively conducted before the model needs to be recalibrated with field data, then GS will be considerably superior to phenotypic selection.

However, phenotypic selection has been singularly *ineffective* at improving yield in the past. Are technological improvements just going nowhere faster? Is improving alfalfa yield potential no possible? Bill Knipe, long-time alfalfa breeder with Forage Genetics, Intl., recently suggested to me (ECB) that "the only way to improve alfalfa yield is to reduce autumn dormancy." Assuming that we don't want to alter the dormancy – attendant changes in other traits can be undesirable – then are we stuck?

Perhaps the alfalfa community needs to think about redesigning the alfalfa plant from first principles, in order to realize yield gains that have otherwise been hard to obtain. Twenty years ago, I (ECB) would have scoffed at this idea. Today, in the face of a further 20 year yield plateau, it seems like an idea whose time has come.