Improving Precision of Forage Yield Trials: A Case Study

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Field-based agronomic and genetic research relies heavily on the data generated from field evaluations. Therefore, it is imperative to optimize the precision of yield estimates in cultivar evaluation trials to make reliable selections. Experimental error in yield trials is sensitive to several factors, some of which are classified as experimental design factors (i.e. plot size, block size and number of replicates). Long-term historical field trials can be used in a variety of ways to improve the precision and power of future field trials. The purpose of this presentation is to illustrate a case-study of long-term ryegrass forage yield trials evaluated by the Department of Agriculture, Food and Marine (DAFM) in Ireland to quantify the effects of block size, block shape, and number of replicates, spatial variability on trial precision and power. A total of 142 perennial ryegrass, Italian ryegrass, and hybrid ryegrass forage yield trials sown between 2001 and 2011 across five locations in Ireland were considered for this retrospective analysis. Row-column designs were 36% more efficient than complete block designs, while spatial analyses were 71% more efficient than complete block designs alone. The best spatial models were correlated errors models that modeled the specific correlation structure present in each field trial. Spatial adjustment had a significant impact on cultivar selection and power to detect mean yield differences of cultivars. The best spatial models and the randomized complete block design without spatial analysis agreed on the top cultivar for only 66% of trials. Using spatial models, four replicates were sufficient to detect mean yield differences between cultivars of 7% of the mean and 80% power, compared to 12 replicates for the randomized complete block design without spatial analysis. The impact of block size and number of replicates on trial precision was dependent on block shape. Increasing number of replicates significantly decreased LSD only in wider (more square) blocks compared to narrow (more rectangular) blocks. Routine use of incomplete block designs combined with spatial analysis must be added to the routine DAFM testing programs, not only to improve the precision of yield estimates but also to reduce the risk of missing potential candidate cultivars, given the existence of spatial variation. These analyses can be employed to improve precision and power in any long-term research program with historical trials data accumulated over several years.