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Development of a forage evaluation system for perennial ryegrass cultivar and endophyte combinations in New Zealand dairy systems

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Introduction

An economic index for perennial ryegrass (*Lolium perenne* L.) cultivars is a relatively new concept, although recently introduced in Ireland (McEvoy *et al.* 2011). By contrast, in dairy cattle breeding, the concept of an economic index rating animals and economic values underlying that index is well entrenched (Philipson *et al.* 1994; Veerkamp, 1998). Historically, forage evaluation data for individual cultivars were either displayed using absolute numbers for seasonal dry matter production within a season or across all seasons with a notation to indicate statistical differences, or percentage values where a reference cultivar is 100. The adoption of an economic index and routine evaluation approach for perennial ryegrass provides a method to identify traits of economic importance to focus plant breeding efforts better and to provide clarity for farmers around predicting cultivars that will maximise farm profit. It also allows for routine tracking of genetic gain of individual traits and the economic index. In this paper, the economic based forage evaluation techniques now used in New Zealand for perennial ryegrass cultivar/endophyte combinations are presented.

Methods

An economic merit index, Forage Value Index (FVI; NZ\$/ha) for perennial ryegrass cultivars was developed for use in cultivar selection decisions for NZ dairy production systems. FVI is the sum of performance values (PV; kg dry matter (DM)/ha) multiplied by economic values (EV; NZ\$/kg DM) for seasonal herbage accumulation (HA; kg DM/ha) (Equation 1):

$$\text{FVI} = \text{WinterPV} \times \text{WinterEV} + \text{EarlySpringPV} \times \text{EarlySpringEV} + \text{LateSpringPV} \times \text{LateSpringEV} + \text{SummerPV} \times \text{SummerEV} + \text{AutumnPV} \times \text{AutumnEV} \dots \dots \dots \text{(Equation 1)}$$

Economic values were calculated using the modelling methodology described by Chapman *et al.* (2013). Performance values for a cultivar and endophyte combination are calculated from the least square mean HA within a region and season based on National Forage Variety Trials

(NFVT; Easton *et al.* 2001) minus the average HA for “all cultivars first trialled in NFVT before 1996”, the Genetic Base. Similarly, FVI for a cultivar and endophyte combination are calculated from its absolute FVI minus the average FVI for the Genetic Base. Performance values and FVI are specific to four regions within New Zealand: Upper North Island, Lower North Island, Upper South Island and Lower South Island, and are presented as quantiles into star rating groups. Confidence within a region, a measure of reliability of the index, is calculated using the following equation:

$$\text{Confidence} = \text{Ntrials}(\text{in region}) + \text{Ntrials}(\text{out of region}) \times r_s \dots \dots \dots \text{(Equation 2)}$$

where Ntrials(in region) = number of trials with a region, Ntrials(out of region) = number of trials outside the region and r_s = Spearman rank correlation between regions. Data are then presented at www.dairynzfvi.co.nz.

Results and Discussion

The present forage evaluation approach utilises many of the concepts from dairy cattle breeding such as economic models to derive economic values and economic indices. A distinction is that performance values are not true genetic values as relationship or genomic matrices are not utilised in the data analysis. A star rating approach (Fig. 1) is adopted, similar to that adopted in Ireland for beef cattle. The advantage of this approach is that it is simple to understand and the emphasis on the absolute FVI is down weighted. This absence of display of absolute FVI for individual cultivars is important as a limited number of trials (minimum of three) are included in a cultivar and endophyte combinations proof so confidence is still relatively low. In addition, persistence and nutritive value information are not yet incorporated in FVI. These economically important traits will be captured in the index in the future based on trials already sown.

The display allows farmers to explore options surrounding secondary selection of cultivar and endophyte combinations for strengths in dry matter production within seasons (for instance, winter seasonal dry matter production). The standardised display and utilisation of multiple



Figure 1: A. Display of forage evaluation data for the Upper South Island of New Zealand. B. Filtering options.

trial results in the proof ensures that selection of individual trial and specific season results is avoided. This allows farmers to see a more comprehensive picture of a cultivar and endophyte combination and importantly on an economic basis. Farmers can use the tool to select a number of cultivars that meet their forage supply needs, for instance, to select a late or very late heading date cultivar to provide higher late spring pasture quality. Likewise, users can avoid cultivar and endophyte combinations where the endophyte does not provide sufficient pest protection for their region.

Conclusion

An economic index, FVI, for perennial ryegrass cultivar/endophyte combinations has been developed. This index, and the associated routine estimation of economic values, provides a better economic focus for plant breeding efforts, and provides an objective, quantitative and economic basis for perennial ryegrass cultivar selection

decisions. The index will strengthen over time as other economically important traits are included in the FVI.

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