The prediction of biological nitrogen fixation

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Keywords: N fixation, models

Introduction In organic farming systems, biological nitrogen (N) fixation is crucial for short-term productivity and long-term sustainability. However, the estimation of biological N fixation is fraught with difficulties, and many equations attempt to estimate the process. As part of an organic research programme, biological N fixation was measured by the ^{15}N dilution technique in the ley phases of 2 experimental organic ley-arable rotations at 2 sites, between 1997 and 2000. Hence, N fixation has been determined on N partitioned to above-ground biomass. The measured values have been compared with N fixation estimates calculated from the equations proposed by Korsaeth & Eltun (2000) and Hogh-Jensen *et al*. (2004).

Materials and methods Equations of Korsaeth & Eltun (2000) and Hogh-Jensen *et al*. (2004), both consider the yield of white clover and the N content of the legumes. The equation of Korsaeth & Eltun (2000) includes the age of the ley and the maximum fraction of fixed N in the legume, which is adjusted for the quantity of added N fertiliser/manure. Also, the N fixation is corrected for the net accumulation of N fixed below stubble height. By contrast, in the equation of Hogh-Jensen *et al*. (2004), N fixation includes below-ground N in the root and stubble, the below-ground transfer to grass, the above-ground transfer to the grass by grazing animals and the immobilisation of fixed N into the organic soil pools, with the age of the ley impacting on the values of these factors. In order to compare the model with the measurements of above-ground fixation (Sanders *et al*. 2001), only factors relating to the roots and stubble were included in the calculation of N fixation. Theil's inequality coefficient (Theil, 1970), which has a value of between 0 and 1, with 0 indicating a perfect fit, was used to compare the performance of the models with the measured values.

Results The performance of the models differs between the age of the ley and year (Figure 1). The poorest predictions were observed in 2000, with Theil's inequality coefficients of 0.11 and 0.08 for Korsaeth's and Hogh-Jensen's models respectively. In 1997-1999, Theils' inequality coefficient ranged from 0.02-0.03 for Korsaeth's model and 0.003-0.01 for Hogh-Jensen's. Predictions for the 1st year ley across all years were worst, and for the 4th year ley were best.

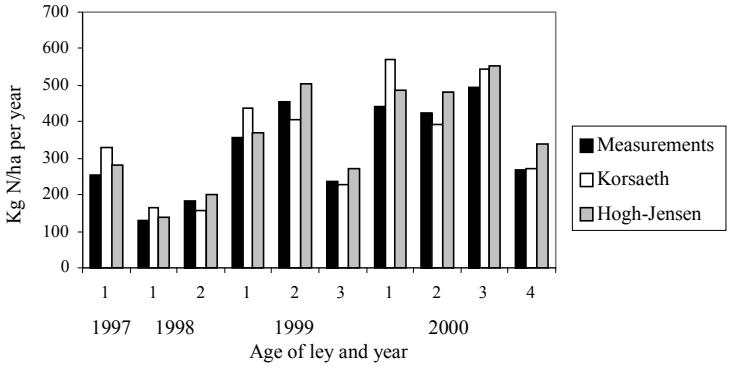

Figure 1 N fixation for age of ley and year

Conclusions The performance of the models varies between the age of the ley and year. However, Theil's inequality coefficient illustrates that the performance of both models is relatively good. Based on the assumptions of the model described by Hogh-Jensen *et al*. (2004), the total N fixation for the second year ley is 182 kg/ha/yr, which is 62% higher than the estimate excluding transfers and immobilisation. The unavailability of reliable field estimates of N fixation is hampering an adequate evaluation of these models currently.

Acknowledgments The Scottish Executive Environment and Rural Affairs Department funded this work.

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