An approach to describe the variability of nitrogen fixation by a clover-grass mixture within a field

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Aims

Nitrogen fixation figures at field or whole farm level are uncertain numbers which cause less reliable N-balances if legumes are part of the crop rotation. For clover-grass mixtures this uncertainty is caused by strong variations in legume yield within one field which is one key parameter for nitrogen fixation. The variation is a result of soil conditions, weather and management. In order to analyse the importance of each of these factors procedures which easily describe legume yield are required.
New harvesting techniques are being developed which will offer the possibility to measure yield as well as quality parameters (Near-Infrared-Reflectance Spectroscopy: NIRS) during harvest. The aim of our project, which is part of the FAM-study at Scheyern, Germany, is to develop methods for deriving reliable nitrogen fixation figures from these types of data. As well as total yield, an estimate of legume content will be necessary for our project focus on.

Material and Methods

Experiments were run in 1999 at the FAM Experimental Farm Scheyern,. The farm is located 40 km north of Munich in a tertiary hilly landscape. Soil conditions vary dramatically over short distances but are dominated by sandy to loamy Brown Earths (Eutrochrepts). Two red clover-alfalfa-grass fields, one following rye (A04: 2,25 ha) and the other sunflower (A09: 2,35 ha), were sown with a mixture of three legume and five grass species. Data [dry matter yield, percentage legumes (estimated by eye and NIRS), nitrogen content] were measured at regular distances within the fields at each harvest. Five additional plots were selected for soil characteristics and wheat yield pattern. At six to nine replicates on these plots legume content was determined by hand sorting and N_2-fixation was measured by ^{15}N-isotope dilution. NIRS was used to determine legume content in dried ground samples. Results for the field were described using inverse distance weighing as offered by ARCView GIS.

Results

Total yield varied vastly between cuttings within each field, but the relative yield pattern seemed to be stable (Fig. 1). Yield variations were intensified during the last growing period as the stands experienced water stress.
Legume content, as a visual estimate, varied greatly within one field (from 20 % to more than 90 %) and between cuttings (Fig. 2). Visual estimates of legume content differed vastly from hand sorted results if they were in the range of 30 – 70 %. Using NIRS greatly improved the accuracy of the results.
Data acquired from the plots showed that N_2-fixation could be calculated by multiplying the N-yield of legumes by a factor of 0.9.

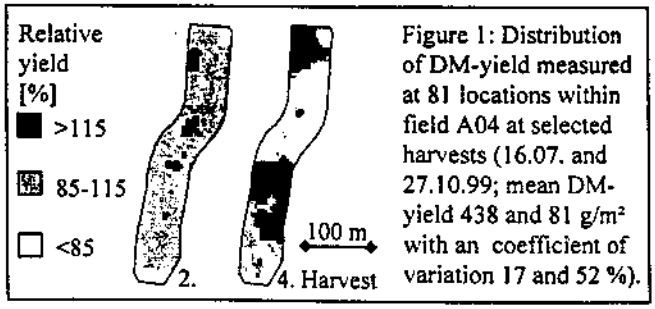

Figure 1: Distribution of DM-yield measured at 81 locations within field A04 at selected harvests (16.07. and 27.10.99; mean DM-yield 438 and 81 g/m² with an coefficient of variation 17 and 52 %).

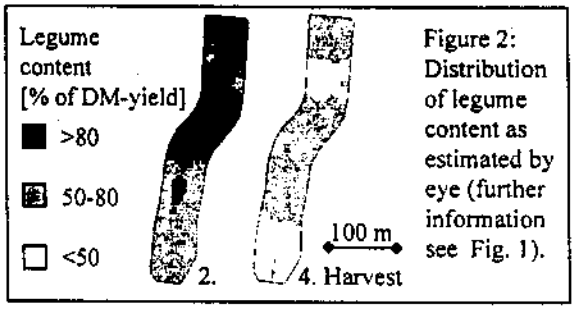

Figure 2: Distribution of legume content as estimated by eye (further information see Fig. 1).

Conclusion

N_2-fixation of mixtures containing grasses and legumes can be calculated from the N yield of legumes. Estimating their contribution to the yield of mixtures appeared to be difficult. However the variation of this parameter, especially in heterogeneous fields, strengthens the need for this measurement. NIRS seems to be a promising tool but requires further investigations for widespread use. From these results differentiation of N-gain within one field as well as improved data for the farm can be calculated.

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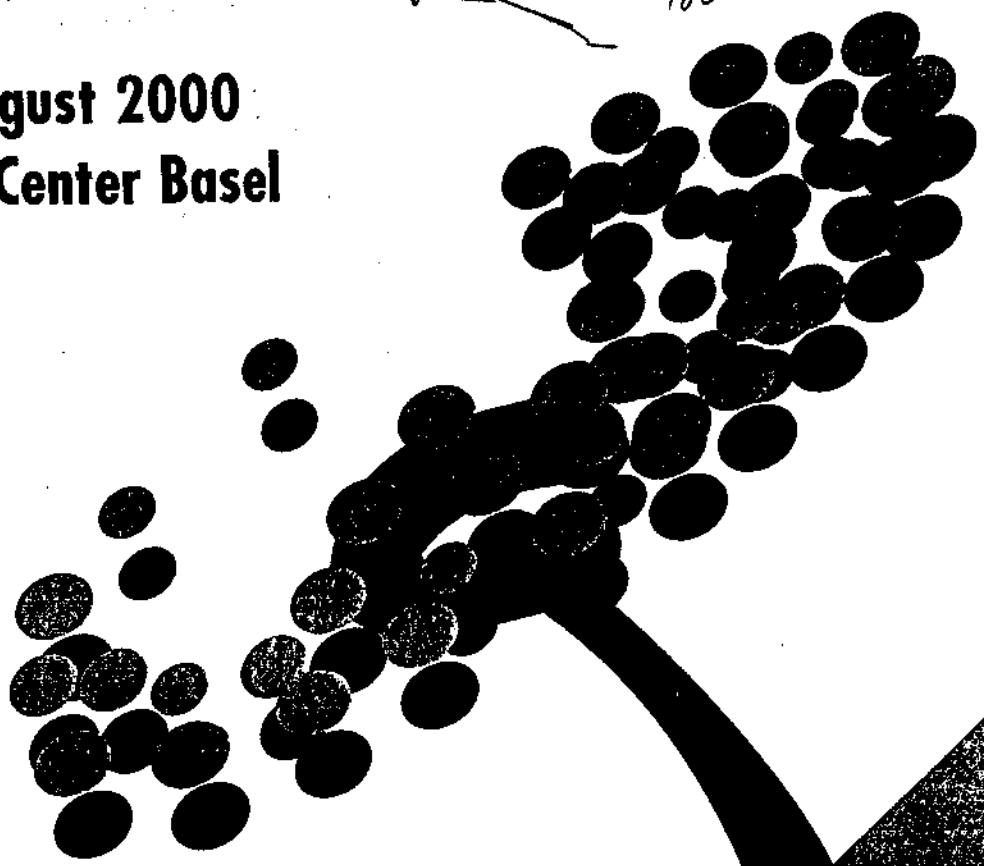

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