A new agro-meteorological simulation model for predicting daily grass growth rates across Ireland

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Keywords: grass, model, simulation, generative, vegetative

Introduction Grass growth rates and herbage yields depend on weather conditions, soil characteristics and grassland management and differ from year to year and from site to site. In the past, grass growth has been predicted using both mechanistic and statistical models. The accuracy of mechanistic models is commonly insufficient for practical application, while statistical models generally apply to one test site only (e.g. Han *et al.,* 2003). In this paper a semi-empirical grass growth model is presented which is numerically accurate, but which can be applied to contrasting sites across Ireland at the same time.

Materials and methods The new model computes changes in herbage biomass as the difference between above-ground primary production and respiration. The potential primary production P_{pot} (kg DM/day) is simulated in a new light utilisation function, with Leaf Area Index (LAI) and instant radiation flux as input variables. The actual primary production P_{act} (kg DM/day) is subsequently computed as:

$$P_{act} = P_{pot} \cdot F_T \cdot F_W \cdot F_N \cdot F_P$$

in which F_T is a sigmoid temperature function. F_W is a water function, which is driven by the Hybrid model for predicting moisture conditions in Irish grasslands (Schulte *et al.*, accepted). F_N accounts for the effects of nitrogen (N) fertiliser inputs, while F_P is a new submodel describing tiller dynamics during the generative phase as temporal functions of vernalisation, heading, apex removal during harvest and subsequent regrowth from dormant buds. The generative growth of vernalised tillers and new tillering from dormant buds are described by interrelated normal distributions over time, while apex removals are implemented as discrete events. Finally, above-ground respiration is modelled as a function of above-ground biomass, temperature and soil moisture.

Results The model was calibrated and evaluated, using data from the Teagasc "FAO grass growth network". This network measures the 4-weekly grass yield on a weekly basis on replicated (n=5) plots, subjected to three rates of N application, on contrasting sites across Ireland. As a pilot study, the model was calibrated for the Solohead site using the yield data from 1998 to 2000, by minimising the residual sum of squares between the observed and predicted yields, using the OpStat module of acslXtreme. Model performance was evaluated independently using the Solohead yields during the year 2001. Overall, the model explained 74% of the variation in yields, with neither consistent nor relative bias (p>0.05). Subsequently, the final values of the model parameters were calibrated using data of all years. Figure 1 shows that, with the exception of early spring 2001, the model accurately predicts the temporal patterns of herbage yields. In particular, the main novel tiller dynamics function satisfactorily accounts for the growth patterns during the generative phase.

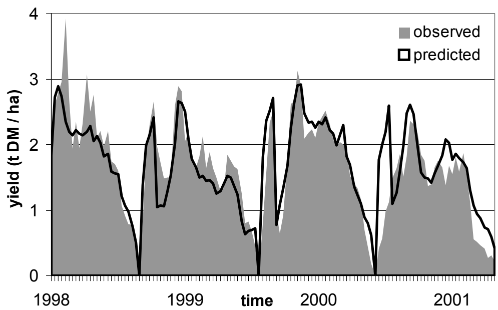

Figure 1 Observed and predicted yields for Solohead

Conclusions The new grass growth model accurately predicts grass yields throughout the year. It accounts for differences between sites that arise from meteorological conditions, soil drainage capacity, grass variety and grassland management. As a result, it allows yield predictions to be customised for individual farms.

Acknowledgements Grass yields and weather data provided by Mr. Frank Kelly (Teagasc, Kilmaley) and Met Éireann, respectively. Members of Agmet are gratefully acknowledged for their feedback.

References

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