Project number: 6334
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Precision Grazing

Key external stakeholders:
Scientific, Advisors, Policy makers, Farmers

Practical implications for stakeholders:

- A grass growth model was developed and evaluated and is available for incorporation into PastureBase Ireland
- A model describing dairy cow intake and milk production has been developed which will allow researchers and advisors to examine the potential of different grass-based milk production systems.

Main results:

The Moorepark-St. Gilles Grass Growth (MoSt GG) model was developed and evaluated. The model can predict grass growth, grass nitrogen (N) content and N leaching using weather, soil type and farm management information. In an evaluation comparing model predictions with measured grass growth at Curtins, Ballyhaise and Clonakilty for 2013 – 2018 the model showed very close predictions with the root mean square errors of <10 kg DM/ha. A dairy cow intake and milk production model was developed and evaluated. The MoSt Grass Growth model and the dairy cow intake and milk production model were combined and tested against Curtins research farm data. The relative prediction error for milk yield was <12%. The model can be used to evaluate the potential of different grass-based milk production systems.

Opportunity / Benefit:

The MoSt GG model will be integrated in to PastureBase Ireland to provide a Decision Support Tool for farmers. The Most GG model is a component of both the platforms and the Targeted Projects in the SFI funded project VistaMilk. The availability of the model allowed the VistaMilk team to develop a core part of the project around grassland and grassland decision support tools. The Grazing Management Animal Performance Model is being used in the DAFM funded project 15/S/696. The Grazing Management Animal Performance Model is a component of both the platforms and the Targeted Projects in the SFI funded project VistaMilk.

Collaborating Institutions:

Met Eireann, CIT, Maynooth University, INRA (France)

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1. Project background:

The competitive advantage of Irish milk and meat production is based on the efficient production and utilisation of grazed grass. Grazed grass is the cheapest feed source available in Ireland (O'Kiely et al., 1994; Dillon et al., 2005; Finneran et al., 2010). This competitive advantage of grass as a feed has increased in recent years due to rising energy and purchased feed costs. Additionally pasture derived dairy and meat products have favourable nutritional characteristics (Priolo et al., 2001; Martin et al., 2004; Coakley et al., 2007; Wyss et al., 2010; Butler et al., 2011; O'Callaghan et al., 2016 a, b) and are more sustainable in terms of animal welfare and the environment (O'Brien et al., 2012). Applying modern grazing technologies has the potential to significantly increase this competitive advantage. This project will developed precision grazing management technologies that will facilitate increases in milk and meat output from sustainable grass-based systems.

2. Questions addressed by the project:

- Can grass growth be predicted accuracy using weather forecasts and farm management information?
- How accurate are weather forecasts?
- Can bias correction methods be applied to improve weather forecasts?
- Can grass quality be predicted?
- Is it possible to predict dairy cow intake using a model?
- Can a model be developed to describe the effects of grass supply and animal feed intake on milk production?

3. The experimental studies:

Development, evaluation and application of a Grass Growth Predictor model.

Soil, water and N sub-models were incorporated into an existing grass growth model (Jouven et al. 2006) to develop the MoSt GG model. The model was tested and evaluated. Forecasted and actual weather data were compared and bias correction methods to improve forecasts were developed. The usefulness of the bias corrected forecasts in the MoSt GG model to increase the accuracy of grass growth prediction was evaluated. A specification of the user interface for the MoSt GG model was written and a web based application was developed for use by grassland researchers.

Prediction of grass quality

A database of factors influencing grass quality was developed. The factors impacting grass quality were identified and a simple model was developed. The factors were: season, cumulative temperature, rainfall, radiation, pre-grazing herbage mass, sward density, pre-grazing sward height, rotation length, number of rotations and N fertiliser. A user interface was developed to allow researchers use the model.

Development, evaluation and application of a Grass Intake Animal Performance Model

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The Grass intake Animal Performance Model was developed and evaluated across a number of production systems. Body condition score and live weight change (energy partitioning) elements of the Grass Intake Animal Performance Model were developed, as well as a prediction equation for peak milk yield.

Integration of the Grass Growth Predictor Model, Grass Quality Predictor and Grass Intake Animal Performance Model to form a Grazing Management Animal Performance Model

The Grazing Management Animal Performance Model was developed by integrating the Grass Growth Predictor Model, Grass Quality Predictor and Grass Intake Animal Performance Model and evaluated.

Development of a Decision Support System for grass based feed systems

The specification of the user interface for the Grazing Management Animal Performance Model was developed. This is in the same platform as the Grass Intake Animal Performance Model (Task 3), but allows grass growth to be predicted using the MoSt GG model (Task 1). The web based application was tested and is available for grassland researchers.

4. Main results:

Development, evaluation and application of a Grass Growth Predictor model

A Grass Growth Predictor model that uses easily accessible inputs was developed. The MoSt GG model responds to daily weather conditions, patterns and methods of sward defoliation, and describes daily variations in soil mineral and organic N content. The MoSt GG Model was evaluated against measured data using two years data from Curtins Research Farm. The root mean square error by week of year was 321 kg DM/ha. The model was also evaluated against a range of management scenarios including N fertiliser application rates. The model predicted an average grass growth response of 9.6 kg DM/kg N applied. A further evaluation comparing model predictions with measured grass growth at Curtins, Ballyhaise and Clonakilty for 2013 – 2018 showed very close predictions with the root mean square errors of <10 kg DM/ha.

The analyses of the predicted and measure forecast found that soil temperature forecasts were accurate at all depths and most precise at greater depths such as 50 cm. Rainfall forecasts performed well up to approximately 5 days. Air temperatures are generally precise, up to 7 days. Over all forecasts predict weather accurately up to 7 days in advance. Bias correction did not significantly improve rainfall forecast but did improve soil and air temperature forecasts.

Prediction of grass quality

The factors affecting grass quality are season, cumulative temperature, rainfall and radiation, pre-grazing herbage mass, sward density, pre-grazing sward height, rotation length, number of rotations and N fertiliser. These are included in a simple grass quality prediction model and a user interface was developed to allow researchers use the model.

Development, evaluation and application of a Grass Intake Animal Performance Model

The Grass intake Animal Performance Model was developed and evaluated across a number of production systems. Body condition score and live weight change (energy partitioning) elements were developed, as well as a prediction equation for peak milk yield. The model predictions were compared with measured milk production and body condition score of cows on the Curtins Research Farm and the accuracy of the model is consider good with a relative prediction error of <11% for annual milk production and <4.5% for body condition score.

Integration of the Grass Growth Predictor Model, Grass Quality Predictor and Grass Intake Animal Performance Model to form a Grazing Management Animal Performance Model

The Grazing Management Animal Performance Model was developed and evaluated. The integrated model can predicted herbage intake, pre- and post-grazing sward height, silage fed, milk yield and milk solids yield, amongst other parameters. The model predictions were compared against Curtins research farm data. The difference between predicted and measured pre- and post-grazing sward heights was, on average, less than 0.1 cm. The relative prediction error for milk yield was <12%.

Development of a Decision Support System for grass based feed systems

A web based application was developed and tested and is available for Teagasc grassland researchers.

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5. Opportunity/Benefit:

The MoSt GG model is a component of both the platforms and the Targeted Projects in the SFI funded project VistaMilk. The availability of the model allowed the VistaMilk team to develop a core part of the project around grassland and grassland decision support tools. The MoSt GG model will be integrated in to PastureBase Ireland to provide a Decision Support Tool in the SFI funded VistaMilk project. The Grazing Management Animal Performance Model is being used in the DAFM funded project 15/S/696. The Grazing Management Animal Performance Model is a component of both the platforms and the Targeted Projects in the SFI funded project VistaMilk.

6. Dissemination:

An overview of the project was given at the Moorepark Open Day in 2015 and 2017. Visitors to Moorepark, both national and international, received presentations on the project and many interesting discussions took place. Poster and oral presentations were made at the Agricultural Research Forum, British Grassland Society Research Conference, EGF Conferences and European Meteorological Society Conference. Five peer reviewed papers have been published and another three are under review. A large number of conference publications were published during the project. Advisors and farmers were informed and received demonstrations of the MoSt GG model and the Grazing Management Animal Performance Model during the project.

Main publications:

Ruelle, E., Delaby, L. and Hennessy, D. (2018) Development of the Moorepark St Gilles grass growth model (MoSt GG model): A predictive model for grass growth for pasture based systems. European Journal of Agronomy, 99: 81-90.

McDonnell, J., Lambkin, K., Fealy, R., Hennessy, D., Shalloo, L. and Brophy, C. (2018) Verification and bias correction of ECMWF forecasts for Irish weather stations to evaluate their potential usefulness in grass growth modelling. Meteorological Applications, 25: 292-301.

Ruelle, E., Delaby, L., Wallace, M., Shalloo, L. (2016) Development and evaluation of the herd dynamic milk model with focus on the individual cow component. Animal: An International Journal of Animal Bioscience 10: 1986-1997.

Popular publications:

Ruelle, E., Delaby, L., Hennessy, D. (2017) Usefulness of nitrogen application in heavy soils compared to more favourable land in Ireland – utilisation of the Moorepark Grass Growth model. In: Proceedings of the 19th Symposium of the European Grassland Federation: Grassland resources for extensive farming systems in marginal lands: major drivers and future scenarios. Alghero, Italy, 7-10 My 2017, 22: 609-611.

McDonnell, J., Brophy, C., Ruelle, E., Lambkin, K., Fealy, R., Shalloo, L., Hennessy, D. (2018) Evaluation of ECMWF weather forecasts and their inclusion in an Irish grass growth model. In: Proceedings of the 27th European Grassland Federation General Meeting Cork: Sustainable meat and milk production from grasslands, Cork, Ireland, 17-21 June 2018pp. 823 – 825.

Ruelle, E., Delaby, L., Hennessy, D. (2018) Impact of climate change on grass growth at two sites in Ireland. In: Proceedings of the 27th General Meeting of the European Grassland Federation: Sustainable milk and meat production from grasslands. Cork, Ireland. 17 – 21st June 2018, 23: 538-540.

Ruelle E., Hennessy, D., Delaby, L. (2018) Link between the number of grazing days and the mineral nitrogen fluxes in grazing systems. In: Proceedings of the 27th General Meeting of the European Grassland Federation: Sustainable milk and meat production from grasslands. Cork, Ireland. 17 – 21st June 2018, 23: 670-672.

7. Compiled by: Dr. Deirdre Hennessy and Dr. Elodie Ruelle

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