Measurement of Pasture Growth, Parameterization for Tropical Grass and Validation of the GrassGro Model

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By

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Declaration of Originality

I certify that the substance of this thesis has not already been submitted for any degree and not being currently submitted for any other degree.

I certify that to the best of my knowledge any help received in preparing this thesis and all sources used, have been acknowledged in this thesis.

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Abstract

The GrassGro model was evaluated using 1995 experimental data from the Temperate Pasture Sustainability Key Program conducted at the Big Ridge 2 experimental site at CSIRO's "Chiswick" farm. The experiment was designed to measure changes in feed on offer (ΔFOO) using the exclosure technique on three pasture types: Phalaris (*Phalaris aquatica*), Phalaris-white clover (P. *aquatica-Trifolium repens*) and 'degraded' (a mixture of C_3 and C_4 pasture species). The model was calibrated for daily growth rate (DGR) and ΔFOO under grazed and ungrazed conditions for the three pasture types. The parameters for phalaris and white clover pastures supplied with the model were accepted for simulation. A set of model parameters was developed for *Eleusine tristachya*, which was the major contributing species in the 'degraded' pasture.

Comparison of predicted pooled data for ungrazed phalaris showed significant relationships ($P<0.05$) between observed change in green FOO and observed total FOO. The R^2 value 0.80 and 0.60 and the associated S.E. of the Y estimates were ±756 and 1340 kg dry matter respectively. The model's prediction was considerably higher than that observed for both Δgreen and Δtotal FOO in the December harvest (3418 vs 5752, 3884 vs 7939). However, when these extreme points were excluded from the regression, the R^2 values improved from 0.8 to 0.9 and 0.6 to 0.91 respectively. The grazed phalaris did not show a significant relationship between observed and predicted for either Δgreen or Δtotal FOO. This is because of the frequent change in stocking rate in the experiment which was not compatible with the running of the model.

The Phalaris-white clover pasture showed a significant relationship ($P<0.05$) for Δgreen FOO under ungrazed conditions (R^2 = 0.94). However, Δgreen FOO (grazed) and Δtotal FOO (ungrazed) showed significant relationships ($P<0.05$) but the coefficient of variation explained by the regression was lower (R^2 = 0.71, 0.61) due to over-prediction by the model. This over-prediction was mainly associated with the modelling of white clover which requires some changes to some of its parameters such as the notional net primary production (NPP), the soil moisture response and the allocation to the target root:shoot ratios.

The *Eleusine* based 'degraded' pasture did not show any significant relationship between predicted and observed Δgreen FOO or Δtotal FOO under either grazed or ungrazed conditions. This was due to fundamental differences in the botanical composition between observed and predicted pastures. However, when the relationships were explored excluding the spring data points from the regression, (the period when *Eleusine* was virtually absent from the paddocks), the coefficient of variation increased significantly both under grazed (R^2 = 0.93) and ungrazed (R^2 = 0.84) conditions. The significant relationships of *Eleusine* pasture under grazed conditions which are different with the other two pasture types, are mainly associated with its low digestibility and palatability to stock. Thus, stocking rate does not have much influence on the *Eleusine* pasture. An analysis of simulated growth factors for this species suggested some adjustments which need to be made with its temperature response and its consequent effect on NPP.

Comparison of the measured daily change in FOO of the three pasture types did not match the predicted, mainly because of the differences in the method of its calculation. This is not clearly documented in the model.

Once calibrated, the model was used to simulate the pasture growth under different climatic regimes (Cooma, Armidale and Canberra) and choice of lambing time for matching animal demand to the pasture supply on the Northern Tablelands of New South Wales. The simulated results agreed well with the information provided by various sources.

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°D	: Degree day or Day degree
AbGR	: Absolute Growth Rate
AGR	:Apparent Growth Rate
AI	: Animal Intake
ASW	: Available Soil Water
BHM	: Beginning Herbage Mass
C	: Herbage Consumed
CG	: Continuous Grazing
CSIRO	: Commonwealth Scientific and Industrial Research Organisation
D	: Herbage Decay, Decomposed
DGR	: Daily Growth Rate
DM	: Dry Matter
DMI	: Dry Matter Intake
DSE/dse	: Dry Sheep Equivalent
DSS	: Decision Support Systems
DU	: Digestibility unit
FC	: Field Capacity
FOO	: Feed On Offer
G	: Herbage Growth
G.FOO	: Green Feed On Offer
GLA	: Grazing Land Application
GM	: Gross Margin
HM	: Herbage Mass
HP	: Herbage Production (change in green herbage mass with time)
ISPD	: Integrated System of Plant Dynamics
LAI	: Leaf Area Index
MOAF	: Ministry of Agriculture and Fisheries
MRC	: Meat Research Corporation
NPP	: Net Primary Production/Notional Primary Production
NZ	: New Zealand

OMD	: Organic Matter Digestibility
RG	: Rotational Grazing
RGR	: Relative Growth Rate
RSR	: Root Shoot Ratio
RW	: Reference Weight
SA	: South Africa
SMR	: Soil Moisture Response
SPUR	: Simulation of Production and Utilisation of Rangelands
SR	: Stocking Rate
T.FOO	: Total Feed On Offer
U	: Herbage Utilisation
UG	: Ungrazed
USDA-SCS	: United States Department of Agriculture, Soil Conservation Services
WP	: Wilting Point
WUE	: Water Use Efficiency