Modelling Alternative Improved Pasture Systems at Bombala

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Introduction

During 2010 a demonstration of alternate improved pastures was established at 'Cobana' between Bombala and Bibbenluke. The demonstration was established as part of the Evergraze project to illustrate the differences in seasonal production and their potential to increase production in the southern Monaro.

Three pastures were established in autumn of 2010 including.

- Phalaris / Lucerne (2.7 ha)
- Perennial Ryegrass / Sub Clover (3.0ha)
- Tall Fescue / Sub Clover. (2.4 ha)

During the period between November 2010 and May 2012 the new pastures were grazed with lambs and the growth of these lambs measured across each grazing period. Herbage mass and digestibility were also measured periodically throughout the period from November 2010 to May 2012.

Due to the practicalities of real farm management the paddocks were grazed sequentially with the same mob of animals during each grazing rotation and therefore animals were not the same weight or with the same nutritional preconditioning for comparable grazing periods on each pasture type. Also because the paddocks were not grazed at the same time the stage of growth and the prevailing weather conditions also differed for comparable grazing periods on each pasture. These factors along with a lack of replication significantly confound the data and hence the conclusions that could be drawn about the relative merits of each pasture type.

It was decided to use the GrassGro decision support tool to simulate the soil / pasture systems for each pasture type in order to then explore the performance of each pasture under conditions of equivalent grazing and over a much wider range of seasonal conditions.

Method

Each system was characterised in GrassGro, a process requires a description of the soil physical parameters a description of the relative soil fertility and pasture species.

The animals grazing the pastures have to be characterised in terms of their genotype as well as their current age and growth stage.

GrassGro requires daily weather data to drive the soil moisture balance and hence the pasture growth model. Weather parameters required include.

- rainfall
- max and min temperature
- solar radiation
- pan evaporation.

Once the systems were established a stop / start modeling exercise was conducted to allow a comparison between model outputs and the measured data from each pasture type. This established the goodness of fit between the model and actual data which helps in the weighting given to the results of long term simulation to more fairly compare the different pasture systems.

Weather

Of all the weather parameters required only rainfall was recorded on site so it was necessary to generate the remaining data using the Silo data drill facility on the Long Paddock web site. This process involves the use of algorithms to populate a gridded data matrix from the actual data available from Bureau of Meteorology record at points in the landscape. The rainfall in the silo data set was not a perfect match for the trial site data but was used due to the difficulty in substituting the rainfall data without upsetting the relationships between wet and dry day temperatures.

Soil

Soil physical parameters were not measured for this particular site so the GrassGro soil atlas facility

was used to determine appropriate soil depths and soil moisture characteristics.

The soils selected was a Yellow Duplex soil described using the Northcote method as a Dy3.42 with the following characteristics

	Top Soil	Sub Soil
Cumulative Depth (mm	300	700
Field Capacity (%)	27	30
Wilting Point (%)	13	20
Bulk Density (Mg/m^3)	1.4	1.7
K Sat (mm/hr)	30	3
Soil Evaporation (mm/d ^{½})	3.3	

Soil chemistry was also tested for each paddock and macro elements were largely not limiting. Potassium was marginal but only 0-10cm soil depth was tested. pH in $CaCL_2$ was around 4.7 causing small amounts of Aluminium to come into soil solution (≈ 3% of CEC). On the basis of this it was decided to set the fertility scalar in GrassGro at 0.9 for the Ryegrass and Fescue pastures. The scalar was set to 0.85 for the Phalaris / Lucerne pasture as these species are likely to be more sensitive to the low pH and Aluminium saturation.

Animals

Different cohorts of animals were grazed throughout the trial. In the absence of better information each cohort was characterised in terms of its genotype using the GrassGro default parameters for the breed.

At each individual grazing the animals were described as to the actual weight of animals as they entered each paddock. Stocking rates for the paddock were determined from the stated mob size divided by the size of each paddock.

This approach allowed the animal performance of each grazing to be modelled without any errors in the model estimates carrying forward into the next grazing period.

Pastures

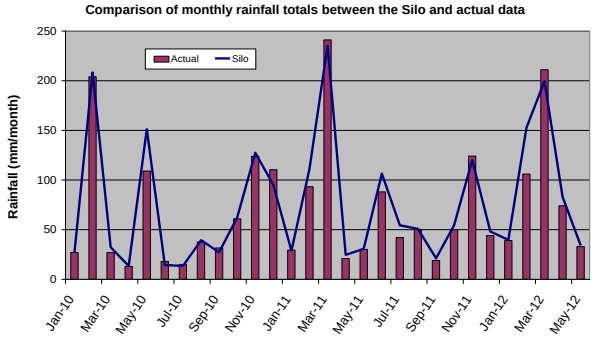
The simplest possible species mix was used to describe each pasture type. The Phalaris / Lucerne pasture was defined as a mix of Phalaris and semi winter dormant Lucerne. The Ryegrass / clover was simply defined as Ryegrass with a fixed 30% legume content while the Fescue / clover was similarly described but with only 20% legume. Differences in legume content were determined from the only pasture composition data available (DATE XXX) and assumed to be representative.

To initialise each simulation the species were defined as vegetative and root mass set to a minimum level (100 kg/ha) with above ground mass set to zero to mimic the establishment phase of the pasture.

Results

Weather

The following graph shows a comparison between the Silo data drill and the actual monthly rainfall data at the site from 2010 to 2012.



In general the discrepancies are relatively minor with only Feb 2012 having a deviation of more than 20mm in the period of measured pasture production. Overall the linear regression between the two sets of rainfall data has an R^2 = 0.96 a slope of 0.95 and an intercept of -1.09 mm/month. This fit was deemed sufficient to consider the Silo data to be equivalent to the actual site data without need for correction.

Simulations vs. Trial Data

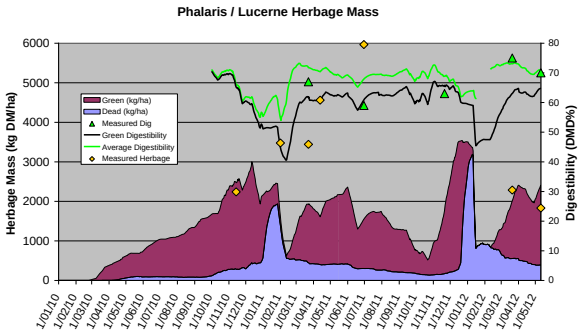
Outputs for green and dead herbage mass, digestibility of green and average herbage digestibility as well as animal performance were collated in Microsoft Excel from a series of stop / start runs. This enabled results to be graphed as a single series and compared to the point measurements taken in the paddocks.

The following graphs represent the fit between the measured pasture data and that modelled using GrassGro in the trial period. Measured herbage mass values are plotted as yellow diamonds and the measured digestibility plotted as green triangles.

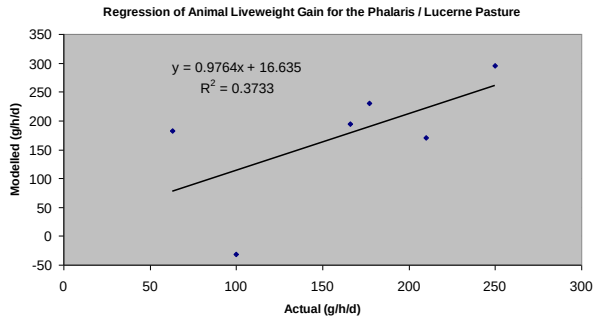
Phalaris / Lucerne

At the November 2010 measurement the fit for herbage mass is good but unfortunately throughout 2011 the herbage mass is underestimated by GrassGro. The size of this discrepancy is too large to be within the bound of measurement error. It

can only be concluded that an analysis using this farm system analysis should be viewed with greater scepticism. After the heavy grazing in early 2012 however the herbage mass measures matched well with the model data. Estimates of dry matter digestibility were much closer and in most cases lie within the expected range of measurement error. Since the pasture treatments were not replicated there can be no direct estimate of the error around these measurements



Model estimates for daily gain were also compared with measurements and are shown in the attached landscape format table (appendix 1) for all three pasture types.

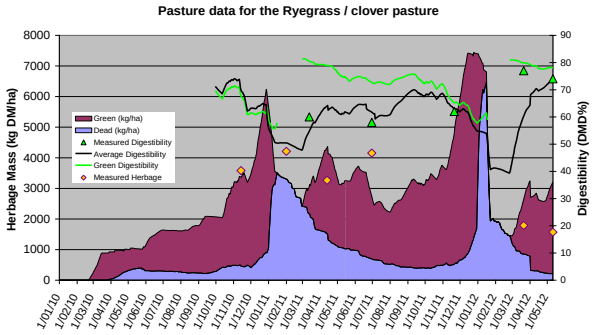


A linear regression of animal live weight on the phalaris / Lucerne pasture indicates that the relationship is around 1:1 but the strength of the correlation is low with an R^2=0.37

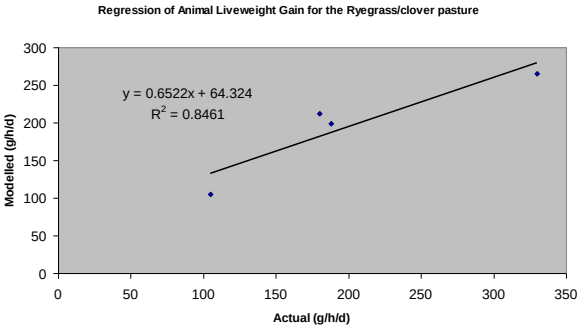
Ryegrass / clover

The fit between actual and model herbage mass for the Ryegrass pasture is generally good giving considerable confidence in the GrassGro farm system as the basis for further analysis. Measured estimates of herbage mass in 2012 are below the modelled data in 2012 but this could be explained by the Silo rainfall data for February 2012 being significantly higher than the actual measured data.

The fit for herbage digestibility is also good and measurements are closely correlated with average digestibility in the model.

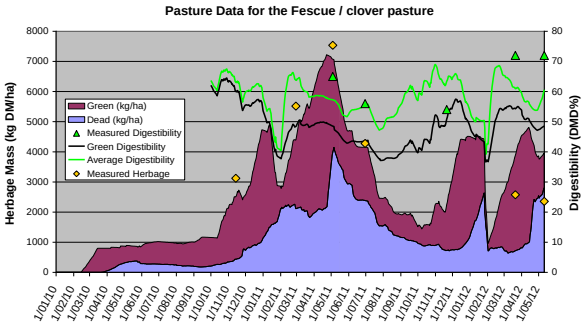


Measured animal performance on the Ryegrass is well correlated with the model data with the exception of the June 2011 grazing. This was the only period of weight loss recorded during the trial but GrassGro predicted considerable weight gain. It was however identified by the manager of the site as an aberration which may have been due to some unseasonably wet weather and certainly growth rather than loss would have been expected given the measured herbage on offer. If this single data point is removed the R^2 = 0.85 indicating good agreement between GrassGro and the measured animal performance.



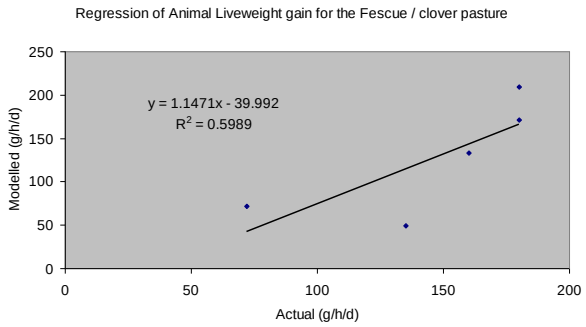
Fescue Clover / clover

The fit between the model and actual herbage mass for this pasture type is exceptionally good. Again the actual measured herbage in 2012 was less than the model predicted again probably due to the discrepancy in rainfall data for Feb 2012.



Animal data for the Fescue / clover pasture also gives an acceptable relationship between the actual weight gain and the predicted gain. (R2=0.60) but GrassGro does tend to under

estimate performance. This is completely consistent with the underestimation of herbage quality. Nonetheless the agreement between the measured data and the model is sufficiently good to make the farm system useful for further analysis.



Long term historical simulations.

Each of the three pasture types were spun up to the end of December 2010 to provide plausible starting parameters for a long term historical simulation of a lamb trading enterprise. Three cohorts of 2nd X wether lambs were traded annually running at an overall 12 head/ha in a four paddock rotation with a constant 21 days between grazings.

1. "Summer": Purchased on 1 November (4months old, FS 2 and 26 kg live weight) and sold on the 31st of January.
2. "Autumn": Purchased on 1 March (6months old, FS 2 and 30 kg live weight) and sold on the 31st of May.
3. "Spring": Purchased on 1 August (4months old, FS 2 and 25 kg live weight) and sold on the 30th of October

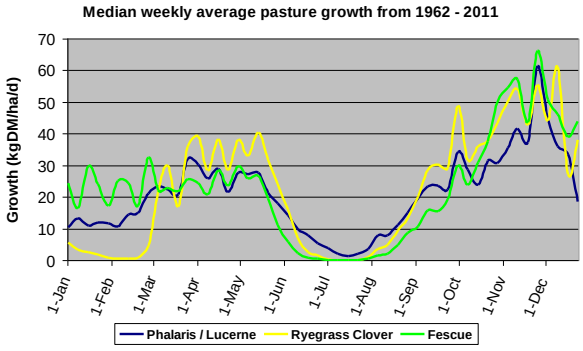
The lambs were also fed barley to maintain their weight if there FS fell below 2.

The systems were run for the 50yr period from 1962 – 2011 using historical weather data derived from the Silo data drill and the long term pasture and livestock production compared

Long term median pasture growth

The fifty years of data was analysed to determine the median weekly average pasture growth rates for each of the three pasture types.

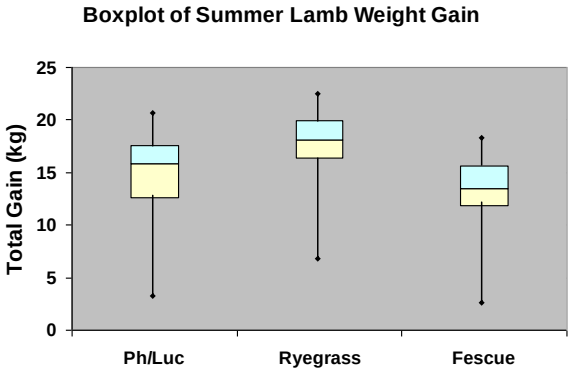
The most significant differences between pasture types occurred late in the summer and throughout the winter. In late summer the pasture giving the most active growth was the Fescue / Clover mix while the Ryegrass / clover mix was dormant through January and February. The pasture with the least winter growth was the Fescue while the most active was the Phalaris component in the Phalaris / Lucerne mix. This mix also gave mid range growth in the January - February period due to the Lucerne component.

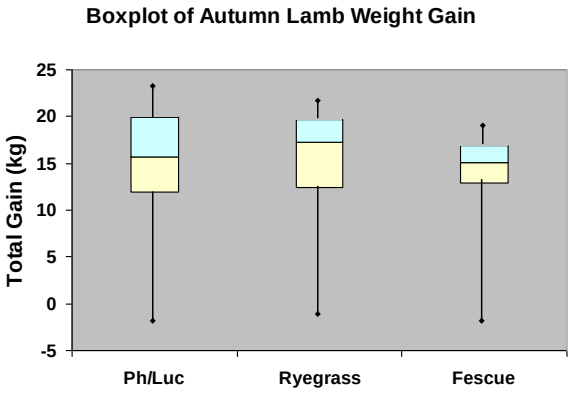


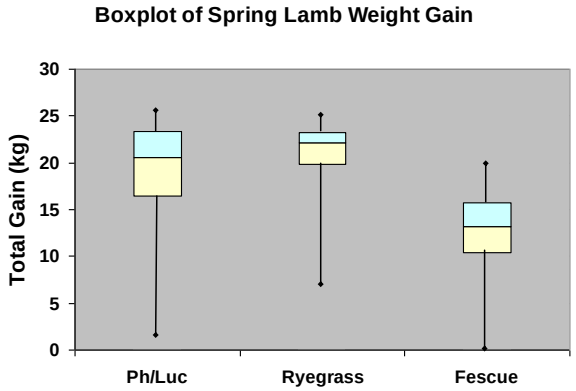
This data bears out the observation that the Phalaris / Lucerne mix was able to generate extra growth of quality herbage in summer although the test simulation compared with the trial data does suggest that this is likely to be an under estimate.

Animal weight gain

The animal weight gain achieved on each pasture type was compared first within season and then for the whole year. The graphs below show box plots of the distribution of total seasonal weight gain for each season.

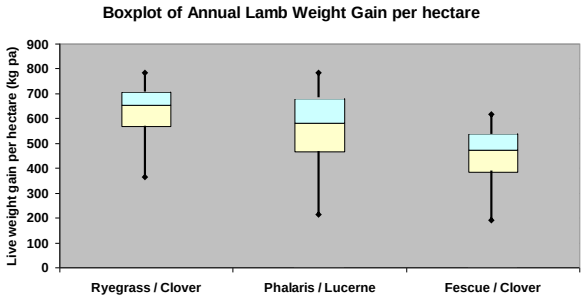






Regardless of season the Ryegrass / clover pasture achieved the highest median gain (mid line between the blue and yellow) with generally lower variability between years. The Fescue mix gave the lowest output with the Phalaris / Lucerne mix intermediate. The best period for Fescue was the autumn and the worst was for the spring graze. Given the more extended period of low growth in winter this may simply have been due to the timing of the spring lamb intake being too early for this pasture type leading to weight loss in August and early September before making a recovery in September / October.

Taken on an annual basis the ranking in terms of total weight gained was in favour of the Ryegrass based pasture with the Phalaris a fairly close second and the Fescue based pasture significantly lower.

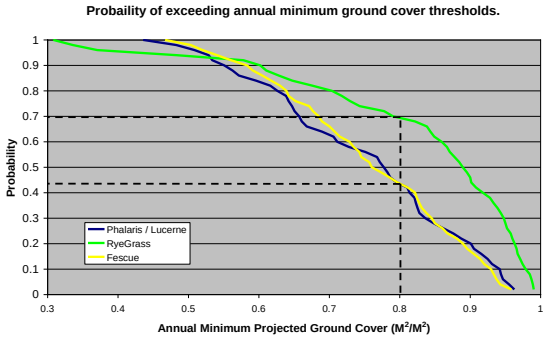


True carrying capacity

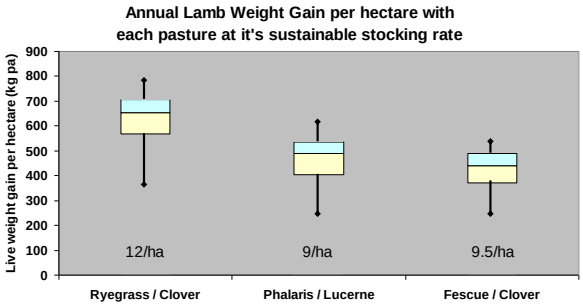
The initial historical runs were compared running the same number of livestock however an analysis of the ground cover from these runs suggests that that the true carrying capacity of the Lucerne / Phalaris and the Fescue pasture types is somewhat lower than the nominal 12 head/ha modelled.

The following graph shows the cumulative density function for annual minimum ground cover for each of the pasture types running at 12 head/ha.

At 12 head per hectare the Ryegrass pasture maintained ground cover above the critical 80% minimum in 70% of years. This is equivalent to the benchmark set for determining sustainable carrying capacity in the Southern Livestock Adaptation 2030 project. The other two pasture types however when run at a nominal stocking rate of 12 only managed to keep ground cover above the target minimum in 45% of years.



A stocking rate analysis was run to determine the stocking rate at which these systems maintained equivalent ground cover to the Ryegrass. It was determined that the Lucerne / Phalaris pasture could carry only 9 head/ha and the Fescue 9.5 head/ha. This equates to a long term stocking rate of 16.3 dse/ha for the Ryegrass / Clover and 12.7 and 12.4 for the Phalaris / Lucerne and Fescue respectively. Clearly this leads to lower annual live weight gain (below) from both the Phalaris / Lucerne and the Fescue based pasture type but also significantly lower variability.



ISSN 1832-6668

Australian Government

Department of Agriculture, Fisheries and Forestry

Extension of the GrassGro Model as a decision support tool in assisting producers to manage climate variability.

This project is supported by funding from the Australian Government Department of Agriculture, Fisheries and Forestry under FarmReady part of Australia's Farming Future.