International Grassland Congress Proceedings

22nd International Grassland Congress

Scenario Analysis: Risk and Return of Aluminium Tolerant Lucerne

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The 22nd International Grassland Congress (Revitalising Grasslands to Sustain Our Communities) took place in Sydney, Australia from September 15 through September 19, 2013.

Proceedings Editors: David L. Michalk, Geoffrey D. Millar, Warwick B. Badgery, and Kim M. Broadfoot

Publisher: New South Wales Department of Primary Industry, Kite St., Orange New South Wales, Australia

Scenario analysis: risk and return of aluminium tolerant lucerne

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Keywords: Alfalfa, economics, grazing, lamb, pasture, transgenic.

Introduction

Lucerne (*Medicago sativa)* yield is limited by aluminium stress associated with acid soils (Campbell *et al.* 1988; Scott *et al.* 2008). With the aid of transgenic technologies, the development of aluminium tolerant (Al Tol) lucerne is proposed. Modelled scenario analysis was conducted to explore the potential net benefits of Al Tol lucerne as part of a grazing system for a sheep production system in the high rainfall zone of south west Victoria.

Method

As there are currently no data available on the performance of Al Tol lucerne in the soils of south west Victoria, the following assumptions were made: (1) current common cultivars of lucerne do not grow on the representative farm due to acid soils and aluminium stress, which cannot be easily amended (*e.g.* acidic subsoils); (2) 10% of the farm area was suitable to grow Al Tol lucerne with no other likely limitations to lucerne performance present (*e.g.* waterlogging); (3) Al Tol lucerne grown in acid soils with aluminium stress would match the performance of the current common cultivar of lucerne with moderate winter activity grown without acid soil limitations; and (4) establishment costs were the same as for a current common lucerne cultivar, minus lime application costs.

Representative farm and scenarios

The 'Base Case' (Table 1) aimed to reflect current practice. The modelled farm was 800 ha running 16.2 DSE/ha. The sheep system consisted of Merino ewes (70% as a self-replacing flock lambing in September, and 30% for prime lamb production lambing in July). All lambs were weaned at the start of December. Monthly animal demand and pasture supply, and subsequent supplementary feeding, was calculated as described by Lewis *et al.* (2012).

The 'Base Case' was compared to two options: (1) *'Base Case + Luc'*: 10% of the farm area sown to Al Tol Lucerne; and (2) *'Base Case + Luc + Lambs'*: 10% of farm area sown to Al Tol lucerne, plus 2nd draft prime lambs retained until the end of January and sold at 52 kg live weight (lwt) (23 kg carcase weight, cwt).

Discounted cash flow analysis and Monte Carlo simulation

A 9-year time period was used for the analysis, allowing a year for initial establishment followed by eight years of full production from the lucerne. Partial budget discounted cash flow analysis considered the extra benefits minus the extra costs over the 9-year period from the two scenarios, compared to the 'Base Case' system. The benefits of the 'Base Case + Luc' equated to supplementary feed savings, plus the value of the extra month of prime lamb growth in January for the 'Base Case + Luc + Lambs' scenario. Variable costs, for all systems, were as described for sheep in Lewis *et al.* (2012). For the lucerne scenarios, an establishment cost for lucerne ($323/ha) was included in the first year of the analysis, plus the cost of agistment of stock off the 80 ha for 9 months. Permanent capital costs of $15,000 for establishing rotational grazing of lucerne (fencing, gates and water troughs) were also included in year one. The salvage value of the lucerne in year nine was assumed to be 20%, and 10% for permanent capital costs.

Net present value (NPV) and internal rate of return (IRR) were calculated for the 9-year period at a real discount rate of 5% (Malcolm *et al.* 2005). NPV results were converted to annuity equivalent values to reflect the potential net benefits on an annual basis for the 9-year analysis period (Malcolm *et al.* 2005). Monte Carlo simulation was undertaken using the @Risk program (Palisade Corporation 2012) to generate a distribution of potential NPV's and IRR's.

Seasonal variability and price uncertainty

Experimental data for 2007- 2009 seasons were used for the lucerne DM accumulation rates (kg DM/ha/day) and estimated metabolisable energy (ME) figures (S. Clark *pers comm*.). It was assumed Al Tol lucerne would perform the same as the lucerne cultivar used in the experiment. The perennial ryegrass/sub clover pasture was modelled for the same seasons as described in Lewis *et al.* (2012), using GrassGro (Moore *et al.* 1997). For all scenarios, a set of three years was repeated three times (Table 2) to establish the pasture production over the 9-year period. Uncertain key price parameters were

Table 1. Description of the 'Base Case' pasture and prime lamb system used in the model.

Pasture system	Prime lamb av. growth rates from birth (g lwt/day) (% of total prime lambs in draft).	Prime lamb sale targets (kg lwt/cwt)
100% of land area perennial ryegrass / sub clover with some capeweed	1st draft: 200 (20%) 2nd draft: 220 (80%)	1st draft: start of December @ 35/16 kg 2nd draft: end of December @ 45/20 kg

Table 2. Potential net benefits from investment in Al Tol lucerne over 10% of farm area when compared to the 'Base Case' system. All figures are after tax of 15%. The seasonal sets used were Set 1: 2007, 2008, 2009, Set 2: 2009, 2008, 2007, and Set 3: 2008, 2009, 2008.

	Set 1	Set 2	Set 3
'Base Case + Luc'			
Mean annuity of NPV 5% real ($/ha/yr) (s.d.)	17 (7.2)	19 (7.7)	11 (5.6)
Mean IRR (%) (s.d.)	53 (16.3)	62 (19.8)	44 (16.9)
'Base Case + Luc + Lambs'			
Mean annuity of NPV 5% real ($/ha/yr) (s.d.)	14 (5.4)	17 (6.1)	8 (4.4)
Mean IRR (%) (s.d.)	44 (12.6)	57 (15.9)	30 (12.3)
9 yr lamb price req. to equal 'Base Case + Luc' NPV ($/ kg cwt)(lamb price distribution percentile)	$5.00 (80th)	$4.50 (70th)	$5.00 (80th)

described using the probability distributions. Parameters (mean, s.d.) were: lamb price $/kg cwt ($3.60, $1.55), merino ewe price $/head ($112, $43), wether price $/head ($90, $33), 18 micron wool prices c/kg clean (1233 c, 111c), barley price $/t ($235, $69) and lupin price $/t ($208, $28).

Results and Conclusion

Based on the assumptions used, the investment in Al Tol lucerne over 10% of the farm area returned positive mean annuity of NPV values under the seasonal conditions tested, ranging from an extra $6-19/ha/year across the whole farm for the 9 year period (Table 1). This was due to savings in supplementary feed for both options compared to the 'Base Case' system. Removing the record rainfall of the 2007 season and replacing it with the drier 2008 (Lewis *et al.* 2012) in 'Set 3' had a substantial effect on the potential net benefits estimated. The additional lamb produced during January in the 'Base Case + Luc + Lambs' scenario did not compensate for the reduction in available carryover feed from summer into the autumn period when compared to the 'Base Case + Luc' scenario. However, the 'Base Case + Luc' option also showed greater risk (variability of return). A lamb price of $4.50 - $5.00 each year for the 9-year period was required for the two scenarios to perform equally under the seasonal conditions tested. Producers will make tactical decisions dependent on seasonal and price conditions that cannot be captured sufficiently in these modelling exercises, which may alter these outcomes.

Acknowledgments

This work was funded by the Dairy Futures Cooperative Research Centre and the Department of Primary Industries Victoria. The authors would like to thank the 'Lamb Directions' team from DPIV for their input, including price data.

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