Impact of including lucerne and other perennials in crop-livestock enterprises in southern NSW

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Abstract

The MIDAS (Model of an Integrated Dryland Agricultural Systems) bioeconomic model was used to predict the change in farm profit and enterprise mix from incorporating lucerne, chicory or perennial grasses in the phased pasture-crop rotation of a typical farm located in the 450-500 mm rainfall zone in southern NSW, as part of the EverCrop? project within the Future Farm Industries CRC. Traditional rotations have utilised either annual pastures or lucerne (*Medicago sativa*) but the need to increase ground cover and overcome the animal health issues (red gut, bloat) associated with lucerne pastures has increased interest in using a greater range of perennials in the rotation. Estimated farm profit on a typical 1,000 ha property relying on an annual pasture-crop rotation was $147,000. Adding lucerne to the rotation was estimated to increase farm profit by 30% compared to a system based on annual pastures only. Including either perennial grasses or chicory in addition to lucerne increased farm profit by an additional 4-5% and profit was maximised at $207,000 when all 3 perennial pasture species were used in the rotation. The optimum area of perennial pastures was 34% of the farm with annual pastures on 10%. The area under crop declined only slightly from 70% in an annual pasture system to 57% when perennials were incorporated into the rotation. Perennials increased the average stocking rate by 28-40% and increased both the area of winter grazed crop and the amount of supplementary feeding required.

Key Words

Farming system, rotations, chicory, phalaris, alfalfa, modelling

Introduction

Farming systems in the mixed farming zone of south eastern Australia typically involve a phased rotation of crops and pastures. Having pastures as part of the rotation is seen as a form of income diversification with pastures also conveying benefits in terms of improving soil structure, increasing soil nitrogen and assisting in management of herbicide resistant weeds. The duration of each phase is typically between 4 and 6 years depending on the perceived relative profitability of the crop and livestock enterprises. Depending on soil type and topography, about 50-60% of the average farm is under crop at any one time (Dear et al. 2010) with the remainder in pasture. The pasture area is likely to be either annual pastures consisting of annual legumes, volunteer grasses and broadleaf weeds, or pastures containing lucerne (*Medicago sativa*) either as a pure sward or mixed with annual legumes. Other pasture options include chicory (*Cicorium intybus*) or temperate perennial grasses such as phalaris (*Phalaris aquatica*) or cocksfoot (*Dactylis glomerata*) but these species tend to be sown on relatively small areas compared to lucerne.

Annual pastures are relatively easy to manage but result in low levels of ground cover over summer and a shorter mainly winter-spring growing season. They are relatively inefficient at using summer rainfall. Increasing the proportion of perennial pastures as part of the rotation is seen as conveying a number of production and natural resource benefits including an extension of the growing season, increased ground cover and better use of rainfall. There is a reluctance however, by farmers to increase substantially the area of pastures and the proportion containing lucerne, due in part to the apparent superior gross margins from cropping and to animal health issues, such as bloat and red gut.

The Future Farm Industries CRC is investigating the economic implications of different perennial pasture species options in the pasture-crop rotation in southern New South Wales (NSW) and determining the optimum areas of perennial and annual pastures required to maximise farm profitability. The MIDAS whole-farm economic model (Pannell 1987) was considered the most efficient way of resolving these questions, given its capacity to include a large range of potential pasture-crop sequences, crop and pasture types and soil types. A major strength of the MIDAS model is that temporal interactions between enterprises are captured. A number of studies (e.g. Pannell, 1987; Bathgate et al. 2009) have demonstrated the importance of these interactions, such as disease breaks and increases in soil nitrogen, on the optimal enterprise mix. The current paper describes the output of the MIDAS model when used to evaluate the impact of various perennial pasture options in the pasture crop rotation of the mixed farming zone in southern NSW

Materials and Methods

A version of the MIDAS model that had previously been developed for the Coolamon region of southern NSW was adapted to include chicory and winter-active perennial grasses as potential pasture options. Pasture production curves for the annual pastures and lucerne were based on output from the GrassGro? model using long-term average climatic conditions for the 450-500 mm rainfall zone of southern NSW, whereas pasture production and quality curves for chicory and winter-active perennial grasses were based on local experimental data. Four possible land-management units (soil types) were selected and combined to represent soils commonly found on typical farms in southern NSW. These units were 100 ha of non-arable tenosols, 50 ha of grey vertisols, 200 ha of red kandosols and 650 ha of red chromosols. Crop and pasture yields were adjusted to account for their different production potentials on the various soils. The model was run assuming a 1000 ha farm with crop and pasture rotations involving wheat, barley, lupins, canola, field peas, mixed annual pasture (based on subterranean clover *Trifolium subterraneum*) and perennial pasture species adapted to the region (lucerne, chicory, phalaris and cocksfoot). A prime-lamb producing livestock enterprise was assumed. Commodity prices and input costs typical of 2009 were assumed. A full description of the model assumptions is given in Bathgate et al. (2010).

The model was run with 5 different pasture options in rotation with crops:

(1) Annual pasture with no perennials

(2) Annual pasture plus lucerne

(3) Annual pasture plus lucerne and chicory,

(4) Annual pasture plus lucerne and perennial grasses (phalaris, cocksfoot),

(5) All perennial pasture options (annual pasture + lucerne + chicory + perennial grasses).

Results

The predicted farm profit, the optimum area of the different pasture and crop options and other key criteria for the 5 scenarios modelled are summarised in Table 1. When annual pastures were the only pasture option available, the optimum farm area sown to pasture was 30% with an estimated farm profit of $147,000.

Including lucerne in the pasture phase of the rotation (Option 2) increased farm profit by $44,000 (+ 30%) compared to having only annual pastures in the rotation. The optimum area of pasture on the farm increased from 30% to 40% of the total farm area, with lucerne constituting 62% of the total pasture area. Including lucerne decreased the amount of supplementary feeding required by 9%.

Providing chicory as an additional pasture option (Option 3), increased farm profit by an additional $9,000. The area of chicory required was relatively small at 44 ha and resulted in a reduction in the area of canola, barley and pulses, but the area sown to wheat remained unchanged. Replacing chicory with perennial grasses (Option 4) gave a similar profit to chicory, the model selecting 68 ha of perennial grass pasture. Stocking rates were highest with this option and the amount of supplementary feeding required increased by 16% compared to the chicory option.

Profit was maximised when all 3 perennial pasture options (lucerne, chicory, perennial grasses) were available (Option 5) with profit being $40,000 and $16,000 greater than Option 1 and Option 2 respectively. While the area of lucerne was reduced when chicory and perennial grasses were available, the total area sown to perennial pastures increased by 8%. The area sown to wheat remained constant when the additional perennials were added to the model, but the area sown to pulses declined. The area sown to crop remained relatively constant at 56-60% with all perennial options but the area of grazed winter cereals and stocking rates both increased as chicory and perennial grasses were introduced to the system (Table 1).

Table 1. Changes in farm profit and key criteria from inclusion of perennial pastures into the pasture-crop rotation on 1000 ha farm.

Key statistics	Option 1	Option 2	Option 3	Option 4	Option 5
	Traditional Annual pasture	Annual +lucerne	Annual +lucerne + chicory	Annual+ lucerne + per grass	Annual+ lucerne+ chicory + per grass
Farm profit	$147,000	$191,000	$200,00	$198,000	$207,000
Total area pasture (ha)	300	403	433	440	436
Lucerne	-	281	267	272	246
Chicory	-	-	44	-	24
Perennial grasses	-	-	-	68	66
Annual pastures	300	122	122	100	100
Total area of crop	700	596	566	560	565

(ha)					
Wheat	250	228	227	232	234
Canola	150	123	113	116	117
Barley	150	123	113	116	117
Pulse	138	122	113	96	97
% Farm under crop	70%	60%	57%	56%	57%
Av stocking rate per grazed ha (DSE)	10	13.5	12.8	14	13.8
Stocking rate whole farm (DSE)	3	5.4	5.5	6.7	5.9
Area grazed crop (ha)	100	106	113	116	117
Supp feed (Tonnes)	127	113	120	139	140

Discussion

The MIDAS scenarios reinforced the contribution that livestock enterprises make to the profitability of mixed farming systems in the mixed-farming zone of southern NSW. The overall analysis suggests that profit is maximised when about 60 % of the farm is sown to crop and 40% to pastures. This enterprise split is supported by a recent survey of farmers in southern NSW showing a similar land allocation to crop across the region (Dear et al. 2010). The largest increase in farm profit resulted from having lucerne as part of the rotation and this is also reflected by the relatively high rate of adoption of this species in the study area (Dear et al. 2010).

The model suggests that farm profit can be increased further through the use of chicory and perennial grasses (grown separately) which allow for an increase in stocking rates while maintaining a similar proportion of the farm under crop. Thus, the use of perennials can be increased for natural resource management (NRM) benefits and animal health reasons, without adversely affecting total farm profitability.

The MIDAS model is a static model which means it assumes that the nominated seasonal conditions exist for the duration of rotation. It therefore tends to overestimate stocking rates as farmers typically run stocking rates below the level required for full feed utilisation, to allow for poor seasons. Similarly, poor seasonal conditions in a previous year can affect pasture production in the subsequent years; the model does not allow for this and hence may overestimate feed availability. Since seasonal conditions are considered to be constant, the model is unable to show the range of returns that would be expected between years. To address this restraint other models that incorporate a range of seasonal conditions and provide a better picture of the changes in income from year to year are under investigation. The outputs from these models will estimate the potential level of indebtedness and profit that farmers may experience as a result of the different enterprises mixes and pasture options.

A further limitation of the MIDAS model used in this current study is that it only values the profits derived from the sale of crop or livestock products. It places no value on achieving improved natural resource outcomes such as increased ground cover, increased levels of soil organic carbon or changes in runoff to fill water storages, that may result from different pasture species or pasture crop rotations. As these aspects are becoming increasingly important criteria and farmers are being financially rewarded for reaching various NRM targets, their inclusion in the model would ensure that a greater consideration and weighting is given to them when determining the optimum rotation and enterprise mix. Important NRM indicators such as proportion of bare ground, soil water leakage, nitrate leaching and change in soil carbon have been successfully incorporated into other versions of the MIDAS model (e.g. Robinson et al. 2009; Monjardino et al. 2010) and their incorporation in the southern NSW model will enhance its capacity to evaluate the wider implications of including perennials in the farming system. Placing an economic value on these NRM criteria may further increase the optimum proportion of perennial species in the enterprise mix.

Conclusion

The MIDAS model provides a valuable tool for evaluating the impact of a large number of variables on farm profit and assessing the implications of the relative areas allocated to various enterprises in the farm business. It demonstrated that perennial pasture species, additional to lucerne, can be introduced into the rotation to achieve natural resource outcomes without sacrificing farm profitability. The attractiveness of perennial species is likely to increase further when these NRM benefits are included in the model. In the future, the MIDAS model will be a valuable tool for evaluating the impact of changes in commodity and input prices on profitability and the potential implications of changing production potentials as a result of climate change on enterprise mix and farm profit.

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