Grazing spring variety cereal crops reduces supplementary feeding in mixed cropping and sheep farms

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Abstract
The grazing of cereal crops has become widely adopted and interest in this practice has spread to the lower-rainfall parts of the cereal-livestock zone where it is hard to grow long-season varieties. A modelling study was conducted to investigate how the use of feedbase components in a mixed cropping and sheep farm might alter when grazing of immature spring variety wheat and barley crops is allowed. The simulation study used climate data from 1961-2010 from 15 locations across southern Australia (annual rainfall 319 to 572 mm/year); the grazing management policy placed livestock on the crops only when green pasture mass was below 800 kg/ha. On average, supplementary feeding requirement in the grazing wheat systems was reduced from 15.9% to 14.8% of the energy intake of the sheep. Wheat crops were grazed in 47% of years for farms located in drier climates, while at higher rainfall locations the frequency of grazing wheat averaged 20% of years, which was largely due to pastures being available for grazing earlier relative to wheat. There was a correspondingly greater decrease in supplementary feeding at the lower rainfall locations. There was a slightly larger utilisation of barley crops than wheat crops (1.9% compared with 1.5% of the total annual energy intake from crop grazing). The difference was due to a longer average length of grazing with barley crops (25 *v* 17 days), owing to barley reaching sufficient standing biomass for grazing on average one week earlier than wheat. This simulation study suggests that grazing spring cereals is likely to reduce the cost of supplementary feeding of livestock marginally, but may be of greater value in seasons with late pasture establishment.

Key Words
grazing crops, sheep, spring wheat, dual-purpose, simulation, modelling

Introduction

Short-term grazing of crops that are intended for grain production can provide an opportunity to increase the supply of winter feed without a significant reduction in grain yield (Virgona et al., 2006). Grain crops can provide a source of forage for livestock before annual pastures can be grazed because of the rapid early growth and upright growth habit of crops that increases plant accessibility to livestock. However, grazing needs to be carefully managed according to the season, with the sowing date, crop species and variety, crop phenology and grazing objectives considered to ensure there is no effect on potential grain yields. This is particularly the case for spring wheat varieties, where there is a short ‘grazing window’ (the interval between sufficient plant biomass for grazing and the crop growth stage beyond which grazing results in significant yield penalties). To date, much of the research on grazing crops has focused on the use of long season ‘winter’ wheat varieties grown in higher rainfall areas, where earlier sowing and delayed crop maturity allows more frequent and longer grazing opportunities during the growing season (McMullen and Virgona, 2009). However, in the drier regions in southern Australia grazing of commonly grown ‘spring’ wheat varieties is of interest because of the potential to access winter feed without changing existing crop rotations (J. Kirkegaard, pers. comm.). Differences between seasons in crop and pasture production as well as differences in the seasonal feedbase in mixed crop and livestock systems in Australia that is due to regional climates supports the use of a farm systems modelling approach to investigate the grazing value of spring wheat crops. The purpose of this study was to compare the value (in terms of reduced supplementary feeding) of grazing spring cereal crops for a range of locations and weather scenarios across southern Australia.

Materials and Methods

A simulation experiment was conducted using the AusFarm biophysical model (Moore et al., 2007), based on a self-replacing Merino sheep and wheat growing enterprise with or without crop grazing. The simulation study used climate data from 1961-2010 from 15 locations across southern Australia, representing the range

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of climates that exist in the main grain growing regions of southern Australia. High, medium and low rainfall locations (transects) were selected for each of 5 agricultural regions (Western Australia – Northern Agricultural, Central Wheatbelt, South-East Coast; South Australia – Eyre Peninsula; Victoria – Mallee). Farm stocking rate was determined according to the total annual rainfall at each location (i.e. dry sheep equivalents (DSE) per winter grazed ha = 0.0225 x annual rainfall (mm) - 2). Two 4-year rotation sequences were applied within the model, across the 8 paddocks allocated to crop and pasture rotations. A single rotation sequence (PCCC) was used in 4 of the paddocks (each 500 ha), and one of two rotation sequences (PCCC or PDDD) was applied to the other 4 paddocks (each 200 ha), where P = annual pasture, C = cereal crop and D = cereal crops that were allowed to be grazed if certain conditions were met (see section on grazing rules). Two crop cultivars, either wheat cv. Wyalkatchem or barley cv. Gairdner, were used in the cereal crop rotations. A further 2 paddocks (each 100 ha) in the model were not cropped and were managed as permanent pastures. The energy intake of green and dry pasture, permanent pasture, crop stubbles, supplementary feed and dual-purpose crop consumed by livestock was determined for 2 scenarios, being (1) with or (2) without sheep having access to grazing crops. Feedbase components available in the model were as follows (listed according to their priority of use); crop stubbles, annual pasture, wheat crops, permanent pasture and supplementary feeding. The supplementary feeding was 20:80 lupins and wheat fed in a feedlot at a rate of 1.5 kg/animal/day when ewe condition score < 2.0, otherwise 0.8 kg/animal/day. The suitability of feedbase components for grazing was re-evaluated each week, and animals were moved to a new component if necessary. Crop paddocks available for grazing were grazed when there was more than 150 kg/ha and before the crop reached stem elongation (GS30). No individual crop paddock was allowed to be grazed for more than 2 weeks. Crops were sown at the first establishment opportunity after April 25. Conditions for sowing were that there had been 10 mm of rain within 5 days.

Effect of location on crop grazing days was tested using a 2-way ANOVA (region x rainfall). The relationship between crop grazing days and farm supplementary feeding requirement was tested by linear regression analysis with grouping by location. The effect of season break on crop grazing was determined by linear regression analysis with grouping by location for (1) the WA central wheatbelt transect and (2) a subset of 3 low rainfall locations (Salmon Gums and Swan Hill were excluded from this analysis because the season break frequently occurred outside the defined period). For this analysis the season break was defined as the first day that pasture germination occurred after 1st March.

Results

The opportunity for grazing spring cereal crops varied among locations, ranging from 4% of years at Cummins, South Australia, to 74% at Binnu in Western Australia ($P < 0.001$). Across all locations, supplementary feeding requirement in the grazing wheat systems was reduced from 15.9% to 14.8% of the energy intake of the sheep.

Table 1. Annual energy intake (%) provided by supplementary feeding with or without grazing wheat, the percentage of years that crops are grazed and the average duration of grazing in those years where crop grazing occurs in a self-replacing Merino ewe and wheat producing farm.

	Supplementary feeding (% of energy intake)			
Location	without wheat grazing	with wheat grazing	Proportion of years crops are grazed (%)	Duration of crop grazing (days)
WA - Northern Agricultural	24.3	22.3	63	17
WA - Central Wheatbelt	14.0	12.7	35	18
WA - South-East Coast	8.3	8.2	14	16
SA - Eyre Peninsula	17.4	16.8	23	14
Vic - Mallee	15.4	14.3	25	20
Low rainfall	23.2	21.8	47	18
Medium rainfall	13.4	12.4	28	16
High rainfall	11.1	10.4	20	17

There was a region by rainfall interaction for the duration of crop grazing (days per year) across the study locations ($P=0.016$). Locations where crop grazing opportunities presented most frequently were in the Northern Agricultural Region of Western Australia (63% of years) and at Low rainfall locations (47% of

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years), and least frequent at Medium and High rainfall locations for the South-East Coast of WA, Eyre Peninsula region SA and the Mallee region in Victoria (Table 1). The reduction in supplementary feeding was in line with the frequency and duration of crop grazing. At locations where crop grazing occurred most frequently, seasonal supplementary feeding requirements were reduced by about 2 percentage units for the average year.

There was a negative relationship between the grazing days obtained from wheat crops and supplementary feeding required (Figure 1; P<0.001). Each DSE grazing day/crop ha obtained from crops that were made available for grazing across the farm (600 ha) reduced supplementary feeding by approximately 350 kg for the farm enterprise (R^2=0.55). In the model the condition of the animals was maintained above CS 2.0 with the provision of supplementary feed, so the overall nutritional effects of grazing crops on animal performance would likely have been small.

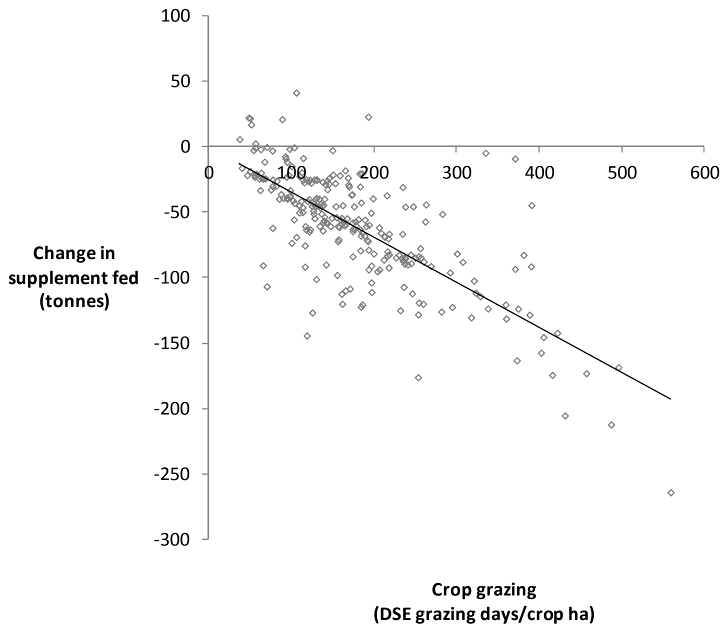

Figure 1. The relationship between crop grazing days and the change in supplementary feed required for wheat and Merino sheep producing farms in southern Australia.

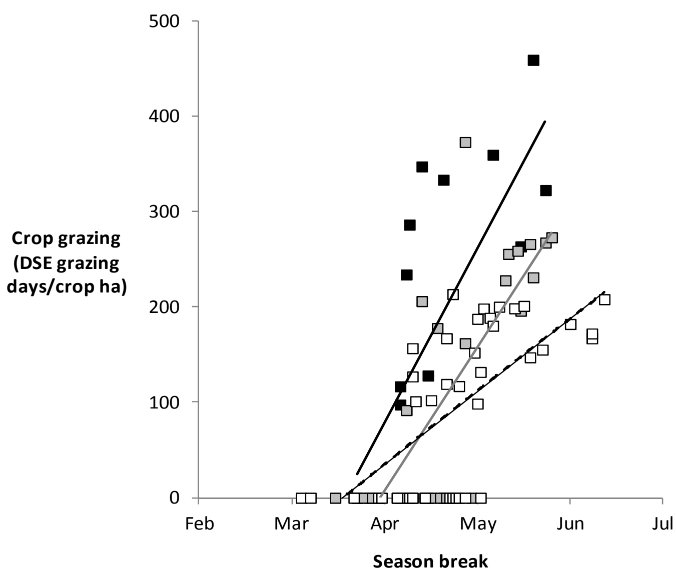

Figure 2. Relationship between season break and the grazing of spring wheat crops at Merredin (Low rainfall, □, ---), Wickepin (Medium rainfall, ■, —) and Kojonup (High rainfall, ■, —) in Western Australia.

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There was a positive relationship between crop grazing days and the day of the break of season for the low rainfall locations (R^2= 0.32; P<0.001), but there was no effect of location (P>0.05). The predicted increase in crop grazing for each day that the break of season was delayed differed for Merredin, Wickepin and Kojonup locations (Low, Medium and High rainfall locations on the WA central wheatbelt transect) (Slope = 2.6, 5.0 and 6.1 DSE grazing days/crop ha; R^2 = 0.45, 0.61, 0.51; P<0.01; Figure 2).

The effects of rainfall and break of the season on the grazing opportunities for spring wheat and barley were very similar across the regions and locations. Nonetheless, barley could be grazed slightly longer (25 days compared to 17 days) and barley grazing resulted in a larger decrease in supplementary feeding requirement (17.5% to 15.5% of the annual energy intake) as compared to wheat grazing. This is attributed to the early vigour of barley, reaching the safe grazing threshold of 150 kg/ha about one week earlier than wheat.

Conclusion

Grazing spring variety wheat crops will generally reduce farm supplementary feeding cost marginally, and tends to be more important in years with late pasture establishment. In particular, farmers in lower rainfall areas should benefit from grazing spring variety wheat crops at a frequency of about every second year. Higher utilisation of crop biomass at lower rainfall locations may be due to a greater difference in the relative availability of crops versus pastures for grazing, as was reported by Thomas et al. (2011). That is, that the time difference between when crops and annual pasture have grown enough to be grazed is longer at lower rainfall locations. Locations where wheat crops were grazed less frequently tended to have higher rainfall and some pasture available at the time when crops were available for grazing. Grazing crops will be most beneficial and achievable in years where the season break does not occur until early May, or later. This is because crops are more likely to be available for grazing before pasture mass reaches 800 kg/ha in later seasons. Opportunities to graze spring wheat crops are likely to be higher where pasture productivity is lower, e.g. poor plant species composition, low plant density and lower soil fertility. Alternatives to spring wheat may need to be considered to improve opportunities for crop grazing for higher rainfall areas and in the South-East Coast of WA and the Victorian Mallee. In this study we primarily considered the potential grazing value of spring wheat since this is the predominant grain crop grown in southern Australia. However, targeting grazing on crops that typically make up a smaller part of the cropping enterprise (such as barley, canola, lupins and winter wheat varieties) may provide greater flexibility compared with spring wheat crops. This can be important for example in Western Australia, where early sowing of spring wheat varieties is restricted by the risk of frost damage on early maturing crops.

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