Managing high stubble loads: is grazing the answer?

Andrew D. Moore and Julianne **M. Lilley**

CSIRO Plant Industry, GPO Box 1600, Canberra ACT 2601.
www.csiro.au Email Andrew.Moore@csiro.au

Abstract

High levels of cereal residues pose problems for sowing of subsequent crops or pastures. Options for reducing cereal residue levels are therefore being explored within the national Grain & Graze R&D initiative. For two regions (south-western Victoria and the south-western slopes of NSW), we use the APSIM and GRAZPLAN simulation models to investigate the effectiveness of (i) grazing of wheat stubbles after harvest and (ii) cutting stubbles and using them as a supplementary feed during the winter.

The farming system simulations suggest that initial stubble masses after dual-purpose wheat crops will average about 10 t/ha with considerable year-to-year variation. At these stubble masses and a typical ratio of livestock numbers to stubble area, post-harvest grazing can only be relied upon to reduce stubble mass to about 6 t/ha by early May. The use of N-rich supplements is predicted to have little effect on either stubble removal or livestock production. Predicted rates of consumption of baled stubbles during winter are so low that this tactic is unlikely to be effective as a means of utilizing cereal residues from high-yielding crops.

Key Words

Modelling, FarmWi$e, APSIM, residues, Grain & Graze

Introduction

Improved crop management and the introduction of long-season cultivars have led to both higher cereal yields and higher stubble loads in south-eastern Australian cropping systems. High levels of cereal residues pose problems for the sowing of subsequent crops or pastures. Farmers' main options for dealing with high stubble loads are to adapt to them by investing in sowing equipment that can deal with dense stubbles; to graze them during the summer-autumn period; or to burn or cut the stubbles prior to sowing. Burning is prevalent in many districts, but smoke is regarded as an environmental pollutant and its use may therefore be restricted in future. It is therefore useful to understand how best to use livestock to reduce stubble loads, and what tradeoffs exist between stubble management and livestock production.

In this paper we use modelling to explore two alternatives to burning of cereal stubbles that are being investigated in the national Grain & Graze R&D initiative as a result of renewed farmer interest: (i) grazing after harvest, with or without the addition of high-N supplements to increase feed intake, and (ii) the less-conventional option of cutting stubbles and storing them to be fed back to livestock during the winter. By using simulation modelling, we are able to assess the frequency with which these management tactics can reduce stubble loads to levels suitable for establishment of following crops and also to estimate the consequences for livestock production.

Methods

Grazing of wheat stubbles

Simulation analyses were carried out at two sites: Harden (34?34' S, 148?22' E) on the south-west slopes of NSW and Inverleigh (38?06' S, 144?03' E) in western Victoria. The weather record for Winchelsea was used for the Inverleigh simulations. Attributes of a Red Chromosol soil at Harden and a Eutrophic Mottled-Subnatric Brown Sodosol at Inverleigh were described based on measurements at local research sites

(Kirkegaard et al. 1994; R Peries, DPI Victoria, *pers. comm.*). All simulations were run over the years 1957-2005.

The APSIM cropping systems models (Keating et al. 2003) with standard parameterizations were used to estimate the amount of stubble present at harvest in each year. A simulation was run in which wheat crops were sown each year when rainfall equalled or exceeded 15mm over a 3-day period. Cultivar Mackellar (a dual-purpose wheat) was sown when the sowing opportunity occurred between 10 March and 25 April, and cv Janz (a spring wheat) when it occurred between 26 April and 30 July. Stubble masses and grain yields predicted by APSIM were then transferred to the FarmWi$e simulation environment (Moore 2001) and the GRAZPLAN grazing systems models were used to examine the numbers of livestock required to graze down wheat stubbles during summer and autumn, the impact on livestock production and the effect of N-rich supplementary feeds on the grazing of stubbles. A set of simulations was carried out at each site, examining the four management options given in Table 1. To explore the effect of available livestock numbers on final stubble masses, each of these options was simulated at three different ratios of effective stubble area to grassland area.

A pasture module within FarmWi$e was parameterized to simulate the decay and loss of wheat stubbles, allowing them to be grazed. A two-paddock management system was used in which mature medium Merino wethers grazed a “grassland” paddock for most of the year, gaining and losing weight according to seasonal conditions. The grassland paddock was assumed to be managed at a high level of fertility, supporting relatively high stocking rates (10 wethers per hectare at Harden and 14 at Inverleigh). At the start of a stubble grazing period each year, a second “stubble” paddock was initialised with the stubble mass from the previous year’s APSIM simulation. Stubble was taken to have an average metabolizable energy (ME) content of 6.0 MJ/kg, N content of 0.7% and to be 20% leaf (of higher quality than the stem) with no variation between years. For greater realism 2% of the simulated grain yield was made available to be consumed by the sheep, and the stubble paddock was also initialised with 200 kg/ha of annual grass seeds that, given appropriate seasonal conditions, could germinate and provide green forage for the grazing sheep. It was assumed that sheep grazed header trails and inter-trail areas in proportion to their mass. Sheep were returned to the grassland paddock on 1 May each year or when stubble mass fell to 1.0 t/ha. In a “control” simulation, the stubbles were not grazed and livestock remained on the grassland paddock throughout the year. In all simulations animals were fed wheat grain to maintain their weight whenever their body condition score fell below 1.0.

Table 1. Stubble grazing systems simulated at Harden & Inverleigh.

System	Stubbles Grazed?	N Supplement During Stubble Grazing	Supply of Degradable Protein	Stubble: Grassland Ratio	Stocking Rate on Stubbles (wethers/ha)	
			(g/head.day)		Harden	Inverleigh
Control	No	None	0	1:1	14	22
Grazed	Yes	None	0	1:3	42	66
+Lupins	Yes	Lupins at 100 g/head.day	21	1:5	70	110
+Urea	Yes	Urea-molasses mixture, 1:4 by weight, at 50	27			

g/head.day

Cutting stubble for use as winter supplementary feed

The GrazFeed decision support tool (version 4.1.14; Freer *et al.* 1997), which contains the same ruminant biology model used in the stubble grazing simulations, was used to explore the likely consumption of supplementary cereal stubble by mature medium Merino ewes in late pregnancy, and the impact on weight change and wool growth. Calculations were made for July, with green pasture of 20% legume content at availabilities ranging from 250 to 1500 kg/ha

Table 2. Average initial and final stubble masses under different stubble grazing strategies at Harden and Inverleigh. Note that the initial stubble masses include residues from both winter and spring wheat crops.

		Harden			Inverleigh	
Initial stubble mass (t/ha)		9.3			7.6	
Ungrazed final stubble mass (t/ha)		5.6			5.3	
Final stubble masses under grazing (t/ha):						
Stubble:grassland ratio	1:1	1:3	1:5	1:1	1:3	1:5
Grazed	4.1	2.1	1.1	3.6	1.6	0.7
+Lupins	4.0	2.0	0.9	3.6	1.5	0.7
+Urea	4.0	2.0	0.9	3.6	1.5	0.7

Results

Grazing of wheat stubbles.

Simulated grain yields for the Mackellar wheat crops averaged 5.1 t/ha at Harden and 6.0 t/ha at Inverleigh, in line with expectations. Predicted stubble masses at harvest from Mackellar wheat crops averaged 10.8 t/ha at Harden and 9.9 t/ha at Inverleigh. In the years where Janz wheat crops were sown owing to a late break of season, the average stubble masses were much lower (3.3 t/ha at Harden and 2.4 t/ha at Inverleigh). While the average stubble masses were slightly higher at Harden than at Inverleigh, the differences were not statistically significant. Over the stubble grazing period, the GRAZPLAN models predicted that (on average) 38% of stubble mass at Harden and 30% at Inverleigh would disappear in the absence of grazing (Table 2). Intake and the effect of trampling in accelerating stubble decay accelerated the rate of stubble disappearance; unsurprisingly, the effect of grazing depended strongly on the number of livestock available to graze the stubbles.

The predicted differences in livestock production relative to grazing dry pastures were quite small (Table 3). At a net clean wool price of $7/kg, the 0.16 kg/head decrease in wool production associated with grazing stubbles instead of dead pasture residues at Harden is valued at about $1.10 per head per year.

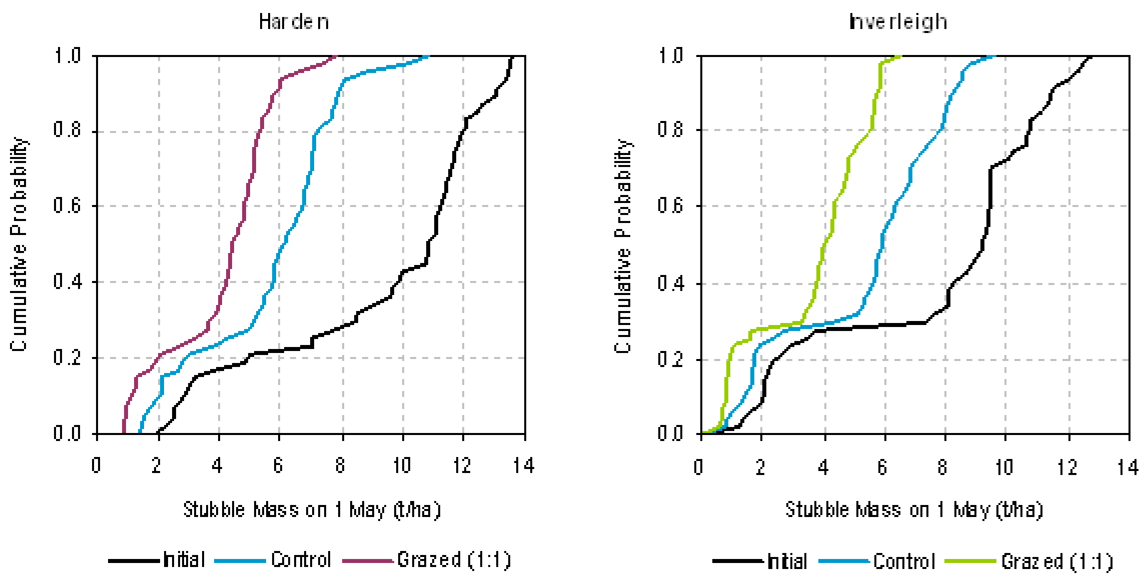
The decrease in wool value will be significantly larger if the tensile strength of the wool is affected by the lower growth rate on stubbles but this effect will depend greatly on the sheep genotype.

Table 3. Effect of different stubble grazing strategies on long-term average weight loss and clean fleece growth over the four months January-April at Harden and Inverleigh. Values are for simulations with a 1:1 ratio of stubble to grassland.

	Weight Loss (kg/head)		Clean Fleece Growth (kg/head)	
	Harden	Inverleigh	Harden	Inverleigh
Control	13.7	11.9	0.86	0.87
Grazed	14.9	10.4	0.70	0.83
+Lupins	11.7	8.2	0.81	0.91
+Urea	14.0	9.9	0.78	0.89

Use of N-rich supplementary feeds during the grazing period had little effect on the average rate of stubble disappearance (Table 2) or on livestock performance (Table 3). At a lupin cost of $250 per tonne, the lupin feeding option would recover about $0.80 per head per year of wool income at Harden while costing about $3.00 per head per year. At ME and protein contents assumed in the simulations, animals are more limited by ME supply than by the supply of rumen-degradable protein (RDP). Sensitivity tests (not shown here) indicate that the assumed protein content would have to be considerably lower before the animals' weight change would become RDP-limited, whether or not volunteer grass populations were included in the stubbles.

Figure 1. Frequency distributions of initial stubble masses and of stubble masses at the end of the grazing period for the control and grazed management options. Distributions are taken over the 48 years 1958-2005 at Harden and Inverleigh.



Given the relatively high background stocking rate assumed in the simulations and a relatively small area of high-yielding crops (e.g. stubble:grassland?=?1:3), the simulations indicate that it should be possible to reduce stubble masses to 2 t/ha through grazing alone in an average year (Table 2). As Figure 1 shows, however, this average obscures considerable variation; as a result, target stubble handling levels need to be set much higher than 2 t/ha if they are to be met most of the time. For example, a farmer at Harden with a more typical 1:1 crop:grassland ratio and who wants to be 90% certain that grazing alone would reduce stubble masses to a level appropriate for sowing the next crop or pasture would need to have equipment capable of dealing with 5.8 t/ha of stubbles.

Cutting stubble for use as winter supplementary feed

Calculations using GrazFeed suggest that daily intakes of conserved stubble by pregnant ewes will be no more than 0.4 kg/head whenever green pasture is present (Table 4). At very low green pasture availabilities, baled stubbles are likely to make an appreciable difference to livestock production. This effect diminishes rapidly as green pasture mass increases, however, becoming negligible at green pasture availabilities as low as 0.5 t/ha.

Table 4. Predicted daily intake of baled stubble (6.0 MJ ME/kg, 0.7% N) when fed *ad libitum* to pregnant medium Merino ewes at different levels of available green pasture, and the effect of feeding baled stubble on live weight change and wool growth.

Available green pasture (t DM/ha)	0.10	0.25	0.50	1.00	1.50
Intake of baled stubble (kg DM/head/d)	0.40	0.27	0.14	0.07	0.05
Difference in daily weight change (g/ d)	77	53	12	6	4
Difference in daily clean fleece growth (g/d)	2.1	0.8	0.8	0.5	0.3

Conclusions

The farming system simulations provide evidence that as the ratio of dual-purpose wheat area to pasture area increases, grazing alone becomes ineffective as a stubble management tactic. In order to sow crops reliably, farmers in this situation will need either to invest in sowing equipment capable of dealing with high stubble masses (on the order of 6 t/ha), or else be prepared to burn stubbles in some years even when employing grazing. The marginal cost to livestock production of grazing stubbles seems, however, to be quite small (on the order of $1 to $2 per head per year), and grazing should not be discounted as part of a multi-pronged stubble management strategy. The use of N-rich supplements does not alter the above conclusions.

Using wheat stubbles as a winter supplementary feed is unlikely to be effective as a means of utilizing cereal residues from high-yielding crops. The GrazFeed calculations indicate that for a 60-day winter feeding period, at most 10-20 kg DM/head will be consumed, i.e. about 500-1000 sheep would be required on average per hectare of stubble baled. Green pasture availability is unlikely to remain below 0.50 t/ha for more than a few weeks after pasture growth commences, so there will be little opportunity for feeding of baled straw to improve livestock production.

Acknowledgements

This work is part of the Grain & Graze R&D programme, which is jointly funded by Land & Water Australia, the Grains Research & Development Corporation, Meat & Livestock Australia and Australian Wool Innovation. We thank members of the Grain & Graze Murrumbidgee and Corangamite/Glenelg-Hopkins regional teams for useful discussions as we developed this study.

References

Freer M, Moore AD, Donnelly JR (1997). GRAZPLAN: decision support systems for Australian grazing enterprises. II. The animal biology model for feed intake, production and reproduction and the GrazFeed DSS. Agricultural Systems 54, 77-126.

Keating BA, Carberry PS, Hammer GL, Probert ME, Robertson MJ, Holzworth D, Huth NI, Hargreaves JNG, Meinke H, Hochman Z, McLean G, Verburg K, Snow V, Dimes JP, Silburn M, Wang E, Brown S, Bristow KL, Asseng S, Chapman S, McCown RL, Freebairn DM, Smith CJ (2003). An overview of APSIM, a model designed for farming systems simulation. European J. Agronomy 18, 267-288.

Kirkegaard JA, Angus JF, Gardner PA (1994). Reduced growth and yield of wheat with conservation cropping. I. Field studies in the first year of the cropping phase. Australian Journal of Agricultural Research 45, 511-28.

Moore AD (2001). FarmWi$e: a flexible decision support tool for grazing systems management. Proceedings of the XIX International Grassland Congress, S?o Pedro, Brazil, 11-21 February 2001 (compact disc).