Integration of a brassica forage crop into a winter wheat/pasture rotation

Walter Kelman, **Hugh Dove** and Libby Salmon

CSIRO Plant Industry, GPO Box 1600, Canberra, ACT 2601. www.csiro.au Email: walter.kelman@csiro.au

Abstract

We determined the impact on soil water content and on livestock production, of including a spring-sown hybrid forage brassica crop, as a prelude to incorporating winter wheat into a mixed cropping/grazing system. Lambs grazed 0.2ha plots of forage brassica for 33 days near Canberra, in the High Rainfall Zone of south-eastern Australia. Weight gains were rapid (294 g/day) and the system provided 2141 grazing days/ha and 637 kg lamb gain/ha. Net of the variable costs of the brassica crop production, the value of the weight gain produced while grazing the brassica was $843/ha. Depletion of soil water was markedly higher under the forage brassica crop than in adjacent fallow plots, however, the estimated potential value of this in terms of the likely yield loss from a subsequent winter wheat crop was much less ($384/ha) than the value of livestock production. While this suggests that there would be value in including a forage brassica within a pasture/winter wheat rotation, computer simulation of the system on a whole-farm basis is needed to quantify the long-term consequences and price sensitivities of introducing a forage brassica into a mixed cropping/grazing system.

Media summary

Including forage brassica within a pasture/winter wheat rotation results in returns from livestock which exceed the reduced wheat yield arising from the brassica’s water usage.

Key words

Forage brassica, winter wheat, liveweight gain, water use, computer simulation

Introduction

The development of dual-purpose (grazing and grain) wheats suitable for the High Rainfall Zone (HRZ) of south-eastern Australia (Freebairn et al. 2002) has led to increased sowings (Figure 1), and may have the potential to increase farm profits in the Zone, an area previously characterized by low farm incomes (ABARE 2001). This potential arises because the value of the winter grazing obtained from the wheat can offset the costs of crop production, so that the grain production can be regarded as profit. The incorporation of such dual-purpose wheats into traditionally grazing enterprises also provides both the cash flow and the opportunity (via crop cultivation) to incorporate lime into the soil, with a view to ameliorating soil acidity problems. This is a major problem in soils of the HRZ of south-eastern Australia (Cooperative Research Centre for Soil and Land Management 1999).

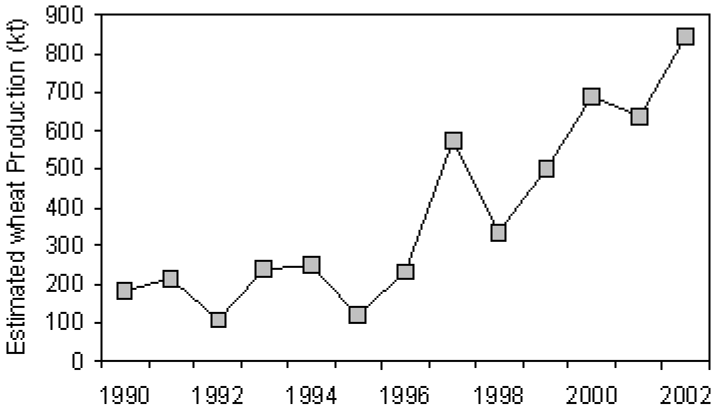

Figure 1. Wheat production in the High Rainfall Zone of south-eastern Australia, 1990-2002. Values recalculated from data in ABARE (2003).

A potential cost in the cropping/grazing system is the loss of grazing between land preparation in late winter/spring of one year and the start of grazing of winter wheat in the late autumn/winter of the following year. This cost might be overcome by sowing a forage brassica crop in spring for grazing in late spring/summer, before the wheat crop is sown in autumn. A brassica crop may provide a more secure finishing system for lambs than pasture grazing and, in addition, might also assist with management of soil-borne wheat diseases such as take-all. However, it is likely that, compared with a fallow, a brassica crop would use soil water which would otherwise be available for the winter wheat. This study examines the effects of the inclusion of forage brassica on animal production and soil water availability in a mixed cropping/grazing system, based on winter wheat. Our aim was to quantify the value of the animal production gained, relative to the cost of any likely reduction in wheat grain yield arising from water use by the brassica crop.

Methods

The experiment was located at Ginninderra Experiment Station near Canberra, ACT, Australia. Following herbicide treatment (August 2003), sixteen plots of approximately 0.2 ha were cultivated in preparation for winter cereal sowing in autumn 2004. Eight of the plots were left in fallow, and 8 plots were sown to a hybrid brassica as described below. The soils in the experimental area were moderately deep Red Chromosols and, prior to lime application (3 t/ha) in March 2003, had a mean pH (0.01 M $CaCl_2$) of 4.3. At sowing of the brassica crop in mid-September, soil pH and Bray P (g/kg) in the upper 10cm were 5.3 and 19.7, respectively.

The hybrid forage brassica (*Brassica campestris* cv. Hunter) was sown on 17 September 2003 at a sowing rate of 5 kg/ha, together with 130 kg/ha Starter 15 fertiliser (14.7% N, 11.8% P, 11.8% S). Germination, establishment and early growth were good, but drought conditions between mid-October and late November slowed crop growth and delayed grazing of brassica plots until mid-December. In early December 2003, random quadrats were cut to estimate forage yield. The mean forage yield was 4.7?0.16 t DM/ha. Border Leicester x Merino lambs (mean weight 36 kg) commenced grazing on 15 December 2003, following a ‘training period’ of 4 days during which they were gradually introduced to brassica forage in a separate paddock. An initial herbage allowance of 70 kg DM/lamb was used to determine the number of animals allocated to each plot; this ranged from 12 to 17 lamb depending on the exact plot size and herbage yield. The mean actual herbage allowance was 71?0.6 kg DM/lamb and the mean stocking rate was equivalent to 67?2.6 lambs/ha. Live weights were recorded at allocation, on 8 January 2004 (day 25 after allocation) and again on 16 January 2004 (day 33) when lambs were removed from the plots. Carcass weights and fat class were recorded at commercial slaughter, 4 days later.

On 19 December 2003, soil cores (5cm diameter) were taken to 50cm depth in 2 brassica plots and in 6 fallow plots. An equipment failure prevented our obtaining cores from more brassica plots. Gravimetric soil water content (g/g) was determined at 10cm intervals in each core, by oven drying.

Statistical analysis

Lamb liveweight gains were estimated from the linear regression of live weight on time. Analysis of variance was used to assess differences in soil water content between depths and between brassica and fallow plots.

Results

Lamb liveweight gain and carcass data

Lambs began consuming the brassica forage as soon as they were introduced to the plots, and no health problems of any kind were observed. Liveweight gains were rapid, and averaged 294?15.6 g/d over the grazing period (Figure 2). The total lamb production over the grazing period was 637?28.5 kg/ha.

At slaughter, the mean carcass weight of the lambs was 20.8 kg. The distribution across the carcass weight classes is shown in Table 1; over 65% of lambs had carcass weights of 20 kg or heavier. The mean dressing percentage (carcass weight/live weight) of 45.9% suggests that there was no effect of gut fill on final live weights, and also suggests that carcasses were lean. This is confirmed by the fact that over 68% of carcasses were classed as fat score 3 or lower (Table 1), indicating that the rapid live weight gain was also lean gain. At the sale price of $3.43/kg dressed weight and $10.70 for skins, the gross return was approximately $80/lamb.

Soil water content

Soil water content was significantly less under the brassica crop than under the fallow plots (Figure 3; P<0.001) and was significantly greater with increasing depth (P<0.01). The mean difference in soil water

content between fallow and brassica plots was 11.8 g water/g soil. Assuming a soil bulk density of 1.2g/cm^3, it can be calculated that this difference is equivalent to 71 mm of water in the first 50cm of soil depth. There is no evidence in Fig. 3 that the soil water contents were converging at a depth of 50 cm, so the actual difference to 1 m soil depth is likely to be considerably larger than 71 mm.

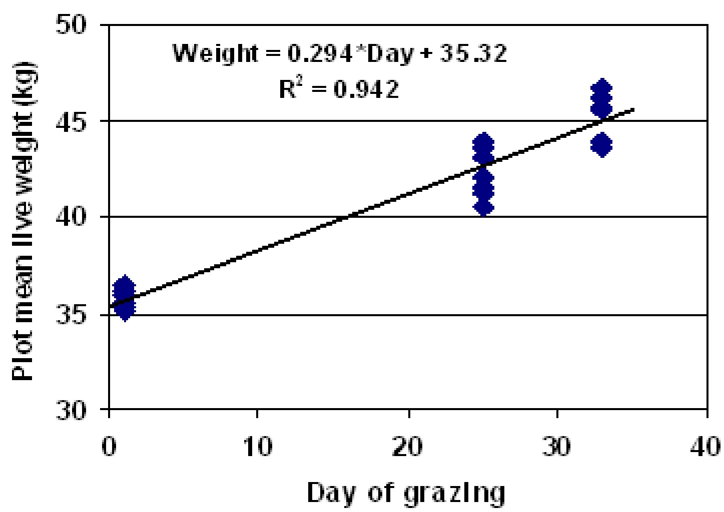

Figure 2. The plot mean live weights of lambs grazing forage brassica in December-January. The solid line is the fitted regression, which implies a mean liveweight gain of 294 g/day.

Table 1. Percentage of lamb carcasses in different weight and fat score classes

Carcass weight class (kg)	Per cent in weight class	Fat score class (fat depth at GR site)	Per cent in fat class
16-18	3.9	1 (<5 mm)	0
18-20	30.7	2 (5-10 mm)	8.6
20-22	48.8	3 (10-15 mm)	60.2
22-24	15.7	4 (15-20 mm)	25.0
24-26	0.8	5 (>20 mm)	6.3

Discussion

Our results provide objective data about the short-term consequences of including a forage brassica in a pasture/winter cereal enterprise. Such data are among the necessary inputs for a longer-term computer simulation of these systems (e.g. Moore et al. 2004), as a means of assessing the likely profitability of different management options in mixed cropping/grazing systems. In the short term, the inclusion of a spring-sown brassica crop had consequences both for livestock production and for the yield of the subsequent winter wheat crop, because of the water usage by the brassica. A comparison of the value of these effects provides an indication of the likely value of the inclusion of the forage brassica.

An assessment of the value of the livestock production can be gained from the dollar value of the lamb gains whilst grazing the crop. The 637kg weight gain/ha on the forage brassica amounted to a carcass gain of 292 kg/ha (637 * 0.459) and thus, given the sale price of $3.43/kg carcass weight, a gross return of $1003/ha. This is probably an underestimate of the total value, since no account is taken of any increase in skin value as a consequence of grazing the crop. The variable costs of establishing and maintaining the brassica crop were $160/ha, giving a return after variable costs of $843/ha. However, this must be discounted for the possible effect of the water use by the brassica crop on subsequent winter wheat grain yield. On the basis of the gravimetric water content curves shown in Fig. 3, we have assumed that in the first metre of soil depth, the brassica crop used 120 mm water. Assuming that every reduction of 1 mm in soil water content reduces grain yield by a maximal amount of 20kg (French and Schultz 1984), and that grain is valued at $160/t on farm, the extra water use by the brassica would cost the system a maximum of $384/ha in wheat yield. The difference of $459 between lamb production obtained and grain yield foregone ($843-$384) suggests that at these prices, it would be economic to include the brassica crop in the rotation, however, this assessment requires two qualifications.

1. These calculations assume that the wheat crop following the brassica crop has been successfully established and will be available for winter grazing. If the reduced soil water content following the brassica crop is enough to cause poor early growth or even complete failure of the wheat crop, then the costs to the system would be much higher and could eliminate any gains from the grazing of the brassica.

2. The value of the inclusion of the brassica crop within the system should only be made on a whole-farm basis, because of the many interactions between the pasture, livestock, brassica and cereal components of the components of the system. Estimating the physical and financial interactions between the

components of the system, on a whole-farm basis and over the long term, is a difficult task and one perhaps best approached using computer simulation.

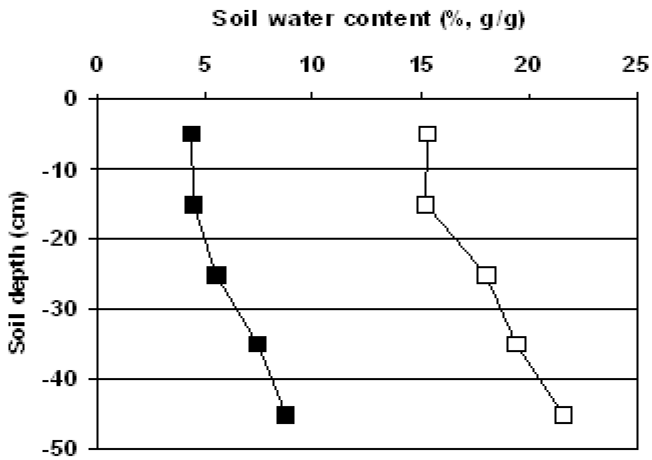

Figure 3: Comparison of mean gravimetric soil moisture content with depth under forage brassica (■) or fallow (□) near Canberra in south-eastern Australia.

Conclusion

We conclude from our results that in mixed grazing/cropping systems based on pasture plus winter wheat, there is likely to be economic value in including a spring-sown forage brassica between the pasture and the wheat, to recoup some of the grazing lost during preparation for and growth of the wheat. However, our assessment is made in the short term. To estimate the likely longer-term consequences of this management approach and its sensitivity to variation in both seasons and prices, long-term computer simulations of the system are required. This is the basis of a companion paper (Moore et al. 2004).

Acknowledgments

We thank the Grains Research and Development Corporation for financial support through Project CSP009.

References

ABARE (2001). ABARE Research Report 2001.9 (ABARE/AWI/AFFA: Canberra)

ABARE (2003). AgSurf - Exploring ABARE farm survey data. http://agsurf.abareconomics.com

Cooperative Research Centre for Soil and Land Management (1999). The costs of soil acidity, sodicity and salinity for Australia: preliminary estimates. Report CRCSLM/CTT2/6/99. Cooperative Research Centre for Soil and Land Management, Adelaide 44 pp.

Freebairn B, Ayres L, Kleven S, McRae F and Ellison F (2002). Productive dual purpose winter wheats. (NSW Agriculture)

French RJ and Schultz JE (1984). Water use efficiency in wheat in a mediterranean type environment: II. Some limitations to efficiency. Australian Journal of Agricultural Research 35, 765-775.

Moore AD, Salmon LM and Dove H (2004). The whole-farm impact of including dual-purpose winter wheat and forage brassica crops in a grazing system: a simulation analysis. Proceedings of the 4th International Crop Science Congress, 26 Sept – 1 Oct 2004, Brisbane, Australia. Published on CDROM.