Optimising the integration of dual-purpose crops in the high-rainfall zone

Summary
Grazing dual-purpose (DP) cereals and canola is known to contribute separately to enterprise gross margins, but their combined impact on whole-farm production and profit across a wide range of Australian high-rainfall zone (HRZ) environments is less clear. This project combined a baseline survey, targeted regional experiments and simulation to provide an overview of the livestock and grain production potential across the HRZ. It also provided robust agronomic guidelines to optimise the benefits, and an understanding of the soil, crop, pasture and livestock interactions that underpin success at the farm level. The outcomes of the project and adoption to date suggest significant potential to expand DP crops in the HRZ.

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Conclusions

Overall, this project demonstrated significant potential to improve productivity, profitability, flexibility and reduce risk by integrating dual-purpose cereals and canola on mixed farms in Australia's HRZ region. Significant grazing potential and high grain yields using the best-bet management guidelines and recommendations developed during the project were demonstrated in experiments, predicted in regional simulations and are being achieved by leading growers. Key conclusions include:

1. Regions: Opportunities to successfully integrate dual-purpose crops were evident in all regions but the best and most likely options in terms of varietal selection and sowing date varied. In most regions, options in wheat and canola existed that could generate at least 800 dry sheep equivalent (DSE) grazing days and yields of 4-5t/ha in wheat and 3t/ha in canola. The potential in the north seems under-recognised, while in the west, improved grazing rules for spring types are required.

2. System benefits: The combination of cereals with canola within the system generated significant benefits including break crop effects (1-1.5t/ha), longer grazing windows, increased pasture-spelling benefits, and weed control options to improve subsequent pasture establishment. The increased grazing arising from pasture spelling represented a significant part (30-60%) of the increased in-season grazing value. Simultaneous increases in farm stocking rates and grain production from dual-purpose crops generated significant increases in profitability.

3. Early sown wheat: Early sowing is necessary to capitalise on the grazing potential of long season cereals but this can generate significant disease risks including root and viral diseases, weed control and establishment challenges. Careful attention to these issues was necessary for success. Facultative wheats (Wedgetail®) provided a flexible option across a wider sowing window and maintained high yield potential. Spring wheats appeared more sensitive to grazing.

4. Potential for winter canola: Long season winter canola demonstrated high grazing and yield potential from early sowing in the HRZ. Three companies have released varieties during the course of this project.

5. Soil damage: Little evidence was found for significant soil damage from grazed crops influencing crop yields.

6. Livestock: The need for supplementing sheep and cattle grazing wheat with sodium and magnesium (Na and Mg) to increase liveweight gain was confirmed. No need was found for supplements when grazing canola or oats while the need for barley remains uncertain.

Recommendations

The specific recommendations for the most likely and most successful crop types and their management have been summarised and provided to industry stakeholders who have extended them through a range of communication vehicles. The best-bet recommendations vary from region to region but some generic recommendations arising from the work include:

1. Be prepared to sow early - the grazing potential of DP crops declines rapidly once sowing is delayed to the "normal" window. Be prepared to capitalise on sowing opportunities with respect to machinery, stubble and weed management and select the correct variety to achieve a safe flowering window. Inclusion of clean canola crops assists in having well prepared weed and disease-free paddocks for early sown wheat, however aphid control to avoid viral diseases is
2. Commonly recommended safe grazing rules based on growth stages work well for early sown winter crops, but may not prevent yield loss in spring crops. Even in crops which are not elongating (<Z30 or no bud elongation), yield reductions will be more likely when grazing too late, too heavily or when recovery conditions are poor (dry, cold). Remove stock earlier or reduce stocking rate to leave more residual biomass under these circumstances.

3. Supplement sheep (20g/d) and cattle (150g/d) with Na and Mg supplements while grazing wheat and barley, but not oats or canola. Cattle appear more sensitive to bloat on canola than sheep - be cautious and take recommended precautions. Do not graze canola for short periods (less than four weeks) if possible as the animals have a lag in weight gain when first introduced that takes some time to pass. Compared to cereals, canola takes longer to recover from grazing, repeated heavy grazing opportunities are less likely and less of the biomass present is accessible to stock (thick petioles and stems). Grazing strategies should account for these differences.

4. Avoid heavy grazing of waterlogged, heavy clay soils, otherwise normal grazing has little impact on soil likely to affect crop growth.

5. Grazed, high yielding canola (>3t/ha) and wheat crops (>5t/ha) have a high nitrogen (N) requirement (>250kg/ha). Ensure 80kg N/t expected canola yield and 40kg N/t of expected wheat are provided taking account of cost-price ratio for N.

Outcomes

This project sought to investigate the whole-farm benefits of new HRZ farming systems that integrate pastures, dual-purpose cereals and canola and to expand the focus from the south-east to other HRZ areas in the northern and western regions. In particular, the project team sought to quantify the synergistic benefits of dual-purpose cereal and canola in combination, the value to pastures and the improved flexibility, productivity and profitability and reduced risk that emerges at farm-scale. The potential risks to the farm resource base associated with grazed crops such as soil structural changes were also considered. Specific benefits demonstrated within the project were:

(1) Economic outcomes

A combination of regional experiments, crop simulation and grower case studies demonstrated significant potential to improve crop, enterprise and whole-farm profit by integrating dual-purpose cereals and canola. However, the recommended approach to crop and grazing management differs across regions. In southern regions, most areas have a high chance (>60% of years) to sow long-season winter cereals and canola in March-mid April and achieve significant grazing (approx. 1,500 dse.days/ha) and grain production (5-7t/ha wheat; 3-4t/ha canola). Combining canola and cereals extended farm grazing windows, provided pasture spelling benefits in winter, provided weed and disease control for cereals (yield increase of 1 to 1.5t/ha) and improved perennial pasture establishment. In the western HRZ areas, these opportunities were more limited though significant (up to 30% of years), while sowing of longer season spring crops in mid April to mid May can provide significant grazing (approx. 500 dse.days/ha) and high yields (4-5t/ha; approx. 3t/ha). Extrapolation from experimental crops to whole-farms involves assumptions, but estimates of $100-$200/ha increase in whole-farm profit from integrating 20-30% grazed crops (canola/wheat) concur with grower case studies. Reduced business risk and increased flexibility are added benefits.

(2) Environmental outcomes

A major concern was to investigate the potential for soil structural damage and yield loss associated with crop grazing in winter. Experiments and comprehensive analysis at three sites (Temora, Young, Canberra) showed surface compaction effects were short-lived. No negative (and in some cases positive) impacts of grazing on crop yields were observed. Environmental benefits included control of intractable weeds and diseases to lift declining pasture productivity, improved system water and nutrient use efficiency, increased income to pay for lime or other environmental spending and improved pasture feedbase and stored grain to avoid overgrazing.

(3) Social outcomes

Increased profitability and flexibility offered by DP crops is providing an economic stimulus in HRZ communities and among younger growers, optimism for improved viability of existing farm enterprises and enthusiasm for dynamic, mixed systems involving increased cropping.
Achievements/Benefits

Background and importance

The climate in Australia’s high-rainfall zone (HRZ) provides opportunities to achieve high grain yields on the estimated four million hectares of arable land, although enterprises in the HRZ have been historically focussed on livestock. The emergence of long season, high value, disease resistant wheat varieties that could be grazed by stock with minimal impact on yield created opportunities for mixed growers to increase winter stocking rates while improving the area and value of grain production. As the intensification of these winter cereals increased, weed and disease control issues emerged and the value of dual-purpose canola as a break crop in the system was demonstrated. Several previous research, development and extension (R,D&E) projects refined the crop and grazing management of these crops in south-eastern Australia and showed that separately, dual-purpose wheat and canola can increase enterprise gross margin (GM), but their combined impact on whole-farm profit over a wider range of HRZ environments had not been demonstrated. This project sought to investigate the whole-farm benefits of new HRZ farming systems that integrate pastures, dual-purpose cereals and canola and to expand the focus from the south-east to other HRZ areas in northern and western regions. In particular, the project team sought to quantify the synergistic benefits of dual-purpose cereal and canola combination, the value to pastures and the improved flexibility, productivity and profitability and reduced risk that emerges at farm-scale. The potential risks to the farm resource base associated with grazed crops, such as soil structural changes, were also considered.

Approach and major achievements

The project team consulted widely throughout the HRZ areas in the initial phase to establish close links with associated work (e.g. G&G2) in order to best target efforts with ongoing projects. Major activities and achievements included:

(1) Core experimental site

In the south-east HRZ, where dual-purpose cereals and canola had been widely adopted, a core experimental site was established with a three-year crop and pasture sequence in large replicated blocks (0.23ha) grazed by livestock to quantify (1) increase in gross margin (GM) due to grazing value of the wheat and canola crops, (2) increase in pasture productivity arising from winter spelling during wheat, canola and wheat+canola grazing, (3) break-crop benefits of canola for both wheat and pasture diseases and (4) evidence of impacts of grazing of crops on soil characteristics and crop performance. Crop, pasture and livestock production were all monitored to capture the key synergies.

An important achievement was to demonstrate that 30-40% of the additional grazing value of dual-purpose crops derived from the spelled pastures, and the remainder from direct crop grazing - a much greater benefit than envisaged. This was consistent in both the favourable 2010 season (early sowing, mild winter, wet spring) and the less favourable 2011 season (late sowing, cold winter, dry spring). The project team also demonstrated the increased benefits from having both crops grazed in the system (15% increase in grazing days), the significant break-crop benefit of the canola to wheat in the following year (1 to 1.5t/ha). Little evidence was found here or at two other sites in southern New South Wales (Temora, Young) that grazing the crops caused soil structural damage that influenced subsequent yield (though soil damage was reported grazing waterlogged crops in Victoria). Extrapolating these experimental results to a whole farm suggested that for the Canberra region, adoption of 15-20% crop area (C-W sequence) into a grazing enterprise would increase grazing by 15%, farm output/ha by 30% and farm returns enterprise $100-200/ha. These concur with case study farms in the area.

(2) Regional collaborative on-farm and replicated experiments

Following initial workshops in each GRDC region, collaborative on-farm experiments and demonstration areas were established to refine the management of dual-purpose crops in those areas and, where possible, investigate whole-farm benefits arising from integration of dual-purpose crops with growers and consultants. The experiments provided data to assist in calibration and validation of crop simulation models. These sites also became a focus for field days and field walks with regional consultant and grower groups with the outcomes widely communicated at a number of different forums.

In the south-east region, collaborative sites at Young (2009), Goulburn (2010) and Delegate (2010/11) complemented the data from the core experiment and previous projects to provide further refinements in relation to varietal choice, break-crop benefits, sowing time, disease management and grazing management. In each area, grower and consultant groups were closely aligned to the work. Experiments, simulation and leading grower results suggest early sown (March to mid April) winter cereals and canola will be feasible in more than 60% of years generating approx.1,500 DSE grazing days/ha and high
yields (5-6t/ha wheat; 3-4t/ha canola). The recent expansion of dual-purpose crops in the Goulburn region (from almost none to 3,200ha in 2012) is an example of the impact of these activities.

In southern Victoria, the project team collaborated with Southern Farming Systems (SFS) to include grazed canola alongside their grazing cereals work within G&G2. The work highlighted the potential for grazed canola in the area and reinforced the grazing management rules developed elsewhere, but also highlighted the limitations to grazing on paddocks on heavy soils prone to winter waterlogging.

In south-west Western Australia (Esperance region), the potential to increase livestock (including cattle) and crop production using dual-purpose crops was demonstrated although the shorter season length and herbicide resistant weed problems highlighted the need for quicker maturing spring types. Barley had significant benefits over wheat in that context and some leaf disease control could be achieved through grazing. Paddock-scale demonstration sites throughout the medium rainfall zones from Esperance to Kojonup and Dumbleyoung with G&G2 suggest the need to consider earlier starting and removal dates for grazing to avoid significant yield losses.

In the northern region, experiments at Coonabarabran, Spring Ridge, Armidale, Warralda and Gatton provided important information on sowing dates, varietal selection and grazing management appropriate to the northern region. As the experiments moved north and west, management strategies developed in the south-east became unsuitable and yield penalties with grazing using those rules increased. The need for mineral supplements with cattle grazing wheat was also confirmed.

(3) Regional modelling scenarios, whole farm analysis and case studies

Experimental data and simulation were used to estimate the potential grazing and grain value of dual-purpose wheat and canola at a set of 13 representative sites throughout the HRZ. The modelling outcome was validated with feedback from growers and consultants before finalising the report. Outputs from the modelling include sowing opportunities, grazing potential, grain yield and yield variability, potential risks of frost and heat damage over the range of sites, seasons and scenarios considered.

(4) Communication and adoption

Interest in integrating dual-purpose crops has been intense during the project period. The project team has endeavoured to meet as many requests for presentations and publications as possible across the GRDC regions. The team presented an average of two communication activities per week throughout the course of the project.

Other research

Some of the new work arising from this project is being continued within a new GRDC project (CSP00160) which has overlapped to allow continuity. The main aim is to understand how to avoid yield loss in grazed crops by refining crop and grazing rules across diverse regions in Australia. Other work on boosting livestock production on DP crops has been funded by the Meat and Livestock Australia (MLA), or has been pursued within G&G2. In addition, a recent GRDC review of dual-purpose crops (Radcliffe et al. 2012) has provided a comprehensive list of gaps in our understanding and highlighted areas for further work.

Specific issues emerging from this project since that review that will not be covered in project CSP00160 include:

1. Blackleg in winter canola: The introduction of longer season winter canola and fodder rape crops into HRZ areas brings with it a change in the dynamics of blackleg inoculum build-up as well as new sources of resistance. HRZ areas within which all known fields of winter canola can be identified have been isolated. This provides an ideal opportunity to study pathogen dynamics and host-pathogen interactions to avoid resistance breakdown and loss of this potentially important option.

2. Weed management: Weed control, in particular ryegrass and other weeds in cereals, poses a significant limitation to grazed crops, both in terms of early establishment and with-holding periods. Grazing itself can have significant impacts on some weeds and a project dedicated to compiling and further researching the successful management of weeds in grazed crops is essential. In particular, where grazed crops move into grazing land, well-managed crops can assist in weed control to improve subsequent pastures, but the risk of pasture grasses becoming crop weeds on farms with...
limited experience in their control is high.

3. Diseases in wheat: Diseases in wheat, including Wheat Streak Mosaic Virus (WSMV) and Barley Yellow Dwarf Virus (BYDV) continue to restrict the earliness of sowing and poor summer weed control exacerbates these issues. A focus on management packages for HRZ crops including grazed crops would be valuable. In addition, the interaction of grazing with some diseases (blackleg in canola, leaf disease in barley) has already been demonstrated.

4. Nitrogen (N) management of crops (grazed and ungrazed) in HRZ: High-yielding crops in the HRZ, especially if grazed, will require high N levels and management to avoid stock health issues. This project has highlighted the significant impact of low N on forage production and grain yield. Risks of N losses from leaching, run-off and denitrification also create a need for careful N management. The effects of grazing on fine roots and N use-efficiency is also uncertain. A focussed project on efficient N supply to crops in HRZ encompassing split applications, slow-release, effects of grazing, as well as the value of pastures (see below) is urgently required.

5. Role of pastures and phase transition management: In many HRZ farms, dual-purpose crops will be used to ‘clean-up’ under-performing pastures and likewise good legume-based pastures will be needed to support the N requirements of high yielding crops. These synergies require management of the transition phases to manage cycles of weeds, diseases, N and water in order to capitalise on the synergies. Short cycle high density legume pastures in rotation with crops may have a role on arable land used subsequently to establish perennial pastures.

Additional information

Since 2009, personnel associated with this project have published 12 peer-reviewed scientific papers, five conference papers and have been involved in a GRDC review of dual-purpose cropping.


