

Dual-purpose cropping: the opportunity for a step change in production in the temperate region of Australia

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Mixed farming businesses, where cropping and livestock enterprises are managed through the integration of the resources and requirements for each, are the predominant farming system of southern Australia. The combination of these enterprises provides a major opportunity to reduce business risks for farming in these regions by mitigating the financial effects of climate and price variability (Bell *et al.* 2021). A key requirement for a profitable livestock enterprise is the provision of a diversified feedbase that will reduce the overall cost of feeding livestock by anticipating seasonal variability in growing conditions and identifying and filling feed gaps (Moore *et al.* 2009).

The past 20 years has seen a resurgence in research and use of dual-purpose crops in Australia. Dual-purpose cropping refers to the establishment of annual crops such as cereals (e.g. wheat, barley, oats and triticale) and brassicas (mainly canola) with the intended purpose of grazing during the vegetative stage and harvesting grain after the crop matures. Twelve years ago, a special issue published in *Animal Production Science* reported key studies from Grain and Graze, a research and extension program which provided impetus for increased uptake of dual-purpose cropping and highlighted management of crops and livestock to optimise production. Since that time research into dual-purpose cropping has continued with focus including management of crops to maximise grain yield (e.g. Harrison *et al.* 2011; Seymour *et al.* 2015; Sprague *et al.* 2018; Bell *et al.* 2020), livestock production outputs from component studies (e.g. Dove *et al.* 2015; Sprague *et al.* 2015) and improving understanding of dual-purpose cropping in the larger farming system (e.g. Bell *et al.* 2014; Dove and Kirkegaard 2014; Bell *et al.* 2015; Thomas *et al.* 2015). Managing livestock to improve animal growth rates and reduce risk of adverse animal health outcomes (e.g. Dove *et al.* 2012; McGrath *et al.* 2013, 2015; Masters *et al.* 2019) has also received attention, and the deficiencies and interactions related to mineral content of forages has been a particular focus for livestock nutrition scientists (Masters 2015; Dove *et al.* 2016; Masters 2018).

In 2011, planning began for a new program of work seeking to further extend the potential for dual-purpose crops by direct measurement of outputs from livestock systems deliberately

planned around dual-purpose cropping systems. ‘Step changes in meat production systems from dual-purpose crops in the feedbase’ was a multi-institutional research program funded by Meat & Livestock Australia, with the overarching question of whether the extra supply of high-quality feed and extra source of income from additional land allocated for grain production can increase the reliability of year-round feed supply, increase farm profitability and reduce business risk. This special issue of *Animal Production Science* includes key papers from that research program, and a synopsis paper that integrates research across the three research nodes as well as some other related recent research. These nodes were; Canberra in the Southern Tablelands of New South Wales (NSW), which has a climate characterised by high rainfall, a long growing season and cold winters; Wagga Wagga in the mixed-farming zone of the South West Slopes of NSW, which has a climate characterised by medium rainfall and medium length growing season; and Hamilton in south-western Victoria, where the climate is characterised by high rainfall, cold winters and mild summers. In the synopsis paper (McGrath *et al.* 2021a), 11 principles for the effective utilisation of dual-purpose crops in meat production systems to increase profit and manage risk are presented and discussed. These principles were developed to cover how, why and when dual-purpose crops can be used to increase the profitability of mixed farming businesses, and some of the potentially unforeseen challenges in managing dual-purpose cropping.

Supporting the synopsis paper, the core research undertaken in the program is reported around measuring feed supply and livestock production, outcomes for cropping systems and how these are managed for dual-purpose production, and the economic impacts of integrating dual-purpose cropping in these cool temperate regions. The research contained herein goes some way to addressing the key gaps identified by the late Dr Hugh Dove in the McClymont Memorial Lecture in Adelaide in 2016 (Dove 2018).

Feed supply and livestock production

The 4-year experiment at Canberra demonstrated the opportunities and challenges of incorporating dual-purpose

crops into the production system. Contrary to previous reports, replacing permanent pasture with crop did not increase feed supply in spring or reduce supplementary feeding costs in the system used at Canberra, likely due to the lower pasture availability during autumn when crops were being established. Sacrificial grazing of failed crops was utilised in 1 out of the 4 years, and cereal crop stubbles were grazed in summer in the other 3 years, however in the grazing system under consideration these feedbase components only made a relatively small contribution (mean 28 days grazing for the ewe flock per year) to the feed supply during the year (McGrath *et al.* 2021b). The 4-year experiment demonstrated that wool and meat production were increased by adding dual-purpose crops to the system. Meat production was higher in a system where yearling sheep were provided priority access to grazing crops, driven by higher growth rates and heavier sale weights of young sheep given access to the high quality forage and flexibility to agist additional stock brought into the system in better seasons. Wool production was also demonstrated to be increased when dual-purpose crops were part of the production system, driven by higher fleece weights and increased stock numbers (McGrath *et al.* 2021c).

At Wagga Wagga, the reproductive performance of sheep genotypes was similar when averaged across the 2 years of the experiment, although using Dorpers as maternals did produce the heaviest lambs at weaning when joined to White Suffolk rams (McGrath *et al.* 2021f). Lucerne was a common treatment in lamb finishing studies (McGrath *et al.* 2021d, 2021e) however it was not clear why lamb growth rates on lucerne did not match those of the top performing mixture (chicory and arrowleaf clover) given the comparable digestibility and crude protein content of these treatments. A subsequent study also published in this issue (Champness *et al.* 2021) identified a positive response to supplementation of salt (NaCl) to improve lamb growth rates on lucerne due to the low sodium content of the lucerne forage, although supplementation did not increase growth rates under warm and dry conditions. Lamb production under warm and dry conditions in south-west Victoria was shown to be higher for lambs fed forage brassica compared with lucerne, likely related to the low metabolisable energy content of lucerne under these conditions (Nie *et al.* 2021).

A more recent application of dual-purpose crops is for spring sowing of crops for grazing in late summer/autumn and harvesting in late spring/early summer in the year after sowing, which has been demonstrated to provide valuable out-of-season grazing without impacting yield (Paridaen and Kirkegaard 2015). Research in south-west Victoria reported in this special issue (Raeside *et al.* 2021a, 2021c) demonstrates that in environments where it is suitable, for example milder summer temperatures and more consistent summer rainfall, spring sowing of canola can improve diet quality in late summer/autumn, and reduce supplementary feeding costs.

Canola can be utilised by different livestock classes and adds flexibility to the system. Canola was a common dual-purpose crop used across sites. Research at Hamilton demonstrated that reproductive rates of ewe lambs that grazed canola were equivalent to or better than other feed options provided (Raeside *et al.* 2021c). At Canberra and Wagga Wagga, ewes grazed canola during late-pregnancy

and lambing. Canola was also utilised by young, growing sheep at Canberra (McGrath *et al.* 2021c) and cattle at Wagga Wagga (McCormick *et al.* 2021). A key finding at Canberra was that prioritising grazing of dual-purpose forages for young livestock increased meat production and provided flexibility to the system, as other classes of livestock (lambing ewes or agistment stock) could also utilise excess crop forage (McGrath *et al.* 2021b).

Research into cattle grazing crops has been studied in other countries, particularly the US (e.g. Gregorini *et al.* 2011; Gunter and Combs 2019). This special issue includes a paper (McCormick *et al.* 2021) that collates results from several small and preliminary experiments utilising crops for grazing by young cattle in Australia. The argument is made that cattle grazing represents an opportunity for mixed-farmers to diversify their income by trading or agisting cattle from other areas to utilise the high-quality crop forage before crops are 'locked-up' for grain. This may be on an opportunistic basis, for example in years where there is an early sowing opportunity.

Management of cropping systems

Management of crops to minimise the effect of grazing on grain yield is an important consideration. In the studies included here grazing reduced yields of summer/autumn sown canola by 17% on average near Canberra (McGrath *et al.* 2021b) but did not reduce yield of spring-sown canola grazed in summer-autumn (Raeside *et al.* 2021b).

Changing the system to rely on forage produced by dual-purpose crops does expose the enterprise to establishment risk. Spring sown canola failed at Hamilton in one of the 3 years (Raeside *et al.* 2021a). The late break in the season at Wagga Wagga in 1 year meant establishment of the wheat crop was slow and sheep needed to be supplemented off the crops until the point of lambing, with feed on offer in the crop low at the commencement of grazing (McGrath *et al.* 2021f). Sowing both dual-purpose canola and wheat at Canberra provided some hedge against poor establishment. Canola was generally grazed first, but in the year where initial germination of canola was slow the wheat crop was first to be grazed (McGrath *et al.* 2021b).

Farm economic implications

The research program sought to understand the impacts on the farm business of including and utilising dual-purpose crops in the different environments. Financial analysis and modelling have demonstrated improved profitability and/or reduction in business risk from including dual-purpose crops. Financial performance was similar for systems where priority access was provided to ewes or their progeny in the systems experiment near Canberra (McGrath *et al.* 2021a). In south-west Victoria, spring-sown canola was similar in risk to the perennial option of lucerne and reduced risk compared with other options such as a conventional target rape or using grain-based supplement to achieve ewe lamb mating weight (Tocker *et al.* 2020).

The results of the 'Step Changes' project and the other related research that is presented in this special issue have

contributed to the understanding of how dual-purpose crops can increase livestock production, fill quality and quantity deficiencies in the feedbase during important time of the year and diversify and increase income and decrease risk. The body of work provides important information that will assist producers and farm consultants to identify best management and use of dual-purpose cereals and canola to improve profit, reduce risks, and to mitigate some of the challenges of integrating cropping and livestock systems.

Conflicts of interest

Dr. Greer and Dr. Thomas were Guest editors of this special issue. Dr. McGrath initiated the special issue and coordinated the papers but was not involved in the review and editorial process for the papers in this issue. The authors have no further conflicts of interest to declare.

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