

Dual-purpose cropping – capitalising on potential grain crop grazing to enhance mixed-farming profitability

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Introduction

Mixed farming enterprises throughout the world balance and integrate crop and livestock enterprises to spread economic risk and capture synergies in terms of forage supply, but in many areas of the world these have become increasingly separated and specialised (Wilkins 2008). Despite an intensification of cropping during the last 25 years, most farms in Australia's cropping zone operate a mix of cropping and livestock enterprises (Kirkegaard *et al.* 2011). Livestock in these farming systems are regularly exposed to periods of forage deficit (feed gaps) that can reduce both animal performance, but also lower the 'safe' carrying capacity of the farm (Moore *et al.* 2009). These feed gaps occur regularly during autumn and winter in much of southern Australia. One option to address this feed gap is to utilise grain crops as a forage source during their vegetative stage, which are then later allowed to regrow to be harvested for grain at maturity – defined herein as dual-purpose crops (Harrison *et al.* 2011a). Dual-purpose crops provide a highly digestible forage source during periods when growth rates of pasture forage is low, and the crops can recover to achieve similar grain yields to ungrazed crops (Kirkegaard *et al.* 2008; Dove and McMullen 2009). Together this can increase the net economic gains from these crops by 25–75% (Bell *et al.* 2014).

Dual-purpose crops have been used in this way in several regions of the world for decades. Early reports of horse grazing in Kansas and cattle grazing in New Jersey on winter wheat was shown to increase crop grain yields (Swanson 1935; Sprague 1954). In Australia, breeding of grain crops has predominantly focussed on short-season spring varieties that do not require vernalisation to initiate reproductive development, and are intended for use as grain-only production (Virgona *et al.* 2006). However, with the release of several long-season and high grain protein cereal varieties during the later 1990s, farmers in the higher rainfall mixed farming regions could make use of dual-purpose crops to increase net returns from crops and provide greater market flexibility. Recent analysis conducted by GRDC suggested the area of dual-purpose crops has grown rapidly in Australia in the past 10 years with at least 300 000 ha of long-season dual-purpose crops are grown in Australia currently (Radcliffe *et al.* 2012), though accurate data is difficult to attain.

More recently, Kirkegaard *et al.* (2008) have demonstrated the potential for dual-purpose use of canola which provides concurrent advantages associated with both disease control of break crops as well as enhanced animal production (Dove and Kirkegaard 2014; Sprague *et al.* 2014). While successful dual-purpose grazing can be achieved with spring canola varieties, most commonly used in Australian grain systems, the introduction of long-season winter-type canola have been shown to provide large grazing opportunities and wider sowing windows similar to long-season winter wheats (Kirkegaard *et al.* 2008, 2012; McCormick *et al.* 2012; Sprague *et al.* 2014).

In addition to increased forage supply, dual-purpose crops have generated a range of other benefits to the mixed farming system. First, grazing reduces crop height and hence the risk of crop lodging in cereals, improves the ease of harvest in canola, and reduces post-harvest stubble load to facilitate sowing in the following season (Baumhardt *et al.* 2009; Nuske *et al.* 2009; Harrison *et al.* 2011a). In addition, the flexibility in sowing date and delayed phenological development after grazing can reduce risk of frost damage during flowering from early sown crops. Finally, grazing crops are generally thought to reduce grazing pressure on pastures on other parts of the farm (pasture-spelling) which enables increased growth and grazing value for livestock later in the season once crops cannot be grazed.

The previous success with dual-purpose crops in higher rainfall regions of south-eastern Australia has increased interest in the potential of dual-purpose crops in new regions of Australia, and the world, including exploration of winter wheat for grazing in north-west China (Tian *et al.* 2012). Capitalising on dual-purpose crops in existing areas and expanding their use in new areas requires underpinning research to understand crop responses to grazing, crop agronomic and grazing management to maximise the benefits and whole-farm integration to optimise the synergies at the farm level. This special issue documents recent research conducted across a range of environments in Australia which deals with these key research areas.

Physiological and mechanistic understanding of grazing effects in dual-purpose crops

In dual-purpose crops, the removal of biomass during vegetative growth can either boost or penalise grain yield. Harrison *et al.* (2011a) surveyed more than 270 experiments and found that the