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Evolution in crop–livestock integration systems that improve farm productivity and environmental performance in Australia

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ABSTRACT

Australian farming systems have an enduring history of crop–livestock integration which emerged in the face of high climate variability, infertile soils and variable landscapes. Ley farming systems with phases of shorter annual legume pasture phases with cereal crops predominate but, emerging sustainability issues and the need to manage risk is driving ongoing innovation in crop–livestock integration. We discuss the recent evolution of selected innovations that integrate crop and livestock production and their impacts on farm productivity, sustainability and business risk. Dual-purpose use of cereals and canola (*Brassica napus*) for forage during the vegetative stage while still harvesting for grain is now practiced throughout southern Australia's cropping zone. This practice provides risk management benefits, diversifies crop rotations, reduces pressure on other feed resources and can significantly increase both livestock and crop productivity from farms by 25–75% with little increase in inputs. Sacrificially grazing crops when expected grain yield is low and/or livestock prices are attractive relative to grain provides further flexibility in crop–livestock management systems vital for business risk management in a variable climate. Replacing annual pastures with perennial pasture phases in rotation with crops can provide a range of benefits including improved hydrological balance to reduce dryland salinity, subsoil acidification and water-logging, provide a management tool for herbicide-resistant or problem weeds, improved soil nutrient and carbon stocks as well as increased livestock productivity by filling feed gaps. In some environments, integration of perennial forages in mixtures with cropping, such as alley cropping and inter-cropping, also provide options for improving environmental outcomes. These practices are all innovations that provide flexibility and enable tactical decisions about the mix of enterprises and allocation of land and forage resources to be adjusted in response to climate and price. We discuss these innovations in the context of the emerging constraints to crop–livestock integration in Australia including the continuing decline in labour availability on farms and increasing management skill required to optimise enterprise profitability.

1. Introduction

While agricultural enterprises in other developed countries are becoming increasingly specialised (Russelle et al., 2007; Wilkins, 2008), mixed farms combining grain cropping and ruminant livestock enterprises dominate Australia's dryland farming regions. The mixed farming zone covers around 70 Mha of land, typically in regions receiving between 250 and 700 mm mean annual rainfall. This covers agro-climates from strong Mediterranean climates with cool, wet winters and hot, dry summers in south-western Australia to continental subtropical climates in inland Queensland and northern New South Wales where rainfall is summer dominant and winter rain highly variable.

Despite the wide spectrum of climate conditions and large variation in production systems, two key features of Australian agriculture underpin the success of mixed farming in the region. Firstly, the variability in climate and price favours diversified businesses. Australian farmers are faced with the most variable rainfall regime on earth (Love, 2004), as well as high exposure to volatile commodity prices due to low government subsidy support of agriculture. As a result, many Australian farmers are motivated by the risk mitigation benefits of operating a mix of crop and livestock enterprises to dampen fluctuations in income as a result of both price and climate variability (Bell and Moore, 2011). Similarly, mixed farmers have the option to tactically alter their mix of enterprise in response to climate or price signals. Secondly,

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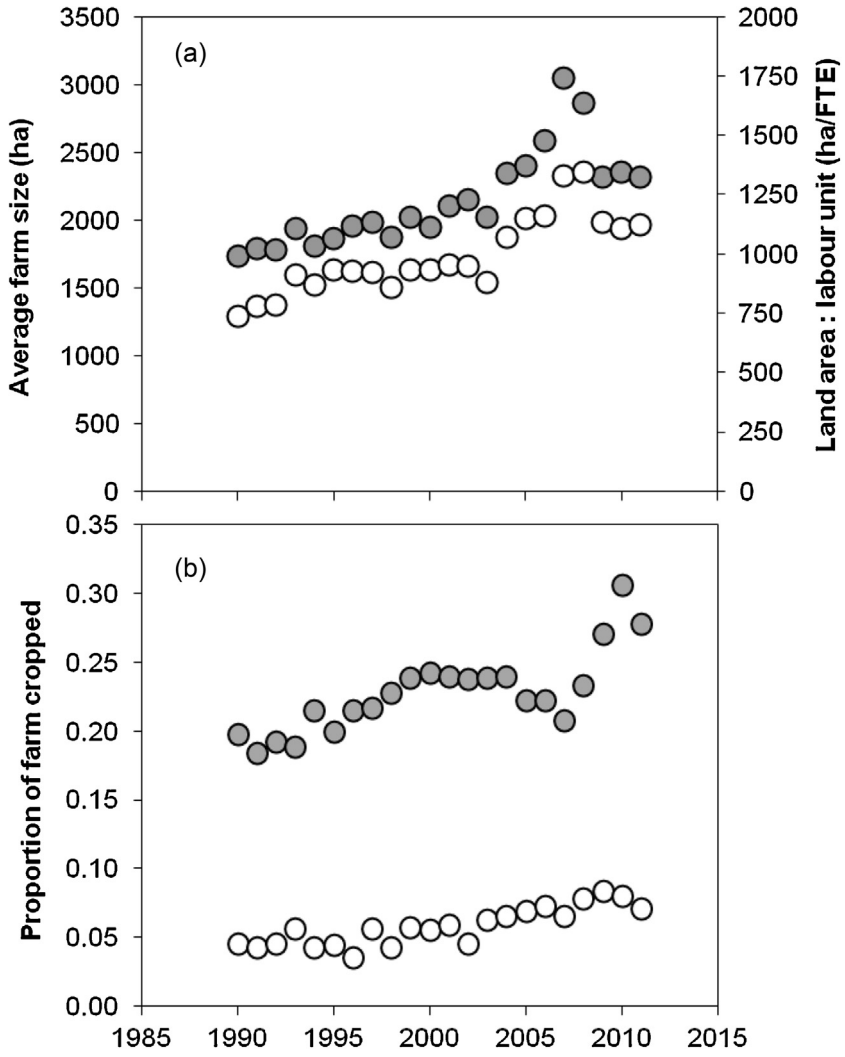

Fig. 1. Farm size (grey) and land area per unit of labour (white) trends across the mixed crop–livestock zone (a) and trends in the proportion of farm area cropped in the mixed crop–livestock zone (grey) and high rainfall zone (white) (b) between 1990 and 2011.
Source: Australian Bureau of Agricultural and Resource Economics, 2011.

Australian farms are large and becoming larger, averaging >2000 ha per farm in the mixed crop–livestock zone (Fig. 1a; Australian Bureau of Agricultural and Resource Economics, 2011). This large scale means farms are often spread across a variety of soil types varying in production capability. In order to use this land appropriately, some areas are devoted to grazing livestock and some to crop production.

While these factors motivate farmers to operate a mix of crop and livestock enterprises as part of their business, there is concern that the integration of crops with livestock is declining and the sustainability and productivity benefits provided may be reduced (Hacker et al., 2009). For example, there has been a large decline in cereal-ley systems involving annual self-regenerating pasture legumes in crop rotations, a system that has brought about improved soil fertility, increases in cereal yields and livestock production in southern Australia since the 1930s (Puckridge and French, 1983). This concern has led to significant research, development and extension programmes (e.g. 'Grain and Graze') that have focussed on ways in which crop–livestock integration might improve productivity and address environmental and sustainability challenges such as soil erosion, declining soil carbon, sub-soil acidification and increased drainage into ground water tables causing dryland salinity (Hacker et al., 2009).

In this paper we will firstly explore some of the possible reasons for recent trends in Australian dryland agriculture that have brought about this concern (Kirkegaard et al., 2011). We will then address in detail some relatively recent but potentially transformative crop–livestock integration practices that appear to have both environmental and production benefits in Australian agriculture.

2. Contemporary influences on crop–livestock integration in Australia

Over the past 20 years the size of farms in the Australian mixed farming zone has increased to obtain economies of scale required to remain competitive (Fig. 1a). In association with this there has been a reduction in the labour available, so that a labour unit is managing 50% more land in 2011 than in 1990 (Fig. 1a). This labour limitation places pressures on farmers to simplify their farming systems. Labour supply has been shown to constrain the adoption of practices that integrate crops and livestock, which generally involve greater and more constant management attention (Bell and Moore, 2012) and increased cropping activity and decreased livestock activities are more favoured under labour constraints (Doole et al., 2009).