Diversity of grain cropping in Australia as an indicator of sustainability

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Abstract

Crop diversity is one indicator of the sustainability of cropping systems. An analysis of cropping intensity and crop diversity used concorded data from the Australian Bureau of Statistics to provide trends and spatial patterns over the Australian wheatbelt. Over the last 15 years cropping intensity and crop diversity generally increased, often in the same localities, but vary widely in spatial pattern and trend. Areas of concern for sustainability are those that have high cropping intensity and low crop diversity.

Media summary

The intensity and diversity of grain cropping, while varying widely, have generally increased over the last 15 years in Australia.

Key Words

Grains, diversity, intensification, sustainability, pattern.

Introduction

Diversity in cropping lands is a useful indicator of the sustainability of cropping systems. Diversity of varieties can provide benefits for managing some crop diseases (Mundt 2002). Diversity of crop species provides opportunities to spread risks from markets and climate variability, while at a functional level, there are differences in the way species can significantly influence ecosystem processes (Evina and Chapin 2003). Importantly, there are often benefits from diversification to increase crop productivity (Stephens 2002). This paper presents an overview of diversity of Australian grain cropping using data collected from agricultural censuses.

Cropping by its nature makes large changes in the landscape: to biodiversity, soil erosion risk, soil carbon, soil nutrient levels, to water balances and salinity. I use the proportion of farmland used for cropping (cropping intensity) here as an indicator of the risks to natural resource condition.

Methods

The Australian Bureau of Statistics (ABS) has conducted detailed censuses of agricultural activities for many years. The data from 1983 to 2201is available electronically at a Statistical Local Area (SLA) level. However, the questions asked, the minimum scale of agricultural operations included and the boundaries of some of the SLAs have changed over this time. The National Land and Water Resources Audit provided funds to concord the census data from 1983 to 1997 into constant definitions and boundaries (Walcott et al 2001). The census years of 1986, 1991 and 2001 were selected for spatial analysis in this paper.

Cropping intensity was calculated as the proportion of farm area (total area of holding) that is used for grain cropping. Crop diversity for this paper assumed that membership of botanical families – cereals (Poaceae), pulses (Leguminoseae) and oilseeds (largely Crucifereae and Compositeae) – provided a good basis for diversity at a functional level. It was calculated using the proportion of the total area used for grain crops that was sown to non-cereals (pulses and oilseeds).

The results are presented for those SLAs that occur in the Australian wheatbelt, outside which cropping intensities are low and less likely to be a major activity for a region.

Results

The area under grain crops has generally increased in the last 15 years (Table 1) and now represents 5.6% of the total farm area of Australia. The greater proportion is sown to cereals, particularly wheat, although declining consistently and was at 82% of total grain crop in 2001. This decline occurs, not from sowing less to cereals, but rather from large increases in the area sown to pulses and oilseeds. The crops leading the increases were canola and lupins but field peas and chickpeas also contributed significantly. The areas sown to oats and sunflowers have generally declined over this time, possibly from competition by triticale and canola.

Table 1. The proportion of total farm area cropped (%), the proportion sown to cereals (%) and the area of the major crops and types (million hectares) at four times. Source ABS AgStats.

	1986	1991	1997	2001
Farm area cropped (%)	4.5	3.9	4.9	5.6
Cereal cropping (% total)	92.6	88.9	86.0	82.2
Total area grain crops	18.61	15.21	19.19	21.67
Cereals	17.24	13.52	16.51	17.81
Wheat	11.74	9.22	10.93	12.14
Barley	3.28	2.56	3.37	3.45
Grain sorghum	0.73	0.38	0.54	0.76
Oats	1.07	1.04	1.05	0.65
Triticale	0.14	0.10	0.35	0.39
Pulses	0.89	1.39	2.06	2.27
Lupins	0.59	0.79	1.26	1.18
Field peas	0.21	0.32	0.34	0.40
Chick peas	0.03	0.18	0.24	0.26

Oilseeds	0.48	0.30	0.62	1.59
Canola	0.07	0.07	0.41	1.46
Sunflower	0.28	0.17	0.14	0.08

The intensity of cropping, indicated by the proportion of farm area that is under crop in any year, is uneven across the Australian wheatbelt (Figure1a). Areas of high intensity of cropping (more than 40% in any one year) occur in eastern parts of Western Australia, in the Eyre and Yorke Peninsulas of South Australia, in the Wimmera-Mallee of Victoria and parts of the eastern Riverina in New South Wales. Further north in New South Wales and into Queensland the cropping intensity is lower.

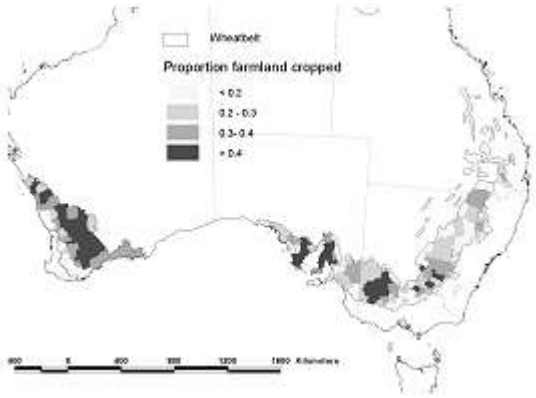
Less crop was sown in 1991 than in the other years (Table 1) so that the change in cropping intensity between 1991 and 2001 (Figure 1c) was larger than between 1986 and 2001 (Figure 1b). The largest increases often occurred in the areas that ended up with the highest intensity in 2001. There were some areas that declined in intensity, particularly from the 1986 reference, in the Darling Downs and Fitzroy Basin in Queensland, Liverpool Plains and Central West of New South Wales, Albury in Victoria, the far west of South Australia and parts of the Central Wheatbelt of Western Australia.

Diversity, exemplified by the proportion of non-cereal in the total crop area, also varied significantly across the wheatbelt (Figure 1d). Areas with a high crop diversity were in northern and southern Western Australia, in the Wimmera of Victoria and the eastern Riverina of New South Wales. In contrast to the change in cropping intensity, crop diversity has generally increased consistently with time: being greater from 1986 (Figure 1e) than from 1991 (Figure 1f) in comparison to 2001. Only a few areas have declined slightly in crop diversity: the northern part of Central Queensland and the eastern Darling Downs in Queensland, Liverpool plains and western Riverina in New South Wales, Albury and central Victoria, southern Flinders Ranges in South Australia and northern Swan Plain in Western Australia.

Discussion and conclusions

Despite widespread increases in the intensity of cropping over the last 15 years this has generally been accompanied by an increase in crop diversity. In fact, Stephens (2002) attributes this to underpinning productivity gains in many areas. In terms of sustainability, it is not easy to define a particular threshold where diversity would be optimal, but is likely to vary by region. There are concerns that continuous cropping (identified where cropping intensity exceeds 40% at least) may be causing long-term damage to natural resources such as dryland salinity, soil quality and biodiversity and hence a threat to the sustainability of grain cropping. Increasing diversification of grain crops provides some assurance that these concerns need not increase. Diversity is but one indicator of sustainability: there are other factors to be considered in determining the overall sustainability of grain cropping in any region, including other crops, the nature of soil constraints and economic incentives.

The areas that would be of most concern to sustainability are those where cropping intensity is high and crop diversity is low. There are some areas approaching this in the western wheatbelt of Western Australia, the Eyre and Yorke Peninsulas of South Australia, the eastern Mallee of Victoria, and the Riverina of New South Wales. Where cropping intensity is low there is the likelihood that functional diversity is provided by pasture phases. This analysis also highlights the need for further investigations into removing barriers for successfully growing alternate grain crops to the cereals in these regions.



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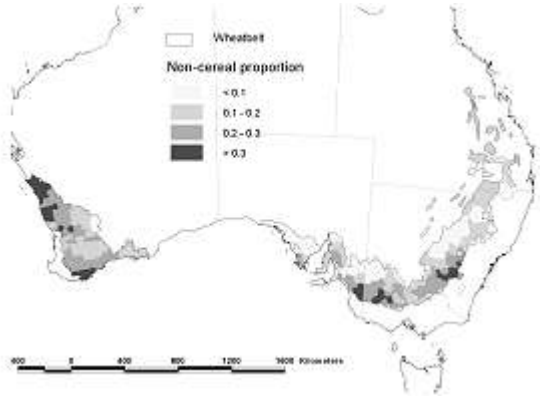

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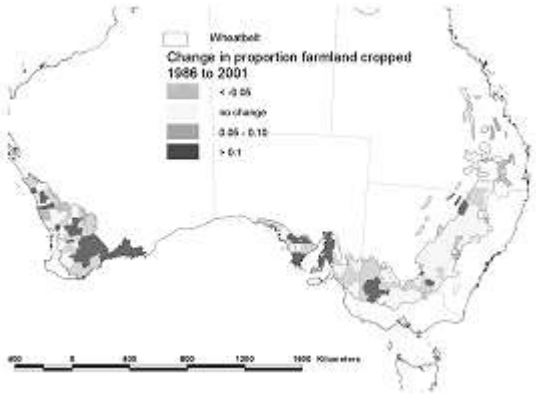

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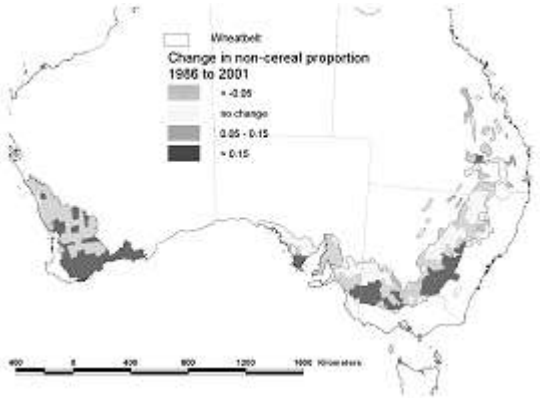

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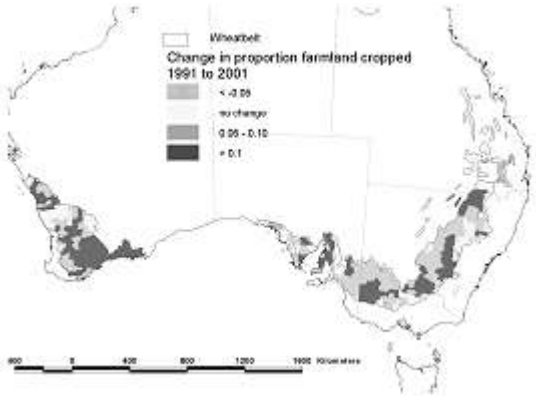

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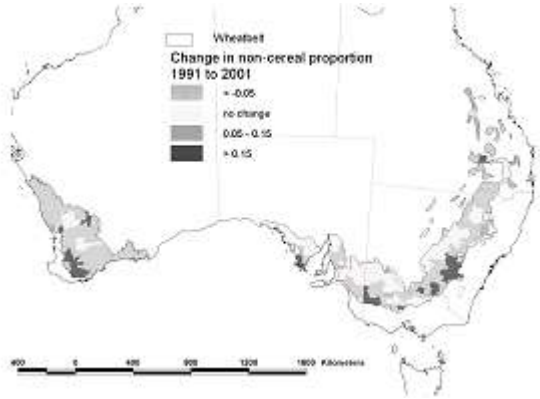

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Figure 1. Spatial distribution of cropping intensity and crop diversity across Australia: a) cropping intensity in 2001, b) change in cropping intensity from 1986 to 2001, c) change in cropping intensity from 1991 to 2001, d) crop diversity in 2001, e) change in crop diversity from 1986 to 2001 and f) change in crop diversity from 1986 to 2001.

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