Productive agriculture and NRM – finding the synergy

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Abstract
In this paper, three agricultural zones in southern NSW (the irrigation areas, the sheep-wheat belt and the high rainfall grazing zone) are considered in terms of five ecosystem properties (imperatives): agricultural productivity, environmental sustainability, economic performance, social well-being and political acceptability. Examples are given of agricultural and environmental indicators that may routinely be used to measure the state of each of each zone. While the management principles and thresholds that have been defined by environmentalists for natural resource management (NRM) in these landscapes may never be met in full, examples are given of progress towards the better management of resources such as soil, water and clean air. The concept of native vegetation (enhancing biodiversity) is discussed as a particular case, since it embraces ideas of ecosystem function and resilience, production and conservation, aesthetics and heritage, evidence and beliefs, and the wellbeing of rural communities and urban societies. Although there is the potential for conflicting outcomes from management for conservation, which may produce long-term ecological gains for society but at an economic cost (short- to medium-term pain) for the rural landholder, there is a strong case for increased biodiversity in each zone. The difficulty is to increase the incentives for NRM. Ideas are given on how these conflicts might be negotiated and how NRM support may be made more efficient towards win-win outcomes. For the future, shared responsibility and healthy collaboration is essential between landholders, communities and the bodies that provide services to them, such as scientists, government, corporations, agribusiness, regional bodies and Landcare.

Introduction

In rural zones, finding a balance between productive agriculture and environmental conservation is an ongoing conundrum. While considerable progress has been made towards the sustainability of Australian crop and livestock farming, especially with the adoption during the last 3-4 decades of practices such as liming, break crops, minimum tillage, stubble management and lower stocking rates, land management still leans heavily towards agricultural production rather than to environmental imperatives such as the expansion of biodiversity[1] to create best-practice landscape management.

The Murrumbidgee catchment comprises ten (10) landscapes, as defined by the Murrumbidgee Catchment Management Authority (Figure 1). These landscapes include the *Low-Murrumbidgee Floodplain* near Balranald; *Rangelands* around Hay; the *Irrigation Areas* around Leeton, Griffith and Coleambally; the *Riverina* plains between Narrandera and West Wyalong, the undulating sheep-wheat belt areas of the *Mid-Murrumbidgee* (Temora-Wagga-Henty), the steeper mixed-farming country of the South-West Slopes (Junee-Gundagai-Cootamundra-Harden); the *South-West* (or Riverina) *Highlands* around Adelong, Tumut, Batlow and Tumbarumba; the *Tablelands* landscape that extends from Jugiong past Yass towards Goulburn; the intensive 'blockie belt' (*Capital* landscape) around the ACT; and the *Monaro* which extends from Bungendore to Cooma. Most of these areas were open woodlands maintained by the Aboriginal people with fire (Barr and Cary 1992), along with forested areas along the ranges and extensive areas of natural grasslands in the Rangelands, Riverina and Monaro landscapes.

This paper focuses on three zones in the catchment: the Irrigation areas; the sheep-wheat belt that spreads across the Riverina, Mid-Murrumbidgee, South-West Slopes landscapes; and the high rainfall grazing zone,

[1]Biodiversity refers to the number and variety of plant, animal and microbial life within a region. Enhancing agricultural biodiversity may involve procedures/protocols that not only ensure a functional combination of agricultural crops, pastures and livestock but also create resilience to stressors by broadening the genetic base of useful agricultural species, preserving/increasing the content of native flora and fauna in production landscapes (NRM), retaining a balance of traditional farming methods with corporate farming and industrialised agriculture, reducing the dependence of farming on non-renewable resources, balancing the commercial gain of individuals with the public good, and recognising the different socio-economic motivations/needs of individuals and communities.

which includes South-West Highlands, Tablelands, Capital and Monaro landscapes. First, these zones are descriptively summarised in terms of agro-ecosystem properties (productivity, sustainability, economic issues and social/political factors). Then, they are evaluated from the perspective of natural resource management, especially with respect to the presence or absence of native woodlands and grasslands that contribute biodiversity, enhance ecosystem resilience, create habitats for wildlife, and improve the aesthetic value of farms. Finally, some considerations are explored and recommendations made on what may be done to increase, in these production landscapes, the areas of land that meet or approach the principles (see Table 2) defined by environmentalist scientists for the conservation of native flora and fauna.

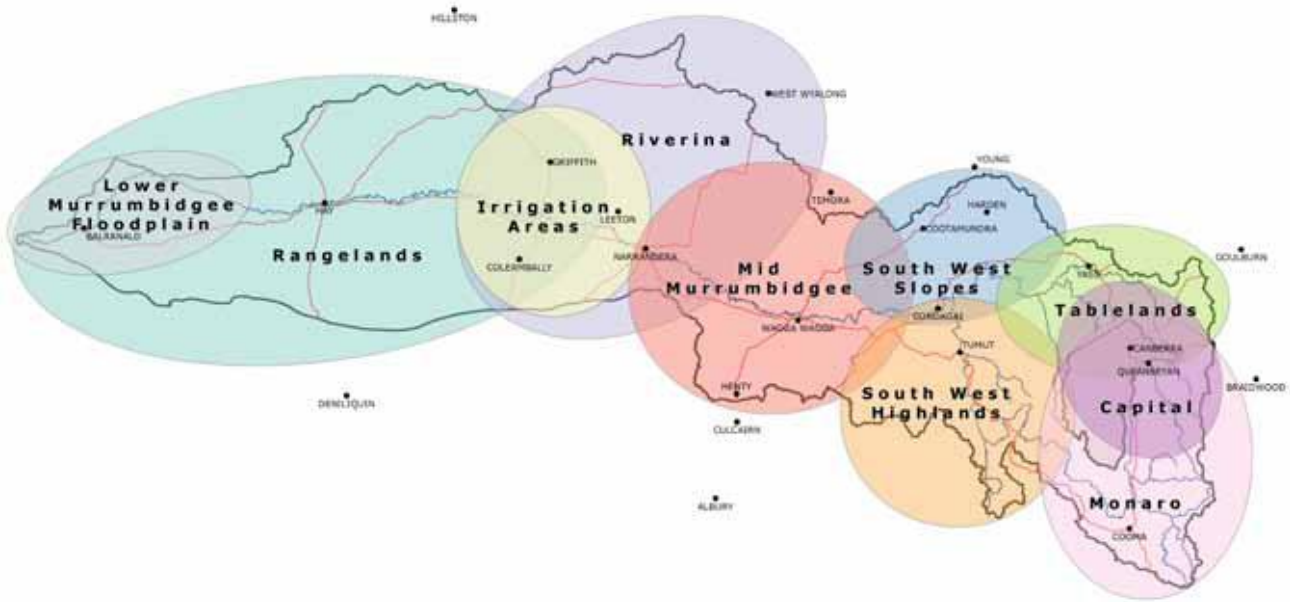

Figure 1. The landscapes of the Murrumbidgee catchment (Image: Murrumbidgee CMA)

An agroecosystem analysis of three Murrumbidgee landscapes

Overview

In Table 1 is outlined an analysis of each of the three zones, irrigation, sheep-wheat belt and the high-rainfall grazing country. The information that is entered under each of five interlinked system properties (profitability, sustainability, economic performance, social well-being and political acceptability) is illustrative of the agricultural features, operating environment and trends in each zone. It is important to appreciate that all five properties needed to be considered from a systems perspective. Quantitative performance indicators are preferred to measure system properties but if they are unavailable or not clear (as in the case of social indicators) each cell in the table can be described and assessed qualitatively. For the three Murrumbidgee zones, perhaps the quantitative measures that are of greatest future interest are the indices of:

- Water use efficiency in food production;
- The efficiency of food production from an energy perspective; and
- In the absence of serious resource degradation (soil, water, air), the state of native vegetation and biodiversity in the catchment.

Water use efficiency is addressed in the table, with benchmarks for grain production and meat production mentioned. Although rice yields are higher per hectare in Australia than wheat and barley, the former crop is grown in summer when daily evapotranspiration rates are as high as 15 mm per day, well above the daily rates during the winter growing season of dryland cereals. On the Tablelands, the industries of lamb or beef production on grazed pastures are comparatively inefficient in terms of water use; however, ruminant livestock do produce human food (meat) from plant materials that are comparatively inedible to humans in a zone where cropping is not possible on a large scale (fragile and shallow soil types, steep terrain, erosion risks).

The efficiency of food production per litre (L) of fossil fuel used in producing the raw food, or per unit (kW) of energy used in transport and processing, is beyond the scope of this review. However, it is important to recall that not until the railways were built (1870s) was it possible to transport grain and livestock from inland NSW to the populated coast. Soon, in an era of 'peak oil', energy use will become a critical issue – it is important now to configure food production and distribution to minimise the use of fossil fuels and energy.

Since agriculture controls the biology of production systems, inevitably it reduces biological diversity in soils and on the landscape. Such reductions do not necessarily constrain agriculture's ability to produce food. However, the Australian community does express concern at the reduction in native flora and fauna. Ecologists point to possible losses of ecosystem resilience if these losses go beyond a certain point, and they emphasise the need for precautions to reduce this risk.

So, in Table 2, the gap between the *agricultural zones*, as they are now (an extreme position, softened by an emphasis on sustainability) and as they could be if managed and conserved as resilient grassy woodlands (the ideal for *environmental landscapes*) is estimated for the irrigation areas, the sheep-wheat belt and the tablelands zone of the Murrumbidgee catchment. The principles and threshold values have been adopted from McIvor and Macintyre (2002). While there is some agreement between environmental scientists and landholders + agricultural scientists in one measure of land use, i.e. the desirability of maintaining vegetative cover to reduce soil erosion (objective 1), there is a divergence between them in the other indicators. This divergence is striking in terms of objective 2 (native grasses vs exotic grasslands, such as using introduced legumes to raise soil fertility and agricultural productivity in the sheep-wheat belt situation, Smith 2000) and in objective 3 (the proportion of the landscape that is devoted to 'intensive', mainly agricultural, land use).

In a world that is facing problems in food production and distribution, the productive zones of the Murrumbidgee catchment will be managed indefinitely for the prime purpose of producing meat, wool and grain. However, it is a 'work in progress' to encourage agricultural scientists and farmers to diminish their domination of landscapes so completely, and so avoid perpetuating:

i. The disdain of many early white settlers for the native people, animals and vegetation of the Australian landscape; and
ii. The traditional "silos" that restrict collaboration between agricultural scientists (degraders) and environmental scientists (restorers).

The reality is that there may be useful conservation, ecological and even agricultural gains to the resilience and amenity of Murrumbidgee catchment if the small proportion of it currently devoted to natural biodiversity was strategically increased by a few percentage points. If the areas converted from production to conservation/amenity were the less productive areas in the landscape (e.g., rocky hills, gullies, soaks, steep hills), modest biodiversity targets could be achieved without necessarily reducing overall production. Careful planning and implementation is needed, since a modeling study undertaken by House et al. (2008) on three wheat belt farms in southern Queensland (two farms) and northern NSW (one farm) indicated that small changes to the production base in order to implement conservation based-approaches can have large potential impacts on farm enterprise profitability.

In the following pages, a contemporary assessment is made of three production zones in the Murrumbidgee catchment, viz. the irrigation area, the sheep-wheat belt and the high-rainfall zone. A fourth zone, the low-rainfall pastoral zone, is not considered.

Managing for production and NRM in the Murrumbidgee catchment

The Irrigation Zone

The first zone is used intensively for agricultural and horticultural production. These industries support a large workforce, at least by rural standards, in production, food processing and the provision of services (farm fertilisers and chemicals, machinery, transport, business services). Like other irrigation centres in inland regions (Shepparton, Renmark-Berri), the city of Griffith (26,000 people) and nearby Leeton Shire (12,000)

Table 1. An agro-ecosystem analysis (production, environment and socio-economic properties) of three Murrumbidgee zones

LANDSCAPE	PRODUCTIVITY	SUSTAINABILITY	ECONOMIC ISSUES	SOCIAL & POLITICAL FACTORS
IRRIGATION AREAS **Comprises several irrigation landscapes including the Murrumbidgee Irrigation Area, Coleambally Irrigation Area, smaller irrigation districts, river pumping and bores**	The irrigation areas of the Murrumbidgee are intensive locations for agricultural production and food processing, with the main activities being rice, cotton, horticultural crops (citrus, viticulture), prime lamb and poultry production, with smaller areas of vegetables, irrigated crops (winter cereals, maize) and cattle feedlotting. Horticultural farms average 130 ha. The average broadacre farm (1250 ha) uses 730 ML water, has 1160 sheep, 117 ha of irrigated crops and 305 ha of dryland crops. Water use efficiency is a key indicator of production efficiency. Improvements to irrigation systems have included reducing leakage from channels, automated water metering, and a switch to pressurized (drip) systems on many horticultural farms. Broadacre ricegrowers now use a crop monitoring protocol called Ricechek (Lacy and Steel 2004), which promotes a multi-factor, co-learning approach to yield improvement. In the rice industry, per hectare benchmarks have improved from 10 tonnes of rice from 15 ML (6.6 kg/ha rice grain per mm of water) to 12 tonnes from 12 ML (10 kg/ha rice grain per mm of water *or* 1 tonne of water per kg of grain). This industry is stabilizing at an average of 800,000 tonnes of rice in the Murrumbidgee and Murray Valleys.	The main sustainability issues are the availability of water for agricultural and environmental purposes, limited diversity in rice farm rotations, the management of wet soils and groundwater, and further improving the water use efficiencies of the total system (canals and paddies). Resistance to weedicides is a problem in rice and dryland crop production. Native vegetation areas probably less than 2% are mainly confined to streams and drainage lines. Until recently, the rice industry supported an Environmental Champions program, concentrating on the retention of residual areas of native vegetation, the ecology of wetland birds, and the conservation of endangered species such as the Bush stone curlew (*Burhinus grallarius*) and the Grey falcon (*Falco hypoleucos*). This program will be redesigned. Federal and State assistance for sustainable agriculture and improving the efficiency of using irrigation water has helped create opportunities for revising irrigation layouts. A core group of producers is establishing tree belts and native vegetation areas.	During the drought years of the 2000s, many growers exited the industry, while others survived only by diversifying and/or selling their water entitlements year by year to other water users (wine grapes, fruit and vegetables, government water buybacks). Rural communities in Griffith, Leeton, Coleambally and Deniliquin have struggled to cope with drought (water availability), free-market competition (imports of juice products) and unfavourable terms of trade (the cost-price squeeze, high $AUD). Ricegrowers and SunRice made several key decisions (mill closures, off-shore processing, alternative grains, cotton) to cope with reduced production during the drought years, and the industry is now profitable. Viticulture/wine-making and citrus/juicing industries are adjusting to the difficult conditions and the recent trend towards a lower $AUD will bring relief.	There has been considerable grower and community anxiety and frustration in relation to the restricted availability of water. Population decline rates are higher in the irrigation areas than in the sheep-wheat belt – there is a considerable exit of school leavers from the area. The rice and cotton industries, in particular, battle metropolitan attitudes that do not understand the economic and social advantages of maintaining agricultural & processing industries in rural areas. **POLITICAL ACCEPTABILITY** The irrigation industries are significant employers. Growers claim an historical right to water. State and Federal Governments were taken aback by the ferocity of community inputs into the water debate and there has been compromise and partial resolution of the water allocation issues between and within States.
LANDSCAPE	**PRODUCTIVITY**	**SUSTAINABILITY**	**ECONOMIC ISSUES**	**SOCIAL & POLITICAL FACTORS**
SHEEP-WHEAT BELT **Includes the following landscapes: Riverina, Mid-Murrumbidgee, South-West Slopes**	In Australia in 2010-11, the average farm in the sheep-wheat belt comprised a total of 2420 ha with 771 ha sown to crops (principally wheat), 1519 sheep and 146 cattle – these statistics have remained static over the past five years. The Southwest Slopes and Plains were regarded as amongst the safest and most progressive farming districts in Australia but farmer confidence was shaken by droughts in the last decade. Farmers operate a mixed farming system (grain production + livestock, chiefly prime lambs). The main farming rotation now comprises cycles of wheat alternated with canola, with smaller areas of pulses and barley, followed by a pasture-livestock phase based on lucerne and/or subterranean clover pastures. The efficiency of wheat production has steadily improved towards 2 t/ha in average years (1.5 t/ha during a run of dry years in the mid-2000s). A target benchmark is 15 kg/ha wheat grain per mm of growing season rainfall (= 0.66 tonnes of water per kg of grain). Average productivity of sheep meat per	At one stage, weeds, root rots and soil acidity threatened crop production, while heavy tillage created hard pans in the soil profile and summer fallowing exposed valuable topsoils to erosion by water and wind. Herbicides, minimum tillage, liming and break crops have collectively improved the sustainability of wheat production. The predicted occurrence of salinity in groundwater discharge areas was offset by the use of lucerne, deeper-rooted annual pasture legumes and healthier crops. On the other hand, cropping options are still too few and the over-use of herbicides has led to herbicide-resistant weeds. The grains industry is sensitive to price shifts in the cost of essential inputs such as fuel and fertilisers (nitrogen and phosphorus), and the cost of transport to export markets. Climate change exacerbates the inherent production and marketing risks inherent in crop production. Substantial research investment, private and	Until recently, land values have increased over time. However, farmers' terms of trade have continued to squeeze profits. More than 50% of low-medium cropping intensity properties in the sheep-wheat belt recorded a negative farm business profit (as defined by ABARES) in each of the five financial years, 2006-07 to 2011-12. Farm debt is now at seriously high levels, averaging more than $500,000 per farm). Compared with the livestock enterprises on mixed farms, the crop enterprises are potentially more lucrative but also more risky.Climate change will increase the riskiness of cropping, driving mixed farms towards increasing the livestock component of their business. There are minor incentives to producers for agri-	Since World War II, there has been a steady drift downward in terms of the number of farms, the size of farm families and the population of most rural communities. A corresponding increase has occurred in the size of farms, which average 2000-3000 ha in the southern NSW sheep-wheat belt. Quality farm labour is in short supply due to isolation and the inability to compete with salaries offered to workers in other industries such as the mining industry. Investment in improved labour-saving equipment is essential but potentially expensive. Information on the physical and mental well-being of farmers is largely anecdotal and sporadic but there is evidence of considerable 'wear and tear', including depression. Dry years have exacerbated these ageing and health problems but some progress has been made towards solutions. Reliable statistics on well-being are needed. Many farms have been sold to corporations – there is some anecdotal evidence of their leaning towards 'industrial agriculture' and more is

	ewe is perhaps half of the productivity of the best prime lamb producers in the high rainfall zone further east, due in part to a lower standard of livestock management. Livestock stocking rates 2 to 6 dry sheep equivalents per grazed ha on mixed farms. Farmers are frustrated by the complexity of managing mixed farms.	public, sustains these production systems. However, progress is incremental rather than in large leaps, and the research force is waning. Wheat growing areas have less than 2-3% biodiversity, revegetation plantings are few and paddock trees are entering 'old age'. Some clearing is being undertaken to facilitate the operation of modern cropping machinery.	environmental schemes that are designed to demonstrate or encourage better natural resource management and the conservation of native habitats – these schemes are commonly administered through Catchment Management Authorities or Landcare groups.	needed. **POLITICAL ACCEPTABILITY** In 2009, a decision was made to abandon the single-desk marketing of wheat by the Australian Wheat Board and wheat growers/industry are still adjusting. Drought assistance is in the process of reform, in part to manage climate change variability.
LANDSCAPE	**PRODUCTIVITY**	**SUSTAINABILITY**	**ECONOMIC ISSUES**	**SOCIAL & POLITICAL FACTORS**
HIGH-RAINFALL GRAZING ZONE **Includes the following landscapes: South-West Highlands, Tablelands, Capital, Monaro**	Forestry is a feature of this zone but livestock grazing (sheep for wool, sheep and lambs and cattle and calves) are the staples of agriculture. Since 1975, Australia-wide sheep numbers have fallen from 175 million to less than 70 million, reflecting the demand for wool and sheep meats; cattle numbers have edged up. The livestock population of the high rainfall zone of the Murrumbidgee catchment has fallen by a similar amount but individual livestock performance (per ewe or per cow) has improved. Key performance indicators include stocking rate (dry sheep equivalents per ha), lambing and calving percentages (towards 100%), the proportion of lambs, vealers or steers that reach a marketable liveweight per season or age, and the weight and quality of wool (4.5 kg/head) and quality parameters produced per head and per hectare. Livestock stocking rates average 6 to10 dry sheep equivalents per grazed ha on specialized livestock farms, depending on rainfall, soil type and the areas of improved pastures. A target benchmark is 0.5 kg/ha meat per mm of rainfall (20 tonnes of water per kg of meat).	Lower sheep numbers and better landscape management have reduced soil erosion rates, which were once unacceptably high. Despite a history of topdressing pastures with superphosphate, many pastures are still deficient in P and S, restricting the growth of both legumes and grasses. Most soil types are prone to soil acidity and require liming for the production of sensitive pasture species. Some pastures are over-fertilised, so soil testing (pH, P, P buffer capacity) is desirable. Phalaris and subterranean clover are the most useful improved species in districts with annual rainfall of 550-800 mm. Native perennials (red grass, wallaby grass) persist with low-moderate levels of superphosphate and appropriate grazing management. Groundwater recharge is excessive under annual pastures, potentially leading to soil salinity in the drier western slopes. Areas of biodiversity are variable, ranging from up to 30% in targeted localities, but native woodland vegetation in many areas is less than 10% of the total area.	Production of medium-strength wool from Merino and crossbred sheep is unprofitable but fine wool flocks, first cross ewes and meat sheep sires are currently in strong demand, reflecting the return to profitability of prime lamb production (demand>supply). A decade of drought during the 2000s restricted production and profits, causing a rethink on managing 'exceptional circumstances' but the last three years have been more normal. Farm business profits range between -$100,000 and + $150,000 per farm. Many landholders have off-farm interests and alternative sources of income.	Most experienced farmers in this zone are excellent managers of livestock. Their average age is creeping up, with many children of farmers exiting the industry. Many farm families lack a plan for succession or exit. It is difficult to find good-quality labour for seasonal peaks in farm operations. The occurrence of Johne's Disease was poorly managed, contributing to disillusionment amongst graziers in this zone in the early 2000s. There are few statistics available concerning the social attributes of farmers, especially their well-being and attitudes – improved information on social factors is an industry need. A major trend has been the development of hobby and lifestyle farms, especially in and around the ACT. These farmers have different attitudes, values and networks to traditional farmers. 'New' farmers also bring new approaches Mendham et al. 2012). **POLITICAL ACCEPTABILITY** In these areas, the electorate comprises diverse stakeholders and people are motivated by many issues rather a single issue. Moderate land use policies are likely to find favour. Farmers and conservationists have found some common ground, tolerance and understanding. The wool industry is sensitive to groups like PETA.

Table 2. Management principles and thresholds defined by McIvor and McIntyre (2002) for managing temperate grassy eucalypt woodlands for resilience, compared with probable actual NRM values in the irrigation, sheep-wheat (slopes and plains) and high-rainfall grazing (tableland) agricultural zones of the Murrumbidgee catchment, southern NSW

Management principles	Theoretical threshold for resilience	Actual, irrigation zone	Actual, sheep-wheat zone (400-600 mm)	Actual, tableland zone (600-900 mm)
1. Exposure to bare ground	<30%	<30%	<30% (was 50% in 1960)	<30%
2. Native grass content	Up to 60-70%	<5%	<5%	40%
3. Extent of intensive land use	<30%	97%	>95%	40-75%
4. Woodland or forest cover	30%	3%	<5%	<20%
5. Size of woodland patches	Min. of 5-10 ha per patch	Median <5 ha, no large patches	Median <5 ha, few large patches	Median <5 ha, some large patches
6. Core conservation areas	At least 10% of property	0-2%	0-5%	5-10%

are the headquarters for a range of national brands such as Casella, De Bortoli, McWilliams and West End wines, Bartters and Baiada fresh and frozen chicken products, the SunRice and Coprice range of products, and several smaller plant or packing houses producing a range of fresh fruit and vegetables, juice and other products.

Threats to these industries, whether they be a consequence the climatic, biological, economic or political environment, are taken very seriously by communities inside and nearby this zone, as the Murray-Darling Basin Authority (MDBA) found out to its cost in the lead-up to the MDB Plan, passed by the Australian Parliament in 2012. The MDBA is now getting on with implementing the plan to maintain a healthy river system by recovering 2,750 GL through a combination of more efficient irrigation infrastructure (600 GL, including 450 GL through on-farm water use efficiency projects) and water buybacks. The amount of water already recovered is 1,590 GL.

The Australian Government is assisting irrigators to revise and update their irrigation layouts, creating opportunities for environmental initiatives on farms such as planting tree and shrub belts for biodiversity, and creating wetland areas for water life. Most horticultural farms retain little or no native vegetation but contribute towards carbon (C) sequestration in the form of citrus trees and grape vines and have converted their former furrow irrigation layouts to drip-lines. Almost all broadacre farmers have ~100 ha of rice if sufficient water is available (Table 1). These larger farms come under the influence of the Ricegrowers' Association (RGA)[2] which is sensitive to the public image of their industry. The cotton industry, also sensitive to its public image, has an increasing footprint in the Murrumbidgee and lower Lachlan valleys; information on the management of riparian zones and native vegetation is coordinated by the Cotton Catchment Communities CRC and allied organisations.

In the Murrumbidgee and Murray Valleys, RGA has sponsored an Environmental Champions Program since 2001; a program that embraces nine key management pathways – water, soil health, biodiversity, chemical management, air quality, farm planning, product quality, farm risk and environmental services. The program was run with a participative approach involving local cluster groups of 5-10 farmers, who worked towards stepped levels of achievement, ranging from Level 1 (Basic industry standards) onward to higher levels of achievement, such as Level 3 (Implementing actions) and Level 5 (Regional efforts towards catchment sustainability). This program has been more successful in the Murray Valley through support received from the Murray CMA than in the Murrumbidgee catchment, where it has not been supported financially by Murrumbidgee CMA. However, activities in the Murrumbidgee have been ongoing, with farm planning services and incentives available from Murrumbidgee Irrigation Ltd and, to a lesser extent, the Murrumbidgee CMA.

Until June 2013, a part-time Regional Landcare Facilitator with Murrumbidgee Landcare Inc. (MLi) was located at Leeton – recent activities included two field days on the theme "Biodiversity in the house paddock", producing a PlaceStory to raise the awareness of the Australasian Bitten (a heron-like bird that inhabits rice paddies, feeding on aquatic animals and crustaceans), and helping with the 'Water for wildlife in the Riverina rangelands' project. The Murrumbidgee component of the program received recognition in the 2011 and 2013 Landcare Awards organised by Murrumbidgee CMA and supported by MLi.

So, the irrigation areas are primarily food bowls but sound protocols are available for native flora and fauna management. A continuation of an ECP or similar program will be a shared initiative of RGA and Riverina Local Land Services (the successor to Murrumbidgee CMA in January 2014). The program will form part of the duties of an Extension Coordinator employed by RGA with funds from the Rural Industries R&D Corporation and support from NSW DPI and the Riverina LLS; it will receive some support also from the Regional Landcare Facilitator hosted by MLi. Hence, the operating framework (protocol, industry involvement) for NRM is in place for the future but it needs to be properly funded, staffed and guided. Opportunities for linking townspeople, horticultural farms and cottongrowers into NRM should be explored. The preferred approach could draw on the Community Partnerships activity of the Riverina LLS and/or the participative operating model of Landcare.

The sheep-wheat belt

In contrast to the irrigation zone, where farmers have a direct relationship with industry associations, mixed farmers (crop and livestock production) in the dryland sheep-wheat zone of southern NSW belong to an industry

[2] Most broadacre irrigation farmers are ricegrowers who also grow winter crops and produce prime lambs

that is more fragmented, in part due to splits both between these enterprises (pastures/livestock vs crops) and within them (for example, cereals and oilseeds). The loss of industry structures such as the Australian Wheat Board and, more recently, a reduction in frontline production advisory services offered by NSW DPI, has not helped industry unity. Another division is between the dominant farm family model of operating farm and several relatively new models involving large-scale farm investment and/or ownership, such as farmland/agricultural investment funds (capital supplied from individual and institutional investors) and farming corporations (Australian and foreign ownership). The global cost/price squeeze and food security concerns are driving the increasing scale of both family farms and corporate farms. Locally, farm ownership by 'outsiders' is a controversial subject that arouses considerable concern, notably where grazing country is converted to crops, fences are removed, and management intentions are obscure; especially with respect to landscape and resource stewardship. Government policies are unclear. The ultimate economic success, social impact and NRM implications of the new business models are uncertain.

One source of continuity is the Grains Research and Development Corporation. GRDC is a big investor in research services for the cropping industries, and it supports a range of activities to extend the findings from research to growers. GRDC is a strong advocate of 'sustainable agriculture' but it is essentially neutral in terms of NRM; it supports a public-private model of research that favours 'big business' in agriculture, a model that possibly undermines the resilience of agriculture (Heinemann et al. 2013).

However, Australia-wide and regionally, the mixed farming system appears to be falling behind crop productivity improvements in worldwide farming systems, possibly due to a shortage of nitrogen, both biologically fixed and fertilizer-N (Angus and Peoples 2012). Furthermore, the majority of mixed farming businesses are underperforming with more than 50% of farm families under financial (partly documented) and emotional (largely undocumented) stress. The Australian industry falls short of world environmental standards in biodiversity in cropping belts such as those in Canada and certainly in Great Britain, each of which are in the world top ten in grain production (annual wheat+barley+rapeseed production over the last 5 years = 46.8 Mt for Canada, 23.7 Mt UK and 30.0 Mt Australia). Furthermore, the diversity of the Australian pasture-crop rotation itself is threatened due to the 'specialise or diversify' conflict – farmers would like to gain scale and specialize in crop production but they are held back by nitrogen limitations and weed problems (the array and frequency of herbicide-resistant weeds are increasing). This conflict is perhaps at the heart of the slow strangulation of the sheep enterprise on Australian mixed farms, since mixed farming is complex and the sheep enterprise is less 'glamorous' to young farmers. Sheep (wool and lamb) production is less lucrative in high-rainfall years, it is more labour intensive, involves a year-round responsibility, and it is difficult to enhance productivity by substituting capital for labour. On the other hand, sheep represent less of a financial risk in poor years and there are many synergies and complementary features between the pasture-livestock enterprise and the cropping enterprise (Wolfe 2011).

In 2013, farmers in the sheep-wheat belt devote a low level of effort to NRM. There was a surge of interest in Landcare in the late 1980s and 1990s, at a time when Australia faced severe land degradation, salinity and erosion, prompting Prime Minister Bob Hawke to make an ambitious pledge (1989) to plant a billion trees during the next decade. Although this vision seemed over-ambitious, more than 700 million trees were reportedly planted before the government lost the 1996 election and the program was scrapped. Since then, interest in Landcare has waned: the land degradation threat has diminished, farmers are concentrating on their business priorities, and in NSW there has been a shift in funding and 'power' from community Landcare towards CMAs. Currently, the much-touted Carbon Farming Initiative of the Australian government has struggled to create interest amongst mixed farmers, who see the carbon tax and CFI as complicated distractions that feed various bureaucratic empires. Most farmers now respond to NRM by mentioning "it is hard to be green when you are in the red".

There are some notable exceptions to this apparent inactivity. A focus by Murrumbidgee CMA on specific wheat belt farms, either because they were located strategically or were managed by farmers aware of the possibilities of NRM, has yielded some good outcomes. One example is the "Boorowa Flats" (Flanery partnership) development at Galong NSW, where financial support from the Murrumbidgee CMA, a dedicated Natural Resource Officer employed by Murrumbidgee CMA, and an active Harden-Murrumburrah Landcare Group has helped transform the property to showcase agriculture and NRM (80,000 trees have been planted). At Binalong nearby is "Glenroy" (Henderson family), which has been transformed since 2000 with sympathetic management and 20,000 trees.

On the 370 ha Lindner farm "Lindoris", which sits astride the Malebo Range, a series of hills approximately 5 km west of Wagga Wagga that run north from the Murrumbidgee River towards Coolamon, 16,000 trees have been planted since 2000 on an area of 66 ha set aside for native vegetation.

Furthermore, a Grassy Box Woodland project coordinated by MLi and involving Kyeamba and Tarcutta Landcare groups has now, with Caring for our Country (CfoC) and NSW Biodiversity Trust funding, extended cross-property planning into mixed farming country east of Junee until 2016/17.

Overall, there is a sound case, based on ecological, aesthetic and functional grounds, for greater investment in NRM in the sheep-wheat belt. Even in the best wheat belt locations in the Murrumbidgee catchment, there are pockets of country (paddock corners, rocky ridges and riparian zones) that could be withdrawn from production without having a serious consequence on total agricultural production. Groves of natural vegetation on these sites would not only offer livestock shelter and reduce soil erosion but could enable the buildup of useful bird and insect life that may reduce insect pressure on crops, improve the hydrology of landscapes, create visual interest in the landscape, and sweeten the life of farm families.

Furthermore, climate change projections indicate the increased likelihood of severe storms occurring in coastal communities and drought disrupting the reliability of crop production inland. Thinking globally, it is now an urgent task to counter the greenhouse effect by converting airborne CO_2 into fixed carbon. Regionally, it makes sense to scale back modestly crop production in the wheat belt, at least on risky paddocks, and increase legume-based pastures, wool and lamb production, and re-vegetation and conservation efforts. In the interests of improved animal husbandry in a more extreme climate, it would be prudent for livestock managers to increase the numbers of shade trees in farm paddocks.

Overall, progress can be made in increasing native vegetation and carbon sequestration without a significant sacrifice of food production capacity in the sheep-wheat belt. Opportunities for carbon sequestration need promotion. Strategically located properties could be purchased and converted to environmental demonstration farms. There is a need to reduce the transaction costs and time that are spent by LLS and Landcare staff in preparing plans and contracts with landholders, and reporting on projects. Together, both LLS and Landcare could cross-promote a more streamlined and broader array of measures, approaches and agreements that encourage, assist and provide incentives for rural landholders to be engaged in NRM. Landscape stewardship champions should be rewarded. 'Win-win'solutions are possible.

The high rainfall zone (Tablelands)

In recent decades there have been two major trends in this zone, trends that have been charted by Behrendt and Eppleston (2011) for the Central Tablelands – the situation further south is undocumented but these same trends are evident. First, stocking rates on properties have fallen overall, in part reflecting a reduced imperative to produce livestock, with a correspondingly greater appreciation of land capability and emphasis on enhancing the sustainability of agriculture (Table 1). These reductions in stocking rate were primarily a readjustment in the sheep industry following the collapse of the wool industry price support scheme; cattle numbers have not fallen.

Second, there is increased competition for the grassland resources that exist in this zone, competition that comes from not only from traditional and 'new' livestock producers who seek increases in scale but also from a range of 'blockies' or 'hobby farmers', who seek land "for its amenity value and its use for lifestyle purposes, biodiversity and broader catchment values" (Behrendt and Eppleston 2011). The significant blockie influence has also been mentioned by Morrison et al. (2008), who surveyed farmers in five areas in NSW (2), SA (1) and Queensland (2). They defined:

- Three types of mainstream farmers - mainstream but not well connected (23.2% of the sample), quality operators (24.2%), and profit first operators (24.2%); and
- Two types of hobby farmers – small, disconnected hobby farmers (19.4%), and high-end community-minded hobby farmers (8.9%).

At the time of the survey, both the mainstream disconnected and the hobby farmer disconnected segments (overall more than 40%) had very low participation rates in terms of their engagement with organisations that provide information on agriculture and NRM.

Due principally to the efforts and influence of high-end community-minded hobby farmers and adjoining graziers, supported by NRM organisations, there have been profound NRM enhancements in the Capital landscape surrounding the ACT, from Yass in the west, around through Murrumbateman to the Kings Highway through Bungendore and Braidwood, and from Queanbeyan to Michelago. I can remember as a boy, when the train stopped at Bungendore, one looked out on a landscape of grassland; now, the grassland areas are almost obscured from view by belts of trees and shrubs. Part of the credit for this peri-urban development also to the operating model of the ACT NRM Council, which supports and funds the activities of four urban/peri-urban catchment groups: Ginninderra, Southern ACT, Molonglo and Greening Australia. These groups operate according to the participative model that also characterises Landcare.

Widespread native grassland and woodland conservation does not extend much into the agricultural grasslands of the Monaro landscape, but organisations such as Kosciuszko to Coast have a clear presence. Over the last two years, K2C partnered with Murrumbidgee CMA and MLi to conduct a Monaro Connectivity Project (CfoC funds), which:

- Engaged over 80 land holders across the Monaro region, signing up 13 landholders for funding for fencing, plants or weed control, and established 3 protective exclosure sites;
- Provided an Indigenous interpretation on over 60 properties by Rod Mason, a popular Traditional Land Manager, who has co-written a booklet on traditional land management practices (Mason et al. 2012) and guided Monaro landholders through 3 cool patch demonstration burns;
- Published 6 PlaceStories, sent out 4 newsletters, and provided 37 properties with species lists.

In the Tablelands zone, there is a tolerance for a variety of land management approaches, ranging from high-productivity pastures to native pastures, from evidence-based agricultural principles to holistic and other alternate management prescriptions, and from grasslands to woodlands. Furthermore, there are landowners who successfully combine production agriculture with NRM conservation, During the four years of a regional CfoC project to 2012/13, Murrumbidgee CMA achieved the following advances throughout the catchment: ~2000 ha of native vegetation protected by way of landholder incentives, ~16,000 ha of priority native vegetation managed through Property Vegetation Plans, ~13,000 ha of protected habitat, ~7,000 ha classified and secured as Endangered Ecological Communities, and increasing connectivity through ~1,000 ha of newly planted vegetation. However, there are still some remarkably barren-looking landscapes, such as many of the views around Gundagai. Fortunately, even here, near the junction of the Tumut and Murrumbidgee Rivers, is a successful CMA-Landcare partnership that has implemented the Tarabandra Hills Box Gum Biolinks Project to connect ‘rivers to ridgelines’ in these hills. Participating landholders and helpers have so far revegetated 47 ha of native habitat, planted 21,000 trees and erected 18 km of fencing to prevent stock access. Benefits have come from providing shade and shelter for livestock, improved water quality by restricting access to waterways, and increased land prices.

Conclusions

What does all of this mean for the future of agriculture and NRM in the Murrumbidgee catchment? This question should be of concern to metropolitan people, too, who depend on farmers for high-quality food and important environmental services (sustainable landscapes, improved water quality, carbon sequestration, biodiversity).

In the irrigation zone, it will be essential for the LLS bodies and Landcare to work with producer organisations in the rice and cotton industries in order to achieve greater areas of native trees and shrubs, to provide habitat for specific and threatened wildlife, and to create and maintain viable wetland areas. I advocate modest objectives in this prime food-producing zone – maintain an awareness of the need for NRM and to support industry sectors in promoting their environmental image.

In Tableland environments, good progress with NRM has been made. One of the main future targets should be land management in peri-urban communities, to increase native vegetation and also reduce the potential to

harbour agricultural weeds and pests on hobby farms. The almost complete inclusion of the peri-urban belt surrounding of the ACT in the South East LLS presents an opportunity for a coordinated approach, especially if the South East LLS aligns this activity with the participative model of the ACT NRM Council and its constituent groups. Hobby farms, which also occur around major regional centres in the Riverina (Wagga Wagga), present a marketing problem (Morrison et al. 2008), since many of these landholders do not have links with traditional livestock or NRM networks – they are more oriented towards their professional, trade and recreational interests (e.g., pony clubs, dirt bikes). Another important target on the Tablelands areas that have only scattered remnants of native vegetation – groups such as Kosciuszko to Coast and the Tarabandra Hills consortium have shown what can be done in these spaces.

In the sheep-wheat belt, a coordinated effort is needed with the leading organisations that service farmers to create greater NRM awareness, to foster commitment to NRM and to provide a broader array of incentives for NRM activities. Cross-property planning to develop belts of native vegetation and wildlife corridors is a proven Landcare approach that builds NRM capacity in communities and achieves results. Targeted financial assistance to landowners – a CMA approach – is also a successful approach in increasing the area of native vegetation but it lacks community engagement and an extension impact. Additional gains could come from strategies to encourage active participation in rural re-vegetation and landscape restoration, from rate relief for private areas of native vegetation to automatic fines for environmental violations.

Overall in the Murrumbidgee, NRM is a work in progress! There is a range of players but more effective partnerships must be fostered between LLS authorities, Landcare, farmer groups (Farmlink), agribusiness (banks, mechandisers) and conservation organisations. The conduct of programs needs to be flexible and responsive to the requirements of the people who are doing the work. A shift in focus is needed from inputs to outputs (how-to manuals, guides, resources and services) and outcomes (attitudes, activities, achievements). A strong Landcare NSW will be a big help to regional Landcare.

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