Futures

Review of farmer initiated innovative farming systems

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Executive summary

An early step …

The critical state of Australia's natural resources is now widely acknowledged. The situation is discussed publicly through the media and by those more directly concerned with resource management and associated research.

It is now timely to direct effort to the process of designing resource management systems that are sustainable in our unique Australian landscape and climate. This will require a combined effort and the formation of partnerships between government, resource managers, researchers and taxpayers (Williams 2001).

This project, *A Review of Farmer Initiated Innovative Farming Systems*, is an early step in the process of establishing communication and partnerships between innovative farmers, researchers and other resource managers. The project is part of phase 2 of the Land & Water Australia program, Redesigning Agriculture for Australian Landscapes (RAAL).

The review of farmer initiated innovative systems has been conducted on a case study basis. Case studies were selected for a range of criteria, including the ability to impact on water and nutrient balance. Case studies identified throughout Australia were visited and interviewed by project officers. The information collected was analysed on a technical and non-technical basis and used to make a series of recommendations.

Important conclusions

A number of important conclusions can be drawn from the information gathered during this process.

- There are few innovators developing new systems or making fundamental changes to existing systems.
- With a few exceptions, innovators are not implementing practices that are sufficiently systemic to deal with issues of sustainability at a landscape scale.
- There is a strong focus on soil health and water management.
- An interest in natural systems and a reduction of inputs was common.
- Innovators are constrained by a lack of institutional support frameworks.
- Practically all innovators studied derived income from a variety of agricultural and non-agricultural sources.

The technical analysis conducted on a representative sample of case studies demonstrated that these innovative systems are capable of addressing a range of sustainability issues, including water and nutrient balance, soil erosion and biodiversity loss. The systems reviewed were isolated, generally small in scale, and focused at the farm level.

The modelling indicated that there may be trade-offs in terms of crop yields, production and financial returns. The results of the study indicate, however, that the innovative farmers who participated in this review are, in many cases, prepared to accept these trade-offs as the process of innovation was seldom driven by production or financial goals alone.

The impacts of these innovations on broader sustainability issues are limited but they can provide useful direction for further research and development and for the process of designing resource management systems that are appropriate for the Australian landscape.

Recommendations

The process of conducting this review, interviewing a broad range of innovators and considering and analysing the results has led to the following recommendations.

We recommend that:

(1) National, state and regional programs to improve natural resource management should be designed to
  - encourage continuous holistic/whole system (rather than partial) improvement in natural resource management
  - enable catchment and sub-catchment priority-setting to meet the required outcomes

   - enable diversity and innovation in the strategies employed to achieve improvement in natural resource outcomes

(2) Land & Water Australia undertakes an assessment of the need for alternative views to be heard and further developed in relation to what constitutes soil health and of what strategies might best be employed in the search for practical means of improving soil health

(3) Land & Water Australia considers the need for an assessment of the breadth and adequacy of the available professional expertise in relation to soil health

(4) Land & Water Australia continue to support the current research effort on biomimicry and address the need to improve the knowledge base within the broader Australian agricultural community through a targeted communication effort

(5) the eclectic mix of experience and understanding held by the case study innovators should be harnessed in non-threatening environments so as to inform the design of further research and development and to provoke further insights from the innovators

(6) ways be devised to ensure that innovators have an opportunity as a group to contribute to the development of policies and strategies at the catchment or sub-catchment level

(7) with a view to informing the institutional arrangements necessary to facilitate improvements in natural resource management, Land & Water Australia reviews the drivers of innovation that may lead to fundamental change in how people use and impact on rural landscapes;

(8) Land & Water Australia considers the advantages and disadvantages of establishing a Centre, Institute or Network for Rural Landscapes, the principal purpose of which would be to provide leadership and support for innovators in rural landscape design and resource management

(9) as soon as possible, a national workshop or similar process be conducted to provide:
   - network support for the key innovators identified by this study (and possibly others)
   - input from innovators into the nature of institutional support best suited to facilitate innovation
   - input from innovators in relation to the best way to evaluate the likely impact of on-farm innovations
   - input from innovators into determination of strategies that enable innovators to contribute constructively to the development of catchment targets and strategies

(10) some effort be directed into developing and applying a design framework to the process of Redesigning Agriculture for Australian Landscapes

(11) Land & Water Australia
   - produce an electronic or video version of selected case studies and recommendations in this report for a stand-alone presentation and for inclusion in a broader RAAL communication package
   - develop a television program, possibly with the support of the Australian Broadcasting Corporation (ABC), presenting and examining stories of innovation in resource management.

Enjoy the earth gently
For if the earth is spoiled
It cannot be repaired
Enjoy the earth gently.

Yoruba poem, Nigeria

Acknowledgment

This review was funded by Land & Water Australia through the Redesign of Agriculture for Australian Landscapes Program.

Introduction

This report

This report — “A review of farmer initiated innovative farming systems” — was prepared by LPM Creative Rural Solutions and Synapse Research and Consulting. It forms part of phase 2 of the Land & Water Australia (LWA) Redesigning Agriculture for Australian Landscapes (RAAL) Research and Development Program.

RAAL was initiated in 1996 to explore how agricultural systems in Australia can be redesigned to address a range of sustainability issues. Phase 1 of the RAAL program (1997–2000) identified broad principles necessary to redesign agricultural systems and phase 2 (2000–2002) examined the basis for a range of redesign options capable of being implemented in priority landscapes.

The aim of this project is to identify and assess a range of innovative farming systems being trialed or implemented by farmers across Australia. The opportunity exists for both innovative farmers and researchers to benefit from the exchange of information that will be provided by the project.

Innovative farmers were identified and interviewed and six were selected for more detailed biophysical assessment.

The gathering of the information and the technical and non-technical assessments have been documented as case studies and recommendations made as a contribution to the process of redesigning agriculture of Australian landscapes.

Background

Resource management — past, present and future

Resource management in Australia is a story of unique achievements, while at the same time a demonstration of inappropriate development resulting in massive resource degradation. We have developed farming systems based on European heritage and knowledge without sufficiently considering the consequences in the vastly different environment of this land.

This lack of harmony has enormous implications and Australians are now beginning to realise that they have built an agricultural sector at immense cost to their natural capital — and that this agricultural sector is not sustainable.

Resource degradation in Australia covers wide range of problems — salinity; soil erosion and degradation; river degradation and pollution; ocean pollution; and biodiversity and habitat loss. The extent of these problems is now well documented.

The extent of land degradation

The recent publicity given to the problem of salinity has amply demonstrated the extent of land degradation. Alex Campbell, the chairman of the National Dryland Salinity Program, stated recently that about 5.7 million ha of land in Australia is in danger of being affected by salinity. If sustainable solutions cannot be found, the affected area could treble to 17.1 million ha in the next 50 years (Weekend Australian, 1 October 2000).

Nutrient loss is another issue of major concern. The Commonwealth Scientific and Industrial Research Organisation (CSIRO), in their recent publication, Sustainable agriculture — assessing Australia's recent performance, conducted an audit of phosphorus (P) and potassium (K) balance. They concluded that potassium levels are being depleted in all cropping areas while the phosphorus balance varies. Phosphorus levels are low and remaining so in northern Australia, being depleted in the major cropping zones, and increasing in the temperate pasture lands of southern Australia (CSIRO 1999). The overall picture is a nutrient-poor land becoming further depleted except for areas where expensive external inputs are maintaining the balance. High levels of acidity and sodicity occur naturally in many Australian soils and current farming systems and practices are increasing the level of soil acidity.

The historic and ongoing loss of biodiversity is seen by many observers as Australia's most serious environmental problem (Williams 2001). The most severe losses are in the agricultural zones where loss of habitat through land clearing, chemical use, introduction of exotic species, grazing and a host of other practices is continuing.

Agriculture occupies 60% of the landmass of Australia but the effects of agriculture cover the entire country. These impacts include contamination and pollution with farm chemicals, loss of biodiversity, soil erosion, and salinisation of streams. The Great Barrier Reef Marine Park Authority, responsible for monitoring the health of the Great Barrier Reef, states that agriculture in the coastal zone is one of the main activities impacting on the reef. Agriculture impacts on fisheries, tourism and environmental amenity values in general (NFF/ACF 2000) and the costs of these must be shared by the entire community.

An enormous research effort has been, and is being, directed at understanding the impact that agricultural practices are having on the natural resource base. This understanding, while it needs to continue to be developed, has now reached a level where new strategies can be developed and a future direction for Australian agricultural systems can be conceptualised.

In a world context, the Australian experience is not unique. Heinrich Wohlmeyer, in a book titled *Eco-restructuring: the implications for sustainable development* (Wohlmeyer 1998), has this to say about world agriculture:

> Mainstream agriculture is now increasingly considered to be not sustainable. There is overwhelming evidence that 'efficient' (industrial) agriculture is not only mining the natural resource base but also influencing other parts of the environment in ways that are detrimental to the well-being of human kind.

However, the naturally poor nature of Australian soils may have ensured that the detrimental effects of industrial agriculture have become apparent over a shorter time span and on a more dramatic scale than elsewhere. This provides Australia with opportunities to develop solutions and appropriate agricultural techniques that may be applicable globally.

A more sustainable future

The problems of resource degradation are obviously massive and are now comprehensively documented. These problems cover a range of issues including social, cultural, spiritual, economic and biophysical. In order to address these problems, Australians will need to work together at all levels — urban and rural, farmer and researcher, community and government. As John Williams (2001) says,

> Partnership between government, businesses, community sectors and scientists can, I believe, build a better future for regional Australia by developing farming that does not harm the environment.

The establishment and maintenance of these partnerships will play a crucial role in the development of sustainable resource management systems in the future. Planning and design are also important steps in developing farming systems that do not harm the environment. Each of these steps requires understanding, communication and commitment.

The RAAL program aims to address a number of these issues through a series of associated projects with input from researchers, farmers, government and other support services. The development of a targeted communication package is also part of the RAAL process.

One of the key objectives of the RAAL program is "to develop a tool box of redesign options to modify current, or develop new, systems for Australian landscapes".

As part of a design process, the Review of Farmer Initiated Innovative Farming Systems can play a key role by providing and presenting information and models on innovative systems and the process of innovation itself. The project will also contribute to the development of partnerships between farmers and researchers and will begin the wider process of communicating the benefits of a range of innovations.

Methodology

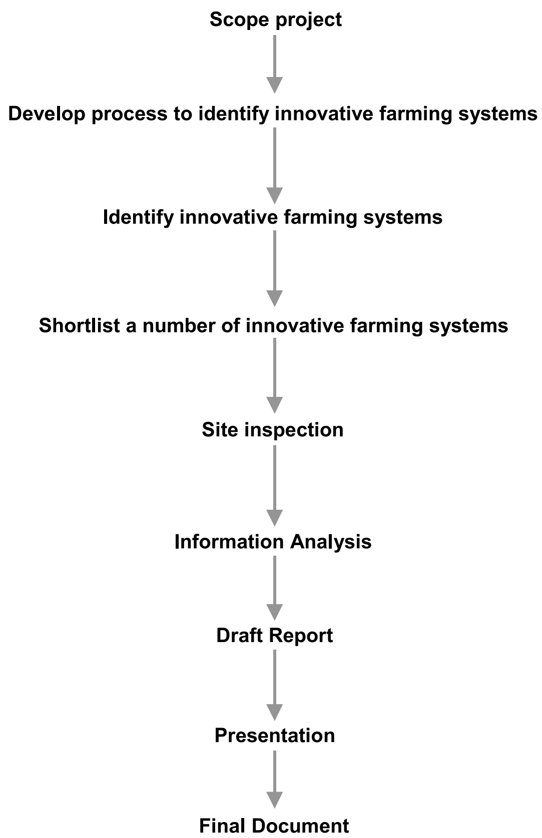
Objectives

The objectives of the Review of Farmer Initiated Innovative Farming Systems project are to:

- identify innovative farming systems being trialed or implemented by farmers in key agro-ecological zones of Australia
- conduct a broad assessment of each system for its capacity to address sustainability issues, including the control of deep drainage and nitrogen leakage problems.

Methodology

The following is an outline of the methodology used to conduct this project.



Development of a process to identify innovative farming systems

A five-phase process was adopted as described below.

1. **Develop criteria for the selection of innovative farmers**

   The following criteria were developed as the basis for selection of the innovative farming systems to be studied. The criteria are based on the terms of reference and developed through project team discussions.

   Criteria for selection of innovative farming systems:

   – *water and nutrient balance* — systems will need to be likely to have some measurable or significant restorative impact on water and nutrient balance — direct or indirect, on or off-site
   – *vertical integration* — the extent of linkages along the product chain of the agricultural component of farming systems
   – *horizontal integration* — the extent of linkages between farms of the same or similar farm-based agricultural enterprises
   – *cultural practices* — the nature of the agricultural component of the farming system, eg. cultivation, no-till, organic, rotational, biomimicry etc.
   – *agro-ecological zone* — reflecting the need for a spread across a range of zones. A map compiled by the Bureau of Resource Sciences 1997, in which Australia is divided into 11 agro-ecological regions, was used (Appendix 2).

2. **Characteristics to describe innovative farming systems**

   The following list of characteristics was prepared to form the basis of an information collection and analysis process with the understanding that it would be adapted as the process unfolded.

Characteristics of innovative farming systems:

- *resource characteristics*
  - location
  - climate
  - soils
  - proportion of perennial vegetation
- *water and nutrient balance* — measurement and modelling of the biophysical effects of the system focusing on water and nutrient balance
- *biodiversity indicators* — an indication of how well the system is maintaining or nurturing natural capital. Biodiversity indicators will be regionally and possibly farm specific
- *regional/catchment implications* — presence or involvement in catchment management planning; regional implications of the innovation.
- *economic indicators* — information was collected and analysed to present a picture of the economic implications of the innovation
- *social and community implications* — level of support within the community for innovation; implications for the social wellbeing of the community; possibility of social factors limiting innovation, such as access to resources and other equity issues
- *presence and nature of philosophical basis* — information was collected, where possible
- *derivation of innovation* — tracing the innovation back to its beginning and identifying, where possible, the drivers of innovation
- *possibility of replication* — in order to achieve change, innovations will need to be applicable and capable of being replicated.

3. Establish contact with:

- farmer representative groups
- research corporations and universities
- government agencies
- farm advisers/consultants
- Landcare organisations.

4. Research literature relating to innovative farming systems, eg.:

- Kondinin Group Magazine
- CSIRO publications
- various industry publications
- Australian Farm Journal
- *Acres* magazine
- Innovative Farm Group newsletters.

5. Advertise in national and regional newspapers and journals

Advertisements in national and regional newspapers and journals were used with an aim to contact a broad spectrum of innovative farmers, eg. those involved with industry groups and those not, those who read industry-specific literature, and others. At the same time, Synapse and LPM were conducting two other similar projects and synergies and economies of scale were achieved by concurrently advertising for interest in the three projects. Advertisements were accompanied by a general-interest article, where possible.

Identification of innovative farming systems

The above process was implemented and a wide range of innovative farmers was contacted by telephone and e-mail. These included respondents to the advertisements, farmers identified by researchers, farmer organisations and farm consultants, other innovative farmers and those identified through literature reviews. A brief discussion was held over the telephone to determine preliminary details and to ascertain the farmers' interest in participating in the project. The criteria for identification were used to develop a shortlist and each system that eventually appeared on the shortlist met the first criteria and one or more of the others. Duplication was avoided while ensuring a range of farming systems were included in the shortlist and studied. During this process, out of a total of 40 contacts, a list of 24 farmers was prepared and visits were arranged.

The effectiveness of the identification process was demonstrated by the confluence of farming system targets from the various sources. Many of the innovative farming systems identified were identified by more than one source and the farmers themselves provided valuable supporting information that had a great deal of commonality.

Site inspection

Case study farms were selected in New South Wales, Victoria, South Australia, Western Australia, Queensland and Tasmania.

The interview team, Tony Gleeson and Ian Perkins, visited each farm to conduct a farm inspection and a structured interview, except for the one Tasmanian farmer and case study 12 in Queensland from which information was collected by telephone interview. Each visit lasted an average of three hours. Where possible, discussions were held with other researchers and resource management specialists in regional centres.

Team meeting

A project team meeting was held in Brisbane in March 2001 to review the process of collection, presentation and analysis of information. As a result of this meeting, it was resolved to expand the characteristics to include more questions on the background to innovation, such as the role of a farmer and the pre-conditions for change and to establish that detailed financial analysis was beyond the scope of this project. The meeting discussed the assessment of innovation and the need to develop a framework for broader assessment of innovation in landscape management.

Information analysis

Information collected has been examined to identify the major issues and these issues are discussed in the body of this report.

The technical team, led by Brian Keating, has conducted biophysical analysis of six representative case studies and the results of this analysis are presented in the report.

Case studies

Summaries of the case studies are presented in the following pages. They are integrated into a discussion on the major issues that arose from analysing the data collected. The discussion is organised around the following:

- basic profiles
- features of innovation
- interpretation of innovation.

A map showing locations of the case studies is given in Appendix 1 and more detailed descriptions of them in Appendix 3.

Through this discussion and the technical analysis, case studies were assessed for the following:

- their capacity to address sustainability issues, including the control of deep drainage and nitrogen leakage problems
- their impact — locally, regionally and nationally
- the ability to replicate the lessons, technology and practices in other situations
- integration within the farm, the environment and with other innovations
- the type of innovation.

Issues

Basic profiles — discussion

Industry

The principal targets of this study were cereal and grazing systems, however mixed horticultural systems and an aquaculture system were also included.

Practices

The range of practices used in the innovative systems studied included conventional, organic and biodynamic.

Organic

A number of the systems studied used organic practices (case studies 1, 5, 14, 20 and 24). Some were certified organic and selling their produce labelled as organic, while others were in conversion or basically using organic practices. The reasons for using organic practices varied from health considerations to a philosophical objection to non-natural systems to a desire to capture a growing market. The most common reason presented for changing from conventional systems to organic was a response to a health crisis in the family. Some farmers stated that while using conventional systems they could see their chemical and fertiliser bills continually growing while income was shrinking and weed and fertility problems were remaining the same. The organic systems studied were largely focused on soils and soil nutrients from the perspective of addressing issues of sustainability. Two of these farmers were regularly testing their soils and applying various nutrients based on the recommendations of the testing and analysis service.

> **Case study 14**
>
> **ORGANIC PRODUCE AND WINE**
>
> **Location:** central Victoria
>
> CS14 is a farm operated by a family who grows and markets organic vegetables, fruit, nuts and wine. Permaculture principles are applied on parts of the farm.

Biodynamic

Three biodynamic systems (case studies 2, 6 and 21) are included in this study. Biodynamic systems are based on the work of German philosopher Rudolf Steiner and generally take a philosophical as well as practical approach to agriculture. Philosophically, the system is based around an appreciation of natural forces and attempts to work with these forces. Practically, the systems are organic and use a number of biodynamic practices, the most common of which is the application of a cow manure preparation called BD500. A range of other preparations and composts are also applied with the aim of stimulating and maintaining the natural biological activity of the soil.

Biodynamic farming systems have a focus on soils and soil health. It is generally claimed that the use of biodynamic systems increases the organic matter in the soil, improves the availability of a range of nutrients, and has a positive effect on the water-holding capacity of the soil. Case study 3 claims to have reduced the area on his property affected by salinity through the use of biodynamic principles. Case study 21 believes the use of biodynamic principles has enabled him to increase his irrigation interval through improving the water-holding capacity of the soil.

Conventional

For the purpose of this study ‘conventional’ was taken to mean ‘non-organic’ or ‘non-biodynamic’ and covered a wide range of systems.

> **Case study 3**
>
> **BIODYNAMIC WHEAT/WOOL/LAMB**
>
> **Location:** eastern wheat belt, Western Australia.
>
> CS3 used biodynamic principles in arid conditions for wheat, wool and lamb production. Biodynamic principles have been used for over ten years and it is claimed they are having a positive impact on areas affected by salinity.

ISSUES	CASE STUDIES MATRIX — BASIC PROFILES																							
	1	2	3	4	5	6	7	8	9	10	11	22	13	14	15	16	17	18	19	20	21	22	23	24
Industry																								
⇒ cereal crops			✓	✓					✓						✓	✓	✓		✓	✓		✓		✓
⇒ livestock grazing	✓		✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓		✓	✓	✓	✓		✓
⇒ horticulture		✓												✓										✓
⇒ aquaculture																							✓	
Practices																								
⇒ organic	✓	✓			✓								✓	✓						✓				✓
⇒ biodynamic			✓			✓		✓													✓			
⇒ conventional				✓			✓		✓	✓	✓	✓			✓	✓	✓		✓			✓	✓	
Family involvement																								
⇒ family working on the farm			✓		✓	✓	✓	✓		✓			✓	✓	✓		✓		✓	✓	✓	✓		✓
⇒ farm owned by number of generations	1	–	2	4	1	1	1	–	–	2	–	3	1	4	4	2	4	–	4	2	5	3	–	2
Income pattern																								
⇒ agricultural (ag) only						✓				✓														
⇒ ag plus non-ag	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Industry integration																								
⇒ horizontal		✓							✓								✓			✓		✓		✓
⇒ vertical						✓					✓			✓				✓		✓			✓	
⇒ neither	✓		✓	✓	✓		✓	✓		✓		✓	✓			✓			✓		✓			


Flame weeder used in organic horticulture

Keyline farming practices

These are based on the movement, use and storage of water and are used for drought-proofing, encouraging tree growth and irrigating pastures. They were first developed by Percival Yeomans in the early 1940s.

Pasture cropping

Pasture cropping is a system whereby cereal crops are planted directly into native pastures. Preparation is primarily grazing and may include some chemical weed control.

Cell grazing

The strategic movement of livestock around a property in groups of defined size.

Albrecht system

The Albrecht system is based on achieving an appropriate balance of anions and cations in the soil. According to Albrecht, the appropriate balance is essential to ensure the availability of nutrients, minerals and trace minerals.

Family involvement

Farm owned by a number of generations

Most of the innovative farming systems studied were family farms usually in the family for more than one generation — three generations was common and one farm in Victoria has been in the same family for five generations. A sense of family continuity is important for many of these farmers and a number stated that being able to hand on the farm to the next generation was an important aim.

The issue of succession planning was frequently raised in discussion and the importance of effective planning was highlighted. One case study had developed an effective farm and resource management system, however sufficient attention had not been given to succession planning and the sustainability of the system is currently in jeopardy as his son has decided to leave the enterprise and work elsewhere.

Family working on the farm

Less than half the systems studied had more than one family or more than one generation working on the farm at the time of the study. One system was basically devised and developed to allow the next generation to work in the farm business and the business now employs a father, mother and three sons. Others have family members coming and going and a number have family who maintain close contact but work elsewhere. The remainder has young children or children who have chosen to work in other occupations. Four case studies have children who work elsewhere because they see a limited future on the farm.

Income pattern

The nature of the study limited the amount of financial analysis that could be performed on innovative systems. However, questions were asked about sources of income and broken into agricultural and non-agricultural income.

Agricultural income only

Of the 24 farming systems studied, only two (case studies 6 and 10) relied solely on agricultural income. Both of these were specialist beef cattle producers. A number of systems derived income from more than one agricultural enterprise as well as non-agricultural income. One system was fully integrated through the production line and therefore generated income from different sources within one enterprise.

Agricultural income plus non-agricultural income

As stated above, virtually all systems studied had agricultural and non-agricultural income streams. Non-agricultural income came from a variety of sources, including off-farm employment, consultancy based on innovative practices, off-farm investments, off-farm businesses, employment by farmer representative bodies. In one case, the farm was leased out and therefore provided one of a number of income streams to the owner who was working in other areas.

Case study 6

BIODYNAMIC BEEF PRODUCTION

Location: central and central west coast Western Australia.

CS6 has developed a vertically integrated beef production enterprise that produces and finishes cattle and markets beef. Biodynamic practices are followed and the product is marketed as biodynamic beef. The system has been developed as a means of accommodating a number of family members in the business.

Case study 10

CELL GRAZING BRIGALOW COUNTRY

Location: central Queensland.

CS10 has developed a system of managing brigalow regrowth and the pastures within it using cell-grazing techniques rather than extensive land clearing.

Case study 5

ORGANIC DAIRY — integration of farming and lifestyle

Location: northern Victoria.

CS5 is a small organic, family-run dairy farm that is integrated with off-farm income to achieve lifestyle and professional outcomes. Soil fertility is monitored using the Albrecht system and external inputs are kept to a minimum.

In discussion, the farmers recognised the importance of non-agricultural income in their systems for a variety of reasons, including:

- reduction of risk — innovation is high risk and another, diversified source of income allows the freedom to take risks, financially, mentally and emotionally
- contact with non-agricultural ideas, principles and people
- wider contact with other farmers
- a source of funds to invest in innovative ideas.

One system studied was established and owned by a consortium of people, none of who had prior agricultural experience but who all brought different knowledge, skills and attributes to the business.

The existence of non-agricultural income was one of the two most common characteristics of all the innovative farmers studied for this report.

A balance of life style and production

Industry integration

In this context the terms ‘horizontal’ and ‘vertical’ integration are used broadly to include contact and linkages between farms and farmers, as well as between products.

Horizontal

Horizontal integration refers to the extent of linkages between farms of the same or similar farm-based agricultural enterprises. Horizontal linkages were demonstrated to be important in the innovation process as they form an important contact network for innovators. Many of the innovative farmers interviewed were in contact with each other or knew about each other.

Vertical

Vertical integration refers to integration along the processing chain and was well demonstrated by one system (case study 6) that involved the breeding, fattening and processing of beef cattle and lambs and marketing the end products, beef and lamb, under a proprietary label. A number of the organic and biodynamic farming systems studied involved marketing the produce into specialty markets under organic or biodynamic labels. The farmers involved in these systems generally conducted the marketing themselves and therefore were in direct contact with the market.

A community-supported agriculture system (case study 2) was studied and this is an excellent example of vertical integration between supplier and consumer. This system enabled direct contact between consumer and producer and also encouraged consumers to participate in production.

Case study 2

COMMUNITY-SUPPORTED AGRICULTURE

Location: central coast New South Wales.

CS2 is a community-supported agriculture enterprise supplying organic fruits and vegetables to subscribers in the northern suburbs of Sydney.

Features of innovation — discussion

Enterprise and conservation integration

The integration of productive enterprises and conservation ideals and practices is the aim of case studies 13, 17, 22 and 24. To some extent, they are all successful in that biodiversity (according to observation) has increased on each of their farms while they have continued to be productive in a conventional sense.

ISSUES	CASE STUDIES MATRIX — FEATURES OF INNOVATION																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Enterprise/conservation integration							✓			✓		✓	✓		✓	✓	✓					✓		✓
Environmental focus																								
⇒ biodiversity						✓	✓			✓	✓	✓	✓	✓	✓	✓	✓					✓		✓
⇒ soil	✓		✓	✓	✓	✓			✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓			✓
⇒ water			✓						✓	✓			✓		✓	✓	✓		✓				✓	✓
⇒ trees / perennial shrubs	✓									✓		✓	✓		✓	✓	✓					✓		✓
⇒ perennial grasses native				✓											✓				✓					
⇒ perennial grasses exotic																	✓				✓			
Sources of social/technical support																								
⇒ neighbours																								
⇒ local formal network		✓	✓	✓	✓	✓				✓				✓	✓	✓	✓		✓	✓	✓	✓		✓
⇒ State departments						✓			✓			✓												
⇒ Universities/CSIRO				✓								✓	✓		✓								✓	
⇒ private sector services					✓		✓			✓	✓												✓	
⇒ none																								
Drivers of innovation																								
⇒ financial			✓	✓		✓			✓	✓	✓	✓		✓	✓	✓			✓		✓		✓	
⇒ resource deterioration	✓		✓	✓					✓	✓		✓			✓	✓	✓	✓	✓	✓		✓	✓	✓
⇒ community responsibility		✓											✓	✓			✓					✓		✓
⇒ personal health		✓			✓			✓					✓							✓	✓			
⇒ philosophical		✓				✓	✓	✓						✓	✓		✓							✓

Case studies 7 and 11, by developing primary enterprises that rely on conservation of native flora and fauna, have integrated enterprise and conservation and have developed enterprises that are adapted to the environment.

Environmental focus

Many of the innovative farming systems studied had an environmental focus as an important component of the system. In many respects, this focus was derived from an appreciation of the consequences of resource degradation and a wish to repair or avoid further degradation. The environmental focus varied with different farmers and systems.

Biodiversity

A number of the innovative farmers interviewed identified the promotion and maintenance of biodiversity as an important factor in the development of their innovative systems. Biodiversity is taken to include native and non-native flora and fauna above the soil and microbial activity below the soil.

Case study 24

INTEGRATED WHOLE FARM PLANNING/ KEYLINE PRINCIPLES

Location: south-western Western Australia.

CS24 has used Keyline principles to develop a whole-of-landscape approach to resource management. Trees are planted on the contour, stored water is used to produce organic horticultural crops, and soil nutrient levels are monitored using the Albrecht system.

Case study 11

NATIVE FAUNA PROCESSING AND MARKETING

Location: Tasmania.

CS11 has developed a business processing and marketing native fauna — wallaby, possum and duck — which are supplied by contractors who harvest on a range of private properties.

Case study 17

TREE PLANTING/INTENSIVE PASTURE USE

Location: western region Victoria.

CS17 manages a portfolio of properties on which he aims to plant trees to cover 30% of the area. To make it possible to retire this land from production, he has increased the intensity of use on the remaining 70% and produces beef and wool.

Biodiversity was seen as important for many reasons including the following:

- species equality
- ecological health
- maintenance of natural systems
- potential for income diversification.

Measures taken to preserve or to improve biodiversity include:

- restoration of wetlands
- tree and shrub plantings
- protection of remnant bushland.

Case studies 6, 9 and 24 were actively monitoring the impact of their practices on biodiversity.

Soil

A focus on soil was common to nearly all of the innovative farm systems studied for this report. This took many forms and levels and was perhaps the strongest common element. The focus was expressed through a variety of systems, using Albrecht, biodynamic and nutri-agriculture through to the development of individual approaches. The Albrecht system focuses on achieving the correct balance of minerals, trace elements and cations and maintaining that balance. It is based on principles established by Dr William Albrecht, a former student of Rudolf Steiner.

Biodynamic farmers focus on the energy of soil life and the microbial activity below the soil. Albrecht and biodynamic principles can be and are used together in a number of situations. The pasture cropping and keyline exponents have a soil focus, as do those using compost and earthworm preparations. One farmer describes

Case study 18

COMPOST MANUFACTURE/ EARTHWORMS

Location: south-eastern New South Wales.

CS18 uses earthworms to produce soil-conditioning agents from waste material from an abattoir. The soil-conditioning agents are sold to farmers and gardeners.

Case study 20

ORGANIC CEREAL CROPS/WOOL/LAMB

Location: south-eastern South Australia.

CS19 produces and markets a range of cereal and coarse grain crops as well as wool and lamb. He monitors the nutrient status of his soils using the Albrecht system and applies a range of soil conditioners.

himself as a 'soil manager' and most were observing or monitoring soil qualities or changes. According to the farmers using these practices, the focus on soils was, in a number of cases, impacting on water balance through improving water-use efficiency and water-holding capacity. This focus was also affecting nutrient loss through a more targeted and informed program of nutrient application. The focus on soils has led to an increase in awareness of soil properties and the impact of farming practices on soils on these properties.

Water

Water use and water balance are issues of concern to many of the innovative farmers interviewed. Keyline systems, trees and shrubs, and biodynamic practices are all being used in attempts to combat or avoid the problems of salinity. In areas where salinity is not such an obvious problem, the awareness is still high and innovative farmers, such as the pasture-cropping exponents, those using cell-grazing techniques and those with a focus on trees, are all aiming to have a positive impact on water balance. The long time lag between cause and effect makes it difficult to assess the impact of these practices on water balance. This will be addressed to some extent by the technical modelling.

In the Western Australian wheat belt and the Mallee, the problems of water balance and salinity are highly obvious. Farmers in these areas have an awareness of and a focus on salinity. Wheat yields in case study 16 demonstrate an improvement since the introduction of water management activities and case studies 4, 15 and 19 all claim to be reducing the watertable recharge rate by avoiding a fallow period. The biodynamic farmers claim to be reducing the recharge rate through improving the water-holding capacity of their soils.

The keyline system is based on the movement, use and storage of water and is used for drought-proofing, encouraging tree growth and irrigating pastures and crops as well as salinity control. Run-off is generally reduced and on-farm storage of water is increased (case studies 16 and 24).

> **Case study 16**
>
> **WHEAT PRODUCTION/KEYLINE**
>
> **Location:** eastern wheat belt Western Australia.
>
> CS16 produces wheat crops using keyline principles in arid conditions. He has used the keyline principles in combination with tree planting to improve water-use efficiency and crop yields.
>
> **Case study 13**
>
> **LAND RESTORATION—TREES AND LIVESTOCK**
>
> **Location:** south-eastern New South Wales.
>
> CS13 has used extensive tree planting and goats to rehabilitate degraded land and to develop a profitable system that also addresses issues of water balance and maintenance of biodiversity. He has also initiated a number of wetland reclamation projects.

Trees and shrubs

Trees were being planted to varying degrees under most of the farming systems studied. One system had a commercial forestry focus (case study 13) while others were using trees for stock shelter, salinity abatement, and promotion and maintenance of biodiversity. On a number of farms, the emphasis seems to be shifting from monoculture to diverse planting of trees and shrubs. Case studies 6 and 12 are using edible shrubs as an important livestock fodder and one farmer in the brigalow belt of central Queensland (case study 10) has developed a system that relies on grazing management, rather than regrowth control, in an area where trees are generally seen as the major impediment to livestock production.

The maximum proportion of revegetation or area devoted to trees and shrubs (on developed properties) was 30% (case studies 17 and 24). In both these cases, the areas planted to trees and shrubs are delineated, either on the contour or along the waterways or both. Conventional, intensive grazing and cereal cropping were practised on the remaining 70% of area. Case study 10 was encouraging the regrowth of trees across the landscape.

The focus was primarily on trees with a growing interest in more diverse plantings, including shrubs and other perennials. Perennials for commercial use were mostly used as stock fodder (old man saltbush, tagasaste, acacias) or oil mallee in one case, but generally there was no evidence of large-scale commercial use of perennial plants in this study.

Trees are being used in an attempt to rectify salinity problems, primarily in Western Australia, but were planted at a rate of no more than 30% of the total area of the farm and trees were not being planted across the entire landscape.

Perennial grasses, native

The pasture cropping (case studies 4 and 19) and advance sowing (case study 15) systems have a strong focus on perennial native grasses. As described, these systems revolve around growing cereal crops in swards of native perennial pasture and combining this with a range of rotational grazing systems. The exponents of these systems have become very aware of the benefits of native perennials and now monitor the number and diversity of native grasses. Western Australian farmers are searching for suitable perennials to use in their systems.

Recent research by Dr Christine Jones of the University of New England suggests that perennial native pastures play a major role in addressing water balance problems (Jones 2001). The farmers using native perennials have all reduced their fertiliser inputs and claim the use of native perennials is beginning to address the issue of nutrient balance.

Perennial grasses, exotic

Some of the systems studied rely on introduced perennial grasses for livestock pasture. Case study 17 is attempting intensive use of perennial pastures as a means by which 30% of the land can be retired from conventional production and planted to trees. Others use introduced perennial pastures with a range of innovative fertiliser and grazing systems to develop a sustainable system.

Sources of social/technical support

Neighbours

Many of the innovative farmers studied had little to do with their neighbours. In some cases, the relationship with their neighbours ranged from thinking the innovative farmers were 'mad' to direct hostility. A number of farmers interviewed said they do not talk about their innovative methods with their neighbours. One or two farmers had been contacted by neighbours after their innovations had been proven successful over a long time, but largely the innovative farmers had little meaningful contact with or influence over their neighbours in relation to innovation in farming practices.

Case study 19

PASTURE CROPPING/WOOL GROWING

Location: central New South Wales.

CS19 has worked with a university researcher to develop a system of cereal cropping and wool production that involves planting cereal crops directly into native pastures while also using cell-grazing techniques.

Case study 4

PASTURE CROPPING/BEEF AND WOOL PRODUCTION

Location: central New South Wales.

CS4 has worked with local networks to develop a system of cereal cropping and beef and wool production that involves planting cereal crops directly into native pastures while also using cell-grazing techniques.

Seed bed after planting wheat directly into perennial pasture.

Formal network

Networks based on voluntary groups such as Landcare, Stipa, the Kondinin Group, Land Management Society, Holistic Resource Management, Grazing for Profit, Biodynamic Farmers etc. appear to play an extremely important role in developing and supporting innovation. The support provided by these networks was highly valued by many of the farmers interviewed. A number of the farmers interviewed played key roles in establishing and maintaining these organisations. These networks are generally networks of interest rather than locality. The growth of and improvement in communication technology is playing a major role in facilitating these networks.

Professional societies

Several of the farmers studied were members of and used professional societies, such as the Institute for Agricultural Science. It is not possible from this study to judge the benefits provided by and influence of these societies on innovation as small compared to other networks.

State departments

Innovative farmers in general had very little involvement with state departments. A number had unsuccessfully sought help or advice from a range of state departments in a range of states. Some had been actively discouraged by state departments and there is a long history of poor

Case study 12

USE OF OLD MAN SALTBUSH FOR WOOL PRODUCTION

Location: far-western Queensland.

CS12 uses old man saltbush in scattered plantations to develop a highly flexible grazing system that can respond to changing seasons.

relationships between keyline proponents and state departments that was mirrored to some extent when grazing for profit and cell grazing were first introduced to Queensland and New South Wales.

Over the years, innovations such as keyline and cell grazing have been discouraged by state departments. State department support is not completely lacking and one Queensland innovative farmer in this study (case study 12) has conducted a joint research project with the New South Wales Department of Agriculture and has maintained useful contact with a number of researchers.

Universities

Two of the innovative farming systems studied (case studies 4 and 19) have been developed through an association between farmers and a university researcher. Another system (case study 13) was developed as a commercialisation of innovative university-based research and a forestry-based system has maintained close contacts with forestry schools in Australia and New Zealand.

CSIRO

A Land & Water Australia project is currently being conducted on one farm (case study 24) by a researcher associated with universities in Western Australia. One innovative farmer in this study (case study 13) has had consistent contact with and support from the CSIRO. Others welcomed the possibility of CSIRO interest and involvement but overall there appeared to be very little contact between innovative farmers and the CSIRO.

Private-sector services

A range of consultancy, soil testing, nutrient provision and other private-sector services has been accessed by a number of the innovative farmers studied. The impact of these services has been both positive and negative, as several farmers were disillusioned by the services of one particular consultant while others were highly satisfied with the services received.

Information transfer has played a vital role in the development of a number of these innovative systems. Information has been sourced, to a large extent informally, from a range of sources. Contact with consultants or attendance at schools has been an important turning point for some innovative farmers.

Drivers of innovation

Financial

Financial hardship was a common driver of innovation. A number of the innovative farmers studied primarily developed systems to reduce input costs. This was often combined with the effects of a 'natural' calamity such as drought or fire. Some farmers observed that their input costs (mostly related to fuel, chemicals and fertilisers) continually increased while income decreased and pests and fertility decline continued.

Although the farmers studied cited financial hardship as a driving force, none appeared to be in a position of having to sell the farm. This may have been due to sourcing non-agricultural income, a low debt load or careful financial management. These are important factors, as it appeared that these farmers, while feeling financial pain, were also in a position to do something about it and for the most part, were not concerned with servicing a debt. Detailed financial data were not collected. However, it appeared that most of the innovations did not result in dramatic increases in agricultural profitability. Nevertheless, none of the innovators interviewed articulated regret about their chosen approach. In fact, without exception, they were passionate about their chosen pathways.

Resource deterioration

One farmer when interviewed said that the catalyst for change came when his mother could no longer use the water from their house dam to water the garden because it was too salty. Resource deterioration (such as the onset of salinity, loss of biodiversity, soil erosion etc.) was a common driver for change but mostly in combination with financial hardship or 'natural' calamity.

Case study 15

ADVANCE SOWING OF CEREAL CROPS/ BEEF CATTLE PRODUCTION

Location: central west New South Wales.

CS15 has developed a system of advance sowing where he sows forage crops directly into native pastures in a dry seedbed. This combined with a cell-grazing livestock management regime to produce beef cattle in a highly flexible and responsive system.

Case study 22

INTEGRATION OF CONSERVATION/WOOL AND CEREAL CROP PRODUCTION

Location: Central west New South Wales.

CS22 has established about 12% of their property as a conservation reserve as a community Landcare project. Bettongs have been released into the conservation area and are being monitored, and the release of other endangered native species is planned.

Several of the farmers interviewed made a connection between escalating resource degradation and financial hardship. It then became obvious that they needed to address both issues simultaneously and this has been achieved through a variety of practices such as advance sowing, cell grazing and keyline systems.

Community responsibility

A number of farmers identified community and social responsibilities as drivers for innovation. One innovative system (case study 22) has used community funds through, for instance, Landcare to achieve a community-oriented goal and others see their community responsibility involving communication of the benefits and implications of their particular innovative system. Several innovative farmers are involved in communication activities through field days with Landcare or industry groups and involvement in other community-based communication activities.

Measuring the effect of innovative practices on water balance

Personal health

A health crisis was a common initiator of innovation among organic farmers and was frequently cited as the factor that drove the development of organic and biodynamic systems. Several of the organic farmers interviewed (case studies 5, 20 and 21) said they first became interested in these systems when either they or a family member became ill. In these cases, the healing process involved organic/biodynamic food and/or avoidance of contact with harmful chemicals. The farmers then became involved in producing organic or chemical-free food. Many of these farmers stated that they believe the role of the farmer is to produce healthy, high-quality food because they have experienced the link between healthy food and personal health.

Philosophical

In a range of cases, philosophical beliefs contributed to the development of innovative systems. A philosophical objection to artificial inputs was one example and a belief that other species have a right to live and enjoy the landscape is another. A belief that people need contact with the land and that it is important to involve more people in the process of farming also contributed to the development of innovative systems. Case study 7 believes contact with the land is integral to emotional and psychological healing and is facilitating the use of the land in that role with teenagers and young adults.

Case study 21

BIODYNAMIC DAIRY

Location: central coast Victoria.

CS21 runs a dairy enterprise using biodynamic principles. He believes the use of biodynamic practices has improved the water-holding capacity of his soils and he uses a longer interval between irrigations than his neighbours. Mr CS21 recovered from a chronic illness and believes there is a link between healthy, organic food and personal health, particularly food produced using biodynamic practices.

Case study 7

YOUTH EDUCTION PROGRAM/BEEF CATTLE PRODUCTION

Location: central west Queensland.

CS7 runs a youth eduction program for 'at risk' youth. He believes a connection to the land is a vital element in the process of emotional and psychological healing, particularly for young people.

Interpretation of innovation — discussion

Ability to address sustainability issues

Water balance

The technical analysis assessed the impact of selected case studies on water balance. Among the innovative farmers interviewed there was a significant awareness of and interest in the impacts of salinity. Practices developed by case studies 3, 9, 10, 13, 16 and 26 were aimed at impacting on water balance and correcting obvious signs of salinity. All these case studies claimed they have made a positive impact on water balance through both reducing the recharge rate and lowering the watertable. Others, such as case studies 4, 15, 17, 19 and 21, developed innovative systems for other reasons and found later that these systems are likely to have a positive impact on water balance through improved water-holding capacity of the soil, improved water-use efficiency and removal of the need to fallow, all of which impact on recharge rates.

ISSUES	CASE STUDIES MATRIX — INTERPRETATION OF INNOVATION																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ability to address sustainability issues																								
⇒ water balance			✓	✓		✓	✓		✓	✓		✓	✓		✓	✓	✓		✓		✓		✓	✓
⇒ nutrient loss	✓		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
⇒ biodiversity loss				✓		✓	✓			✓	✓	✓	✓		✓	✓	✓		✓			✓		✓
Integration of innovations				✓		✓							✓		✓	✓			✓					✓
Whole-of-landscape approach						✓	✓			✓		✓	✓		✓	✓	✓							✓
Type of innovation[a]																								
⇒ alpha		✓	✓		✓				✓	✓		✓	✓	✓		✓	✓			✓	✓	✓		✓
⇒ beta	✓					✓												✓					✓	
⇒ gamma				✓			✓	✓			✓				✓				✓					
Replication		✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Impact																								
⇒ local		✓	✓	✓	✓			✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
⇒ regional	✓			✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
⇒ national	✓						✓				✓												✓	✓

[a] See page 22 for explanation of alpha, beta, gamma

Nutrient balance

An interest in natural systems and biomimicry was common to many of the systems studied. This has resulted in the use of native perennial grasses and shrubs and will possibly impact on nutrient balance. Case studies 4, 10, 15 and 19 reduced inputs because of financial or philosophical reasons and then developed an interest in natural systems as a way of farming with less external inputs (mostly fertiliser and fuel). An improvement in nutrient balance may be a beneficial by-product.

Biodiversity loss

Case studies 17 and 22 saw biodiversity loss as a major issue and have taken significant steps to rectify this loss. Others, such as case studies 14 and 24, see the promotion of biodiversity as a way of eliminating the need for chemical pest control, while case studies 6, 10 and 20 see the biodiversity of soils as the key to profitable and sustainable production.

While many of the innovative farmers studied were addressing biodiversity issues on their own farms, only one (case study 24) was attempting to connect his farm and biodiversity maintenance program to others in the neighbourhood or region. Case study 17 was implementing a tree planting and wetlands restoration project on a number of adjoining properties, all belonging to the one owner.

Integration of innovations

In general, the innovative farmers studied focused on their own areas of innovation with little integration of other innovations or ideas, even though there are obvious synergies between a number of systems, such as keyline and pasture cropping, Albrecht soil testing, and use of compost and tree planting etc. Case studies 4, 15 and 19 integrated pasture cropping and advance sowing with cell grazing and they may have achieved an important breakthrough by combining two innovations. It may be possible to achieve other significant benefits by combining two or more of the innovations studied.

Whole-of-landscape approach

Most of the case studies focused on a particular feature of the landscape, possibly to the detriment of the rest of the landscape. Case study 16 took a whole-of-landscape approach through a combination of keyline, conservation farming and tree and shrub planting. Case studies 17 and 24 attempted to take a whole-of-landscape approach but tended to focus on small, circumscribed areas of trees, while conventionally farming the remainder of the property. Case study 10 took a whole-of-landscape approach by using grazing management rather than tree clearing to achieve sustainable productive pastures.

Type of innovation

Innovation can be classified into the following categories (adapted by Synapse Research and Consulting from Rabson and DeMarco 1999 and Chisholm and Elden 1993).

Alpha

Alpha innovations are incremental changes within existing system parameters. Most of the case studies involved in this project fall into this category, as they are working within existing systems. The case studies involved are mainly working with introduced plant and animal species and producing products for existing markets.

Beta

Beta innovations are changes to the system parameters.

Gamma

Gamma innovations are major system changes. Case studies 7 and 11 are using resources in a different way —

Case study 23

AQUACULTURE/RECYCLING TECHNOLOGY

Location: central coast New South Wales.

CS23 has developed an aquaculture system that uses recycling technology to improve water-use efficiency and reduce pollution. The waste-water is used to operate a hydroponic vegetable-growing enterprise.

Case study 17

TREE PLANTING/INTENSIVE PASTURE USE

Location: western region Victoria.

CS17 manages a portfolio of properties on which he aims to plant trees to cover 30% of the area. To make it possible to retire this land from production, he has increased the intensity of use on the remaining 70% and produces beef and wool.

Case study 9

RESEARCH PROJECTS ON ROW CROPPING WHEAT

Location: north-western Victoria.

CS9 is conducting a number of experiments in which wheat is planted in widely spaced rows. The system may eliminate the use of fallow and will require precision planting and cultivation.

one to heal the emotional and psychological damage to future generations, and the other to establish a business in food production from native fauna. Case study 8 is using a variety of innovative healing modalities to address issues of nutrient depletion and past problems.

Replication

The innovative systems studied could all be replicated with varying degrees of difficulty and commitment. Several systems involve a level of commitment and belief that may make them difficult to implement but none of the systems relied so much on a unique set of circumstances that they are impossible to replicate.

Impact

The impacts considered for the purpose of this report are the biophysical and ecological impacts. However, it is important to note that these innovations are having, and will have, a range of other impacts, including social and economic.

Local

All of the innovative systems studied were able to demonstrate a local impact. The level of this impact varied from a reduction in costs for the operator, to ensuring only clear run-off left the farm, to the rehabilitation of waterways and protection of endangered species. An increased population of perennial plants in the landscape was a common local impact, as was a reduction in the use of chemicals and chemical-based fertilisers.

Case study 1

COMPOST-MAKING FROM CITY WASTE

Location: central Victoria.

CS1 has developed a system of making compost using liquid waste from a city centre with various sources of organic matter. He applies the compost to his own farm and intends to sell compost and the process. The process on his farm is certified organic.

Case study 8

HEALING MODALITIES

Location: central Victoria.

CS8 uses a range of healing modalities — alchemy, colour, sound and kinesiology — to control pests and address various resource management issues such as nutrient balance.

Regional

A small number of the farming systems studied were able to demonstrate a regional impact. One farmer (case study 24) convinced his neighbours to allow him to continue the contour-planted tree lines and another (case study 17) was beginning to have a local impact through the scale of a tree-planting program. Several innovative farmers were having a broader impact through the spread of their ideas at field days and discussion groups and through informal and formal networks. The physical impacts, where discernible, were primarily local in their expression.

National

A number of the concepts behind innovative systems are having a national impact. Concepts such as keyline, biodynamics, cell grazing and holistic resource management are expressed throughout the country. The farmers themselves, however, generally have very little national impact either through large-scale physical change or though the spread of ideas. One farmer, who also works as a consultant with his innovative approach, has worked in several states and many of the systems studied have been described in national journals and papers. However, the overall national impact of the systems studied to date has been small.

The establishment of wetlands has a range of impacts.

Issues summary

Analysis of the information collected shows a number of points of strong commonality among the 24 innovative farmers studied. The points of commonality that impact on sustainability criteria are:

- an interest in soils
- an emphasis on reduced inputs
- a focus on natural systems
- an explicit recognition of a range of material and non-material values.

An interest in soils is common to all but one of the innovative systems. This is perhaps part of a wider agricultural trend as it is becoming more apparent that all agricultural systems are driven by soil health and condition and that external inputs alone are not sufficient to maintain productivity. The interest in soils encompasses the microbial life within soils as well as the balance of minerals, microelements and other physical properties and is expressed in various monitoring and management systems. These farmers have addressed soil nutrient balance in a variety of ways — from conventional fertilisers to organic conditioners, biodynamic preparations and compost.

An emphasis on reduced inputs was common — either a reduction in the quantity of inputs or the cost or both. This emphasis was driven by a range of factors including financial, personal health and a philosophical objection to the use of chemical inputs. Combined with an emphasis on reduced inputs is a focus on natural systems. Observing and recreating natural systems and reducing the alteration or modification of natural systems was a common focus.

All of the innovative systems studied, with the exception of two (a wildlife harvesting and processing enterprise and a youth education enterprise) were basically modifying existing farming systems that rely on producing introduced cereals or other crops, including horticultural crops, or grazing sheep, cattle or goats. It could be claimed that the wildlife harvesting and processing enterprise and the youth education enterprise are contributing to the resolution of water and nutrient balance problems by not altering the landscape to any appreciable extent.

Other important points of commonality were also noted. These generally relate to the background to the innovation. These points are:

- income derived from agricultural and non-agricultural sources
- absence of formal institutional support — ie. from state or federal agricultural departments or research organisations
- a family farm base
- membership of informal and formal networks
- absence of a framework for design
- hardship.

As discussed earlier, the presence of non-agricultural income appears to be associated with the development of innovative farming systems. Reduction of risk, social and intellectual connections and input from outside the farm and a source of capital all contribute to an ability to develop innovative systems.

There was a notable absence of formal institutional support for these innovators. In some cases, government departments provided significant hindrance to the development of different and innovative systems. Two of the systems studied had received useful support from formal institutions — a university, a state government agricultural department and the CSIRO. A clear message from the innovators was that they felt they have operated without support from formal institutions.

A family farm, generally one that has been in the family for more than one generation and is now being run by one or more family members, forms the base from which a majority of these innovators are operating.

Social interaction is also an important factor as most innovators were members of informal or formal networks — networks not based on locality but on interest. Many of the innovative farmers studied believe they are regarded as ‘mad’ by their neighbours and have developed national and international networks based on their particular area of interest. A number of farmers interviewed had initiated the formation of networks and played key roles in the maintenance of these networks.

Most of the case studies represented were isolated. A number of individual innovative systems were used but there was an absence of overall design frameworks within which these innovative systems could fit. Also, the individual innovations generally lacked a design process.

An experience of hardship is an interesting common factor (“necessity is the mother of invention”). It seems that pain is an important part of the process of change for people and innovative farmers are no different. Hardship factors include financial hardship, natural calamity, personal health issues, and resource deterioration, and they vary in severity and impact.

Technical analyses

Introduction

This project has sought to identify cases of farmer initiated innovation in farming practices or enterprises that have potential to contribute to more sustainable land management in Australia. As well as lessons from the specific cases, the case studies inform our understanding of innovation in agriculture.

Assessment of the sustainability benefits of a particular innovation presents a number of difficulties. The precise technical understanding of how the innovation might impact on soil and water is not always present and direct experimental investigations of these impacts was outside the scope of this study. In addition, the indicators of sustainability that are relevant are not things that even innovative farmers have ways of measuring. These indicators include the maintenance of soil organic fractions, restriction of nutrient and water loss below root systems, restriction of soil acidification processes etc.

Finally, year-to-year variability in climate makes it difficult to assess long-term performance of certain practices.

We examined the innovation in each case study and used the experience of a knowledgeable agronomist to identify likely consequences on sustainability. In a number of cases, we have been able to call upon simulation models of the crop/pasture–soil–climate system to ascertain likely impacts of innovative practices, particularly when considering likely impacts on the water balance. These simulation analyses have made use of the APSIM (Agricultural Production Systems sIMulator) model and, in some cases, the GRAZPLAN model. The technical assessment was undertaken by Dr Brian Keating of CSIRO Sustainable Ecosystems and links with other activities in the RAAL program that have used models to explore farming system design and performance issues.

Note: the technical analysis was limited by the available budget and the available data. Analysis has focused on water balance with some informed comment on other sustainability issues such as nutrient balance, soil erosion and biodiversity and generally welcomed the opportunity for contact with research scientists and institutions. (The farmers involved were very interested in learning more about the impacts of their farming systems on innovation.) Further detailed technical analysis, while requiring more time, money and data, would be useful, ie. performed on selected case studies. Additional analysis of nutrient balance, soil properties and characteristics and biodiversity levels would be useful, both to researchers and farmers.

Technical analysis one

Assessing water balance and grain yield outcomes in native pasture systems oversown with grain crops.

Farms under consideration

Case study	Location	Type of operation	Agri-eco zone
CS4	Central NSW	**Grain and native pasture mix** — pasture cropping combined with sheep production	9
CS19	Central NSW	**Grain and native pasture mix** — pasture cropping combined with sheep production	9
CS15	Central west NSW	**Grain and native pasture mix** — pasture cropping, primarily focused on growing fodder for cattle	10

Technical questions being assessed

1. How effective is the perennial pasture – annual grain crop system likely to be in reducing drainage below the root zone?

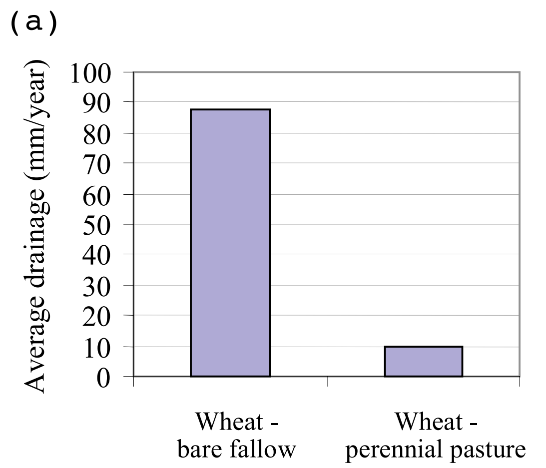
2. What grain yield penalties are likely in a system wherein crops are being sown on a generally drier soil profile?

Source of technical assessment

APSIM modelling — analyses undertaken for CTC11, and interpretation adapted for this current purpose.

Assessment

Grain cropping in association with perennial native pastures in the 500 to 600 mm rainfall zone of central NSW is likely to be very effective in limiting leakage of water below the crop and pasture root zone (Figure 1a). However, yield reductions associated with water and nitrogen use by the perennial pasture are likely to place a significant limitation on grain crop yields (Figure 1b).



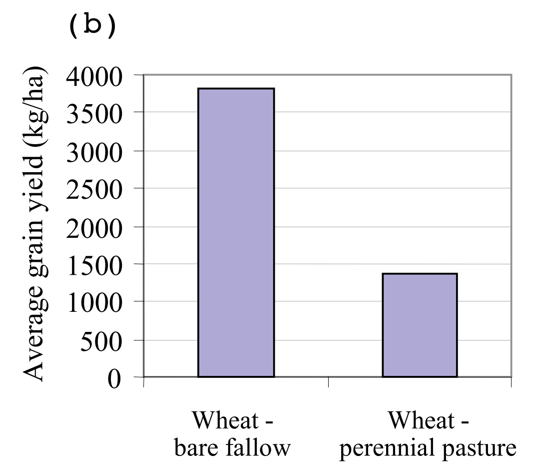


Figure 1. Estimates from the APSIM model of (a) deep drainage (average in mm/year over the 1957–1998 climate record) and (b) grain yield (in kg/ha) from alternative farming systems. Analysis comes from a 600 mm rainfall zone at latitude 33°S in the Murray–Darling Basin for a red–brown earth soil. The wheat system received 80 kg N/ha/yr, 25% of residues were retained and fallows were weed free.

Other considerations

There would be other long-term benefits of this perennial pasture/grain cropping system not considered in this modelling analysis. These include:

- erosion protection
- enhanced soil structure
- enhanced biodiversity.

Management of nutrient availability to the grain cropping enterprise must be an issue determining the overall performance of this system. The modelling analysis has focused on the likely water balance benefits and issues of nutrient cycling in the complex perennial pasture – grain cropping system have not been explored in any detail.

Technical analysis two

Assessing irrigation requirements for dairy pastures in southern Victoria, as modified by rooting depth and water-holding capacity.

Source of technical assessment

APSIM modelling — analyses undertaken specifically for project 6 by Brian Keating and Neil Huth, CSIRO Sustainable Ecosystems.

Assessment

Irrigated pasture systems were modelled with APSIM, configured for generic pasture, not limited by nutrient supply, on a clay–loam soil, with the four-week strip-grazing cycle simulated by cut and removal. The model was run for the rainfall record of Warrnambool, over a 40-year historical period (1957–1998). Four root system depths were examined, namely 60, 90, 120, 150 cm. In addition, four irrigation amounts were examined, namely 20, 40, 60 and 80 mm per irrigation, with three irrigation frequencies, namely 4, 8 and 12 days. Knowledge of the irrigation amounts applied by the travelling irrigator is critical to answering the technical question being posed.

Case study 21

BIODYNAMIC DAIRY

Location: central coast Victoria.

CS21 runs a dairy enterprise using biodynamic principles. He believes the use of biodynamic practices has improved the water-holding capacity of his soils and he uses a longer interval between irrigations than his neighbours. Mr CS21 recovered from a chronic illness and believes there is a link between healthy, organic food and personal health, particularly food produced with biodynamic practices.

If we assume that the travelling irrigator applies 20 mm per irrigation, and the root system depth in conventionally managed pastures is 60 cm, then the likely effect of irrigation interval on water use and production by the pastures is shown in Figure 2a and b, respectively. The point to note from Figure 2 is that extending the time between irrigations from 4 to 8 and then to 12 days, reduces pasture production (and water use) during the summer months (November–March). Pasture growth is unaffected by irrigation management during the autumn, winter and spring months as rainfall exceeds the pasture's water requirements (Figure 2a).

If we now examine the same simulations, but with 40 mm per irrigation applied via the travelling irrigator, we can see that pasture water use and production is relatively insensitive to irrigation interval (Figure 3).

Given that irrigation amounts of 40 mm per irrigation come close to meeting pasture requirements, the sensitivity to root system depth was only seen at smaller irrigation amounts (eg. 20 mm per irrigation). The interaction between root system depth and irrigation interval is summarised in Figure 4. Note that it is possible to extend the irrigation interval from 4 to 8 days, and then from 8 to 12 days, with only small losses in production, provided the root system depth is increased from 60 to 90 and onto 120 cm, respectively. By way of reference, the simulated pasture production for a 12-day irrigation interval with a shallow, 60 cm root system is shown on Figure 4.

In summary, the simulations provide some support for the notion expressed by CS21, that a deeper pasture root system achieved through his farming practices has allowed him to extend his irrigation intervals without loss of production. The support is not absolute however, because the simulations suggest:

- a small loss of average pasture production during February/March in the order of 10% with extension of irrigation intervals from 4 days to 12 days
- little sensitivity to irrigation interval if irrigation amounts exceed 40 mm per application.

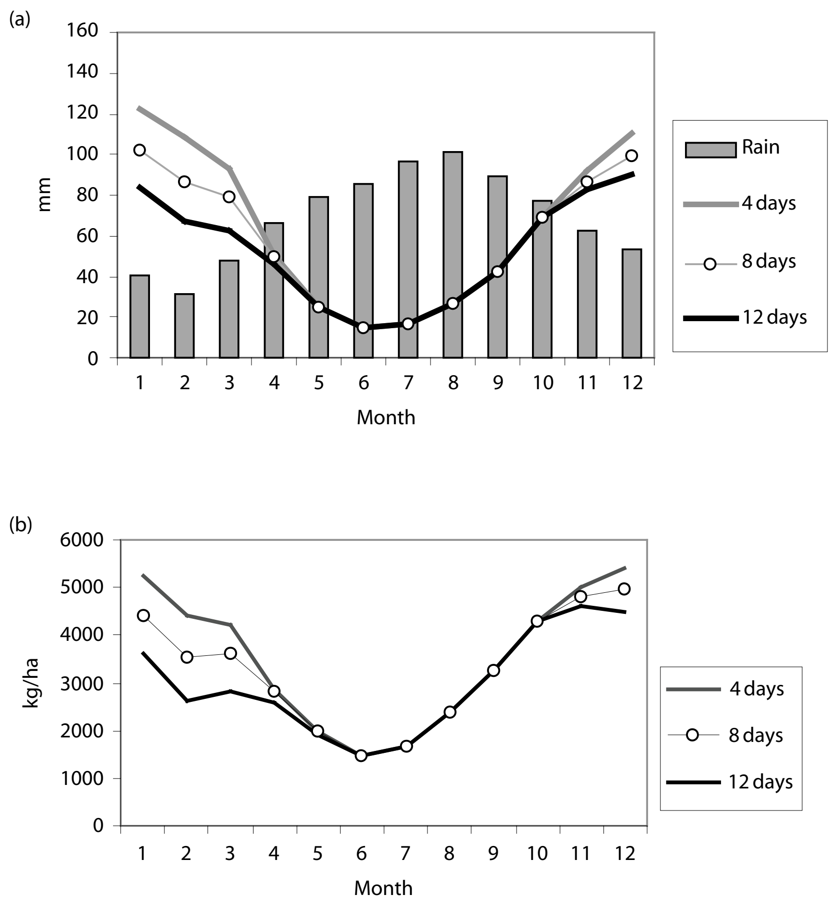


Figure 2. APSIM estimates of (a) average monthly pasture water use (Ep) and (b) average pasture production (kg/ha/month) for Warrnambool, Victoria (over the 1957–1998 climate record). Irrigation amount = 20 mm, rooting depth = 60 cm. Average monthly rainfall also shown as bars.

Other considerations

The technical assessment has not addressed the issue of whether the farming practices have in fact increased rooting depth. There is no way of knowing this without experimental investigations.

Technical analysis three

Likely impact of large-scale tree planting on the landscape water balance in sheep-grazing enterprises in the Hamilton district, Victoria.

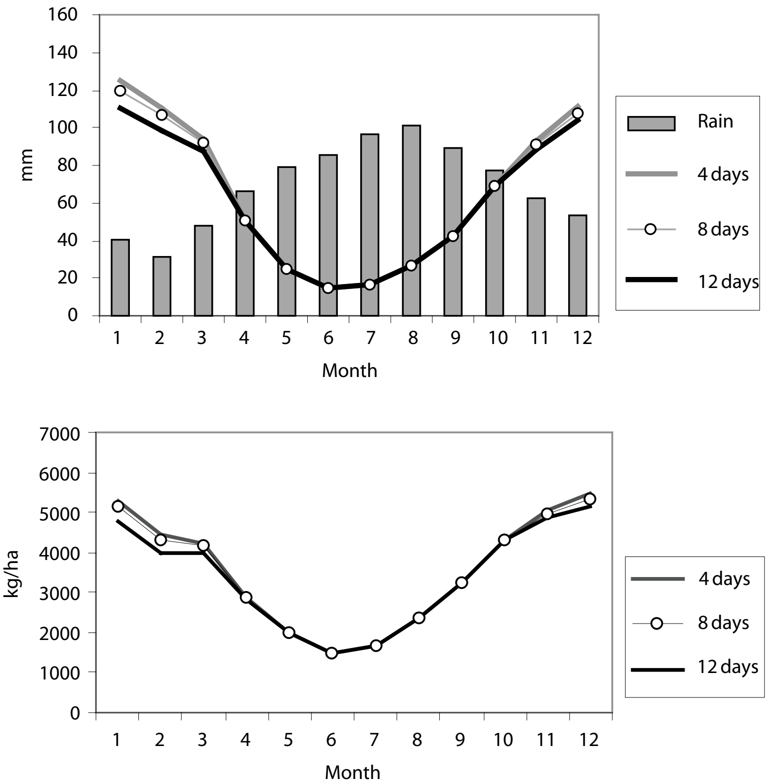


Figure 3. APSIM estimates of (a) average monthly pasture water use (Ep) and (b) average pasture production (kg/ha/month) for Warrnambool, Victoria (over the 1957–1998 climate record). Irrigation amount = 40 mm, rooting depth = 60 cm. Average monthly rainfall also shown as bars.

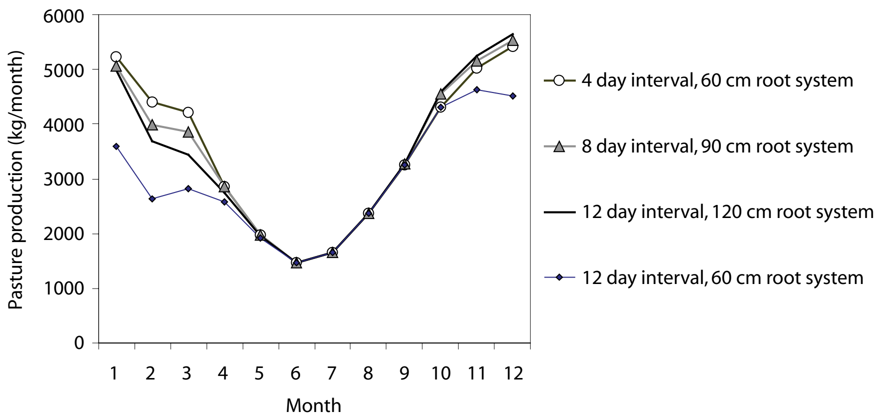


Figure 4. APSIM estimates of average pasture production (kg/ha/month) for Warrnambool, Victoria (over the 1957–1998 climate record). Irrigation amount = 20 mm, rooting depth and irrigation interval as indicated.

> **Case study 17**
>
> **TREE PLANTING/INTENSIVE PASTURE USE**
>
> **Location:** western region Victoria.
>
> CS17 manages a portfolio of properties on which he aims to plant trees to cover 30% of the area. To make it possible to retire this land from production, he has increased the intensity of use on the remaining 70% and produces beef and wool.

The management system on CS17 and the aggregation of properties involves allocating 30% of the land for tree planting and habitat provision while intensifying production on the remaining 70% of the land. Pastures (phalaris, cocksfoot, rye grass and clovers) have been extensively renovated and an intensive fertiliser program is applied to these areas. 25 units of P are applied to pastures each year and lime is applied at the time of pasture renovation at a rate of 2.96 t/ha. Through renovation and the use of fertilisers, CS17 has been able to lift production on the pasture areas. To maintain an economic level of production while also taking 30% of the area out of production, CS17 has calculated he needs to lift production from the current level of 15 dry sheep equivalent (dse)/ha to 20 dse/ha.

Technical questions being assessed

1. What are the likely impacts on the water balance of replacing pastures with trees in the Hamilton region of Victoria (650 mm rainfall zone)?
2. What landscape-scale impacts might result from having 30% of the land under trees (in terms of watertables and extent of dryland salinity)?

Source of technical assessment

For question 1: APSIM and GRAZPLAN modelling — analyses undertaken for a Meat and Livestock (MLA) pre-investment study and interpretation adapted for this current purpose by Brian Keating, CSIRO Sustainable Ecosystems.

For question 2: expert opinion, informed to some degree by catchment-scale modelling, conducted for the National Land and Water Resources Audit.

Assessment

Question 1. Point-scale impacts on water balance

Water balance of pasture and tree systems in the Hamilton district of Victoria was examined in 1997 in a modelling study that was based on the APSIM and GRAZPLAN models (Bond *et al.* 1997). The scenarios simulated included a range of annual and perennial pasture systems with alternative soil fertility levels and grazing management. These were contrasted with a mature eucalypt wood lot. The climate record used was for the Rocklands Reservoir meteorological station, with some gaps filled from nearby research stations. The historical period simulated was 1970 to 1995.

Long-term average rainfall at the simulated site was 639 mm. Average monthly rainfall exceeds potential evapotranspiration in the months of May, June, July and August. Hence, deep drainage occurs in this environment if a dry soil ‘buffer’ can not be created through water use by vegetation at other times of the year.

Long-term average rates of deep drainage estimated from the APSIM–GRAZPLAN modelling are summarised in Table 1.

Table 1. Predicted long-term average water-balance terms for alternative land-use systems at the Vasey–Hamilton site (long-term rainfall = 639 mm) (from Bond *et al.* 1997).

Scenario	Evapo-transpiration (mm)	Drainage (mm)	Run off (mm)
Annual pasture, low fertility	425	209	7
Annual pasture, high fertility	454	181	6
Perennial pasture, high fertility, continuous grazing	529	108	5
Perennial pasture, high fertility, rotational grazing	529	108	5
Perennial pasture, high fertility, intensive grazing	530	107	5
Perennial pasture, high fertility, intensive grazing with ‘rest’ periods	525	112	5
Mature eucalypt woodlot	630	13	5

These simulation studies suggest deep drainage rates in excess of 100 mm/year are likely in perennial pasture systems in this 640 mm rainfall environment, in which approximately 70% of the rainfall falls in the winter months. In contrast, a well-established stand of trees will reduce this ‘water excess’ to approximately 10 mm/year.

Question 2. Landscape-scale impacts on water balance

It is not possible to say with any degree of certainty what impacts will come from planting 30% of a property to trees will be on the landscape-scale water balance. There is little doubt that tree planting on this scale will reduce the volumes of water leaving the unsaturated zone and moving onto saturated flows via groundwater and surface water systems. However, the significance of such reductions and their impact on surface expressions of salinisation and on salt flows into streams and river systems cannot be quantified with the information currently available. Landscape-scale hydro-geology will determine the quantitative outcome of such land-use change.

Catchment-scale modelling conducted for the National Land and Water Resources Audit (NLWRA 2000) would suggest that revegetation of 30% of a catchment might have a small impact on the expression of dryland salinity in catchments over the next 50–100 years. This impact might be in the form of a reduced rate and final extent of salinisation or might be to stabilise salted areas to the current expressions. Direct evaluation of water flows at the catchment scale would be needed to make any more definitive statements.

Technical analysis four

The innovation here is the establishment of contour banks (a keyline approach) to direct water flows over the undulating landscape and the use of soil surface management practices (ploughing on the contour and applying soil conditioners) to reduce run-off on the cropped land between the banks. Tree planting along the contour banks is another feature of the system.

Technical question being assessed

What are the likely impacts of the trees, contour banks and farming practices on the water balance, in particular on deep drainage contributing to dryland salinisation?

Source of technical assessment

A qualitative assessment based on broad principles of water balance and farming system management.

Assessment

An annual wheat cropping system in a 325 mm rainfall zone in Western Australia might be expected to ‘leak’, on average, 30–50 mm/year, depending on soil type and farming practice (Asseng *et al.* 2001a,b). The fact that salt scalds are reported on this property suggests that water balance problems contribute to localised rising watertables and salinisation.

Land management practices that encourage water infiltration in the cropping areas (ploughing on the contour and application of soil conditioners) may improve crop growth and yields, but their impact on the water balance and the deep drainage term is probably small. There will be a trade-off between greater infiltration contributing to drainage and better crop growth, increased water use, and reduced drainage. While increasing soil organic matter will promote greater water-holding capacity, the suggestion that a 1% increase in soil organic matter doubled soil water-holding capacity seems large.

The gathering of run-off waters and their direction along the vegetated contour banks may be more significant in terms of landscape water balance. If run-off is a significant term in the water balance of these soils, then the direction of this water to areas of deep-rooted perennial vegetation would have significant sustainability benefits. Mention is made of 25% of the landscape now covered in trees. If these trees are capturing water flows from some of the remaining cropping land, this system has the potential to provide an effective balance between crop production and watertable and salinity control.

> **Case study 16**
>
> **WHEAT PRODUCTION/KEYLINE**
>
> **Location:** eastern wheat belt Western Australia.
>
> CS16 produces wheat crops using keyline principles in arid conditions. He has used the keyline principles in combination with tree planting to improve water-use efficiency and crop yields.

Other considerations

The effectiveness of the contour banks and trees in controlling the broader-scale watertable issues cannot be adequately assessed without local knowledge of the hydro-geology of this region.

Technical analysis five

The issues here appear to be the combination of grazing management and brigalow regrowth management to improve returns from the animal production enterprise. There are suggestions that by allowing the regrowth of the brigalow, watertables are falling and a potential salinity problem is being averted.

Technical question being assessed

What impact would pasture establishment and management and brigalow regrowth be likely to have on water balance in these heavy clay soils in a 700 mm central Queensland rainfall environment?

> **Case study 10**
>
> **CELL GRAZING BRIGALOW COUNTRY**
>
> **Location:** central Queensland
>
> CS10 has developed a system of managing brigalow regrowth and the pastures within it using cell-grazing techniques rather than extensive land clearing.

Source of technical assessment

A qualitative assessment based on broad principles of water balance and farming system management.

Assessment

It is difficult to comment on the assertions of animal production benefits from areas where brigalow has been allowed to regrow in the pastures. Clearly in an extreme case, a brigalow forest might re-establish and this could be close to grass-free. In such a situation, animal production would be strongly limited.

In terms of water-balance impacts, deep drainage below a natural brigalow forest in a 700 mm annual rainfall zone in central Queensland (on a heavy clay soil) could be expected to be effectively zero. When this forest is cleared for pasture, there is some risk that the drainage term in the water balance might be increased (in this case study, there is anecdotal evidence suggesting this might have happened. However, current APSIM modelling (eg. work reported in RAAL project CTC11) suggests this risk is very small. A productive perennial pasture in these environments should be able to make use of the rain that falls with relatively small run-off terms in the water balance and effectively zero deep drainage terms. If pasture establishment and growth was poor or if the pasture did not establish a deep root system, than the risk of drainage would be greater.

Allowing brigalow regrowth to occur would certainly reduce the chances of the excess water contributing to deep drainage.

Other considerations

The assessment of water-balance terms under brigalow and pastures in central Queensland is based on extrapolation of model-based assessments from southern Queensland environments. There are very few direct measures of water-balance terms in these Queensland situations.

Technical analysis six

A Land & Water Australia project, "Documenting Concepts of Integrated Whole Farm Planning", within the RAAL program is currently being conducted on this farm (Walker 2003).

Discussion with the project manager, Colin Walker, has indicated that although the project is in the early stages, the following points can be made:

- the hydrology of the farm is basically in good health and salinity problems are localised
- the drainage system is effective in intercepting the base flow of water and diverting it into surface flow — it is an effective recharge-avoidance strategy
- the water diverted and stored is used effectively to generate income and diversify the enterprise base
- stream water has been regularly monitored and provides a stable data set
- ecosystem health is good, largely because of the vegetation that has been established along the drains and waterways. The tree-lines effectively conduct wildlife around the farm and contribute to ecosystem health as well as the success of organic farming practices by maintaining a healthy level of biodiversity.

The project will continue and will provide data on hydrology and ecosystem health.

Summary

The technical analysis demonstrates that each of these innovative systems is capable of addressing aspects of various sustainability issues — water and nutrient balance, soil erosion, biodiversity loss, etc. There may be trade-offs with production, yields and financial return.

This analysis tends to highlight the isolated and small-scale nature of these innovations while at the same time suggests that the potential does exist for the principles used in these innovative systems to have a positive impact on a number of sustainability issues.

Case study 24

INTEGRATED WHOLE-FARM PLANNING/ KEYLINE PRINCIPLES

Location: south-western Western Australia.

CS12 has used keyline principles to develop a whole-of-landscape approach to resource management. Trees are planted on the contour, stored water is used to produce organic horticultural crops, and soil nutrient levels are monitored using the Albrecht system.

Recommendations

Background to recommendations

This is a report of case studies of on-farm innovations related to water and nutrient balance. It is impossible not to be enthused by the dedication and persistence of the innovating farm families who participated in the study. However, our general conclusion from our search for/from the 24 case studies is that the extent and nature of current farm-based innovation, by itself, will not be sufficient to prevent a continuation of the adverse environmental impacts of Australian agriculture.

The principal factors leading to this assessment are:

- there are too few innovators working to implement fundamental improvements to existing systems or new systems for managing the adverse environmental impacts of agriculture
- with a few notable exceptions, innovators are not implementing innovative practices that are sufficiently systemic or holistic to deal sustainably with biodiversity and the avoidance of resource degradation
- innovators are principally, if not solely, focused at the level of the farm with little or no potential to influence biodiversity or resource degradation more broadly at the local, catchment or landscape levels
- innovators are constrained by a lack of appropriate institutional support frameworks, including from public, industry, and conservation organisations, from the local community and from the market
- innovators are constrained in their ability and capacity to monitor the impacts of their innovations on key environmental parameters and/or to ensure that continuous improvement spans successive owners or generations.

Having made these points, it is worthwhile noting that the innovative farming systems studied do provide valuable insights into the desirable direction for future innovation and for research and development — including a focus on soils and water management, an interest in natural systems, and a reduction in inputs.

The case studies described help to paint a picture of Australian farm innovators and innovative practices with reference to practices that may affect nutrient and water balances. Clearly the study presents only a small sample of innovative practices and further work would be required before an in-depth assessment could be made of the likely impact of all such practices. Additionally, it should be noted that this study adopted a farm-level focus. Broader regional and industry-wide alterations to land-use practices that may affect either nutrient or water balances were outside the scope of the study. For instance, we have not considered the possible positive or negative environmental impacts of expansion of the viticultural industry, of dairy deregulation, or of trends in agricultural policy more broadly.

The limitations and strengths of the study should neither be ignored nor overstated.

The limitations include:

- the practical restrictions on the resources available for identifying innovative farmers and the size of the sample selected for interview and further study — however, these are considered to be minor limitations as resources were pooled between this and related studies and often the same farmers were identified by more than one process to identify innovators
- the sampling approach which intentionally excluded most farmers developing alternative enterprises or mixes of enterprises and those who are focused principally on incremental improvements to existing systems
- the paucity of hard data on the probable effects of the innovations

The strengths include:

- the willingness of innovative farmers to contribute to the study, in part because of the selection procedure and the practical background of the project officers
- the complementary backgrounds and expertise of the project team members and the opportunity for interaction between the paired interviewers
- the geographical spread of the selected sample of innovators.

The following discussion points and recommendations are grouped according to whether their prime focus relates to resource management, the innovation process, or to the process of design.

Resource management

The innovations described in this project related principally to soil health, water management and natural systems. Presumably this reflected, at least in part, the emphasis in the project on water and nutrient balance. However, we believe that these directions are likely to be typical of a broader cohort of innovators in natural resource management.

Several factors from this study and elsewhere point to the dangers in designing policies and programs to improve natural resource management which do not take account of:

- the large differences between regions, catchments, sub-catchments and farms in the relative importance of the factors that contribute to water and nutrient balance
- our lack of agreed strategies to prevent and redress environmental degradation
- our historically poor record of success in achieving desirable ecological outcomes from focusing only on particular aspects, such as salinity, tree cover etc.

Furthermore, the case studies illustrated that there are numerous schools of understanding about the meaning and determinants of soil health and about how soil health might best be improved.

The case studies exhibited a consistent interest in natural systems and the adaptation of principles from Australian natural systems to agricultural practices. The innovators did not specifically refer to biomimicry and there were no innovators whose focus was solely biomimicry. The level of interest, however, demonstrated an interest in and a need for an expansion of the current knowledge base on the principles of biomimicry and their adaptation to Australian agricultural systems.

We recommend that:

(1) national, state and regional programs to improve natural resource management should be designed to
  - encourage continuous holistic/whole system (rather than partial) improvement in natural resource management
  - enable catchment and sub-catchment priority-setting of the nature of the required outcomes
  - enable diversity and innovation in the strategies employed to achieve improvement in natural resource outcomes

(2) Land & Water Australia undertakes an assessment of the need for alternative views to be heard and further developed in relation to what constitutes soil health and of what strategies might best be employed in the search for practical means of improving soil health

(3) Land & Water Australia considers the need for an assessment of the breadth and adequacy of the available professional expertise in relation to soil health

(4) Land & Water Australia continue to support the current research effort on biomimicry and address the need to improve the knowledge base within the broader Australian agricultural community through a targeted communication effort.

The impacts of the innovations studied in this project generally were limited to the farm upon which the innovation arose. However, it was not intended that this project would provide the detailed evaluation of farmer-initiated innovations that would be necessary before advocating an expansion or extension of particular innovations.

However, what this project does highlight is the need to extend and evaluate soil and water management practices from innovative farms to the local, sub-catchment and catchment levels, rather than to rely on, for instance, the widespread application of best management practices. Such reliance would be of particular concern when those practices are specified without due regard to the thoughts and practices of innovators and/or when they are specified primarily as a means of legitimising existing mainstream practices.

We recommend that:

(5) the eclectic mix of experience and understanding held by the case study innovators should be harnessed in non-threatening environments so as to inform the design of further research and development and to provoke further insights from the innovators

(6) ways be devised to ensure innovators have an opportunity as a group to contribute to the development of policies and strategies at the catchment or sub-catchment level.

The innovation processes

The case studies reported here raise several issues about the nature of innovation on farms that are worthy of further consideration.

The innovation imperative

The principal factors prompting the recognition of the need for innovation were poor farm cash flow and spiritual, ecological and health considerations. However, maximising or optimising profitability was rarely the principal determinant of the innovative approach taken to the management of the farm resources. In most situations, the innovation was driven by a high level of intrinsic interest in improving ecological sustainability, in contributing to current and future communities, and in the biophysical phenomena underpinning the innovation. In other words, the innovation was not market driven.

Our understanding of the drivers of creativity (see Gleeson *et al.* 1999) supports the finding from these case studies that innovation leading to new system parameters or to new systems is not usually driven primarily by market factors. This situation is likely to contrast with that applying to innovation leading to refinements of existing systems. It is also supported by our understanding of the effects of innovation systems on the nature of innovations, and more tangentially by the conclusions of our recent review of the determinants of natural resource management behaviour (see <www.synapseconsulting.com.au>).

This project is titled "A review of farmer initiated innovative farming systems". However, to our knowledge no case has been made that such innovations are likely to be fundamentally different to innovations initiated by other people. Consideration of what drives people to be creative and of the drivers of innovation is probably more instructive than an examination of innovation from the perspective of who has initiated the innovation. Furthermore, the creative insight that might lead to innovations in system parameters and in new system development is likely to come from an effective interplay of people with great expertise in varying domains rather than from people working solely within one domain.

Barriers to innovation can best, or perhaps only, be examined in relation to the nature of the innovation sought. In other words, there is a relationship between the innovation system and the nature of the innovation arising from the innovation system. For instance, farmers who are well established in an existing enterprise or business and whose focus is circumscribed by that domain are less likely to establish or participate in an innovation system that is directed towards the creative replacement of the business than is someone without those attributes. Furthermore, this phenomenon is reinforced if, as is often the case, the influential gatekeepers of ideas and systems are those farmers who are close to the market and who are primarily driven by commercial values.

The proposition that fundamental changes to existing system parameters and new system development are not market driven is, if verified, a most significant observation. For instance, it will have major implications for the nature of the institutional arrangements best suited to facilitating innovation.

We recommend that:

(7) with a view to informing the institutional arrangements necessary to facilitate improvements in natural resource management, Land & Water Australia reviews the drivers of innovation that may lead to fundamental change in how people use and impact on rural landscapes.

Fragility

The second issue related to innovation in the farm sector is the fragile nature of the innovators and of the innovations. Invariably, the innovators, as is generally true of creative people (see Gleeson *et al.* 1999), judged themselves to be isolated from social support groups. However, they expressed the desire to experience more supportive and challenging social interaction.

It is highly probably that the innovators tend to isolate themselves by their actions and attributes. However, it is also likely that dominant biophysical paradigms, political considerations, organisational cultures and processes, and the inherent conservatism in rural and scientific communities play a part in isolating innovators. Furthermore, some innovators expressed the view that agricultural education and training institutions constrain revolutionary thinking. Other factors that might be constraining innovation in landscape management are discussed in a separate paper, "Landscapes and mindscapes: making space for creativity", by Tony Gleeson.

We conclude from this study and the literature that the nature and extent of existing on-farm innovation in relation to water and nutrient balance are sub-optimal, at least in ecological terms; that is, there is a *prima facie* case for change.

We also conclude from this and other studies that existing innovation systems lack diversity and that this will limit our capacity to innovate; that is, we need to add new innovation systems rather than or in addition to augmenting existing innovation systems.

The cost of short-lived institutional changes can be substantial. Hence, whilst certain principles could now be defined, a cautious approach should be taken to determining the nature of additional innovation systems.

We recommend that:

(8) Land & Water Australia considers the advantages and disadvantages of establishing a Centre, Institute or Network for Rural Landscapes, the principal purpose of which would be to provide leadership and support for innovators in rural landscape design and resource management

(9) as soon as possible, a national workshop or similar process be conducted to provide:
- network support for the key innovators identified by this study (and possibly others)
- input from innovators into the nature of institutional support best suited to facilitate innovation
- input from innovators in relation to how best the likely impact of on-farm innovations might be evaluated
- input from innovators into determination of strategies that enable innovators to contribute constructively to the development of catchment targets and strategies.

Specific issues related to innovation that warrant further consideration include:

- how to provide better monitoring of the effects of farm innovations on the state of natural resources
- how to support extension of innovative concepts and practices beyond the originating farm/farmers
- how to better protect investments in on-farm innovations for appropriate periods across different land owners/managers.

The process of design

As mentioned earlier, most of the innovative farming systems studied have been developed individually and in isolation. In addition, much of the research and development work currently being conducted in agriculture and resource management is responsive — that is, it is focused on dealing with problems (such as salinity, loss of biodiversity etc.) as they arise. Farmer-initiated innovation is similar and innovative practices have largely been developed as a response process. Generally, they have been developed without a design framework at the farm level (the level of development of each innovation) or at other levels such as catchment or a national level (the level of redesigning landscape management systems appropriate for this country).

A design framework or frameworks to guide innovation at a number of spatial levels will be useful. One of the drivers behind the development of the RAAL program is that very need, and analysis of data collected in this project supports that need. The initial aim of the RAAL project was to re-design agriculture. It would follow, therefore, that there is a role for the application of a design framework, or the involvement of people with a design background, in this process.

It is worth noting, however, that the process of design itself will be facilitated and improved if the cognitive framework within which it operates is understood. This is, and must be, foremost a landscape framework, which will encompass agricultural and non-agricultural aspirations, issues, options and strategies.

Confusion between what is meant by 'agricultural systems', 'farming' and 'rural' can lead to a misunderstanding of what needs to be done to promote rural innovation. Hence it is important that we use these terms consistently and universally.

'Agricultural systems' are the economic, social and physical activities involved in the marketing, handling, processing and production of food, fibre and related products such as plant and animal-based pharmaceuticals and floriculture.

'Farming' is the term we use to describe activities that occur solely or principally on farms, including, for instance, agricultural activities, off-reserve conservation, management of investments (which might be on- or off-farm) and farm tourism. The term 'farming system' is the purposeful management of farming, including the economic, social and cultural determinants of this behaviour (after McCown, unpublished). The important point here is that these definitions extend the activities encompassed by farming beyond agriculture and enable integrated development of potentially synergistic agricultural and non-agricultural farming pursuits. We should also recognise that future food and fibre-producing systems increasingly may not involve a land or marine environment as they are conventionally conceived.

The aspirations of rural and urban Australians will not be well served by land-use policies or innovation frameworks that are based on the premise that the prime, universal use of natural resources should be expansion of agricultural activity.

The RAAL program is one of a number of initiatives across the country focusing on the design of new agricultural systems. Design processes are used in disciplines such as architecture, landscape architecture, urban design etc. Many of the principles of these processes would be appropriate for a process of designing resource management systems that 'farm without harming' and for designing a national process of developing landscape management systems that are appropriate for this country.

The work of Christopher Alexander (1964), a distinguished contemporary design theorist, began with the study of landscapes and led to the development of a design method that is used as the basis of a range of design processes. According to Alexander and others, the process of design itself is important and is a crucial step in achieving an appropriate fit between form and function.

> I believe that our feeling for form can never reach a comparable order of development until we too have first learned a comparable feeling for the process of design. (Alexander 1964)

Carl Steinitz, a professor of landscape architecture and planning at the Harvard School of Design, developed a framework for design that identified six questions. This framework is passed through at least three times in any design project: first, downward in defining the context and scope of a project; second, upward in specifying the project methodology; and third, downward in carrying the project forward to its conclusion (Steinitz 1999).

The six questions

The six questions are as follows, listed downward in the order in which they are usually considered when initially defining the context of a design problem.

1. How should the state of the landscape be described? **Representation models**
2. How does the landscape operate? **Process models**
3. Is the landscape functioning well? **Evaluation models**
4. How might the landscape be altered? **Change models**
5. What predictable differences might the changes cause? **Impact models**
6. Should the landscape be changed? How is a comparative evaluation among the impacts of alternative changes to be made? **Decision models**

Each of these questions relates to a model that may also be used as part of the design process (Steinitz 1990).

If we consider the RAAL program as a similar design process or part of a similar design process, the Review of Farmer Initiated Innovation can contribute usefully to the questions, 'How might the landscape be altered?' and 'What predictable differences might the changes cause?' and by doing so can contribute to Steinitz's Change model and to the Impact model.

The Steinitz framework suggested, or an adaptation of it, would provide a framework that could be applied across the entire landscape. However, before applying this process, it is useful to ask, 'What do we want from the landscape?' This is a question of values and community expectations and must be an important step in the initiation of a design process. Answering this question is possibly beyond the scope of the RAAL program but as it is approached and discussed, it will provide a starting point for the application of a design process such as suggested by Steinitz. The questions asked in the Steinitz framework would then be answered in the context of community aims and expectations and the process used to achieve those aims.

Much of the ground-work in this country has already been performed by a range of research and development organisations and it would be possible to compile a reasonable understanding of questions 1 and 2 in the Steinitz model. Community expectations and values would provide, with scientific understanding, a base against which to evaluate the function of the landscape, as in question 3. The remaining steps of the design process would then be applied on a landscape scale within the context of the first three questions with question 6 acting as a check against expectations and aims.

This process may form an integral part of a national debate on natural resource management and future direction for the redesigning of agriculture for Australian landscapes. Land & Water Australia is in a position to lead this debate and the framework suggested could be used to establish a framework for the debate and for the process of design.

Innovative farmers themselves may also benefit from applying a design process to the development of their innovations and would perhaps also benefit from understanding where their approach fits into a broader process. It is important to note, however, that the process of innovation may be detrimentally affected by the application of external processes.

We recommend that:

(10) some effort be directed into developing and applying a design framework to the process of redesigning agriculture for Australian landscapes.

Earlier comments and readily accessible evidence point to a need for radical change in the way we approach our landscape. In many ways, these changes need to go back to the beginning and the implementation of planning and design processes at a number of levels will be essential to ensure appropriate changes are made. The need is apparent and the available information is sufficient to begin the process. The process itself will be as important and instructive as the changes that are made as a result.

Communication

An important aspect of the success of the RAAL program in achieving significant change in Australian agriculture will be communication. This project has highlighted a lack of communication between innovators and possible support institutions. This lack of communication may be costly in the long term, as innovations studied during this project have the potential to contribute to the process of addressing a number of sustainability issues. Not only will communication be essential in addressing sustainability issues, but it is also vital in ensuring that innovation is an ongoing process.

Effective communication, therefore, needs to be planned and progressed at a number of levels, beginning at the level of communicating the results of this project.

A communication strategy will need to target policy-makers, research institutions, media and farmers with a focus at the farm level, the catchment level and broader.

It will be important to present selected case studies and the key findings of this report as a stand-alone document or presentation, knowledge and recommendations from this review have direct relevance to farmers, researchers and policy makers.

It will also be critical to include the results of this review in a broader communication framework applying to the RAAL program.

We recommend that:

(11) Land & Water Australia
- produces an electronic or video version of selected case studies and recommendations in this report for a stand-alone presentation and for inclusion in a broader RAAL communication package
- develops a television program, possibly with the support of the Australian Broadcasting Corporation (ABC), presenting and examining stories of innovation in resource management
- develops a forum for innovation in agriculture (see recommendation 9).

We also suggest developing a capacity to establish direct communication between innovators and research organisations. This could include a capacity to collect detailed data for the researchers to use but also to conduct modelling and supply performance information back to the innovators. This would be achieved through the establishment of a Centre for Alternative Rural Landscapes (recommendation 8).

Recommendations summary

In summary, we recommend that:

(1) national, state and regional programs to improve natural resource management should be designed to
- encourage continuous holistic/whole system (rather than partial) improvement in natural resource management
- enable catchment and sub-catchment priority-setting of the nature of the required outcomes
- enable diversity and innovation in the strategies employed to achieve improvement in natural resource outcomes

(2) Land & Water Australia undertakes an assessment of the need for alternative views to be heard and further developed in relation to what constitutes soil health and of what strategies might best be employed in the search for practical means of improving soil health

(3) Land & Water Australia considers the need for an assessment of the breadth and adequacy of the available professional expertise in relation to soil health

(4) Land & Water Australia continue to support the current research effort on biomimicry and address the need to improve the knowledge base within the broader Australian agricultural community through a targeted communication effort

(5) the eclectic mix of experience and understanding held by the case study innovators should be harnessed in non-threatening environments so as to inform the design of further research and development and to provoke further insights from the innovators

(6) ways be devised to ensure innovators have an opportunity as a group to contribute to the development of policies and strategies at the catchment or sub-catchment level

(7) with a view to informing the institutional arrangements necessary to facilitate improvements in natural resource management, Land & Water Australia reviews the drivers of innovation that may lead to fundamental change in how people use and impact on rural landscapes

(8) Land & Water Australia considers the advantages and disadvantages of establishing a Centre, Institute or Network for Rural Landscapes, the principal purpose of which would be to provide leadership and support for innovators in rural landscape design and resource management

(9) as soon as possible, a national workshop or similar process be conducted to provide:
- network support for the key innovators identified by this study (and possibly others)
- input from innovators into the nature of institutional support best suited to facilitate innovation
- input from innovators in relation to how best the likely impact of on-farm innovations might be evaluated
- input from innovators into determination of strategies that enable innovators to contribute constructively to the development of catchment targets and strategies

(10) some effort be directed into developing and applying a design framework to the process of redesigning agriculture for Australian landscapes

(11) Land & Water Australia
- produces an electronic or video version of selected case studies and recommendations in this report for a stand-alone presentation and for inclusion in a broader RAAL communication package
- develops a television program, possibly with the support of the ABC, presenting and examining stories of innovation in resource management.

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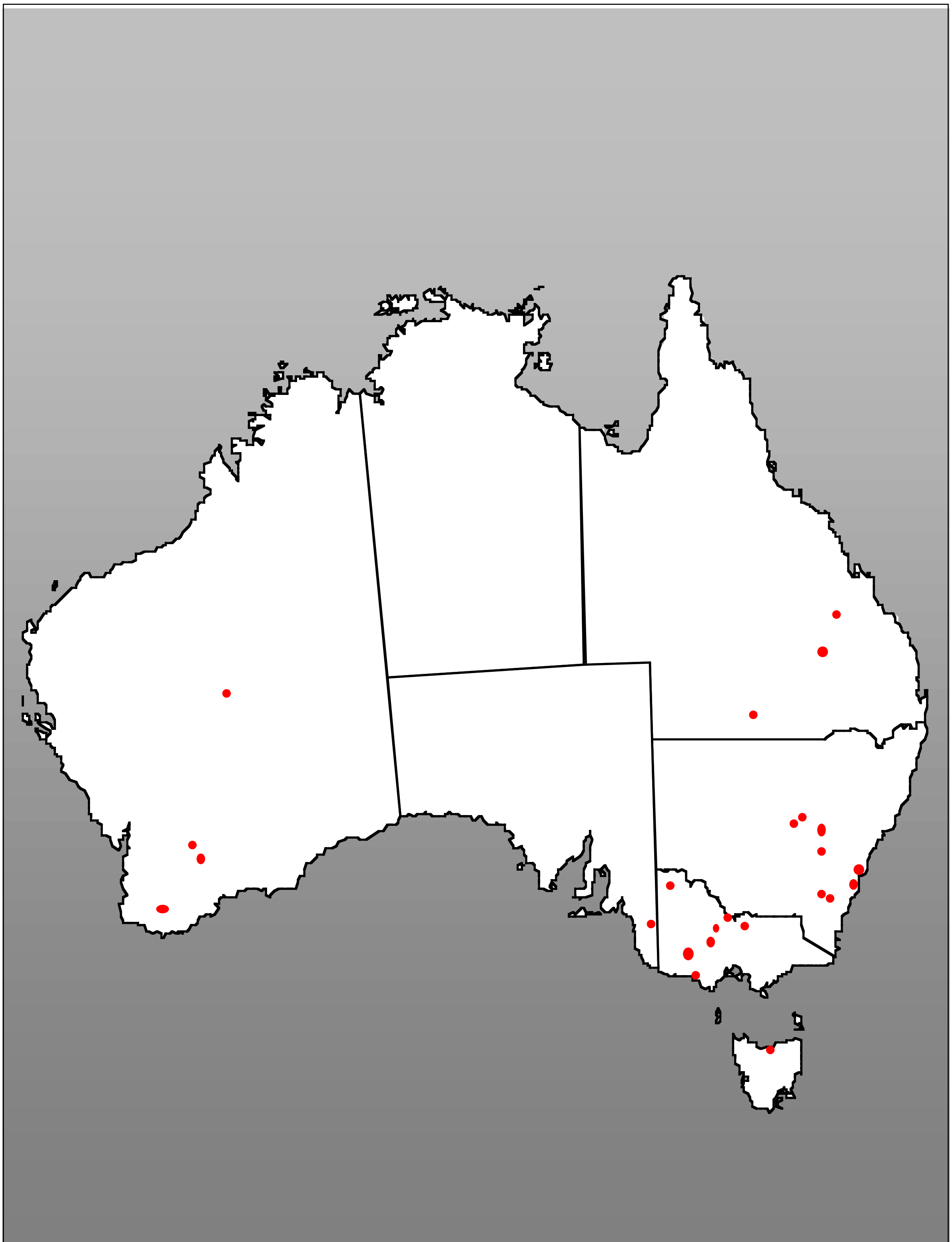
Appendixes

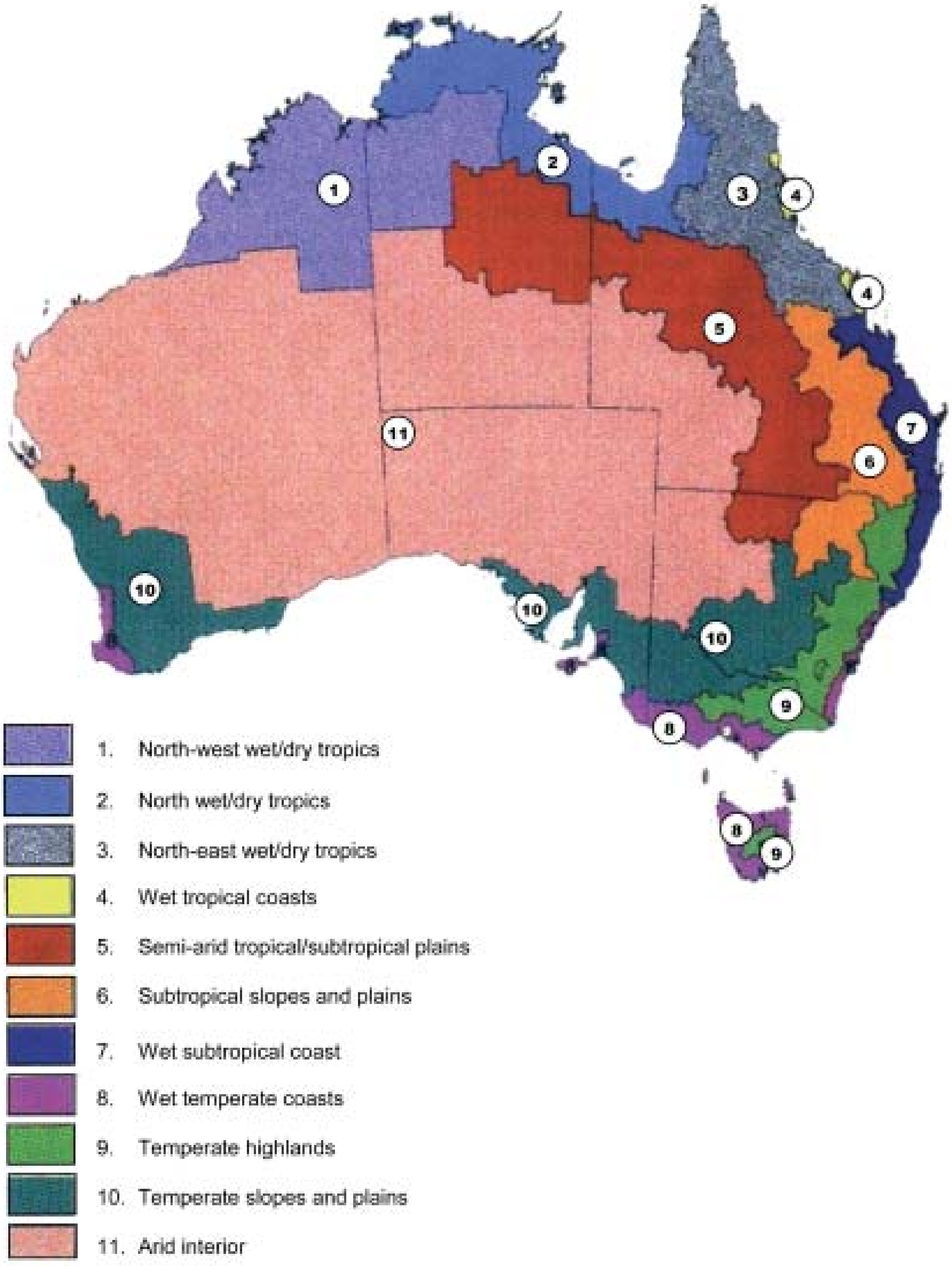
Appendix 1

Map showing case study locations



Appendix 2

Map showing agro-ecological zones of Australia



Appendix 3

Case studies

The case studies in this report have been reported as presented by the innovators with no attempt to pass judgement on the innovations. The claims herein are those of the innovators.

Case study 1

Location: 10 km south of Kyneton in central Victoria.

Type of enterprise: beef cattle production; cereal crops; hay and silage production.

Agro-ecological zone: 9

Climate: cool temperate.

Rainfall: 750–1,000 mm, mostly in winter.

Proportion of perennial vegetation: Mr CS1 is planting eucalypts and acacias as windbreaks and for timber production and has planted a variety of pines as wood lots.

Topography: undulating.

Water — creeks, dams, bores etc.: stock water is supplied by dams.

Innovation: since the early 1980s, Mr CS1 has been concerned with the continued use of superphosphate, weedicides and pesticides and their effect on soil structure and local waterways. He is also concerned that material is taken off the farm in the form of cattle, grain and hay and very little is returned. He has developed a compost process as a way of addressing these issues. Mr CS1 operates a beef-breeding operation on the property. He has investigated a number of ways to return nutrients to the land and through this investigation he has developed a compost-making enterprise. Mr CS1's first attempt to return nutrients to the land was spraying duck manure from a nearby duck farm onto his land. The results were immediately apparent and within three years hay production had doubled, veterinary visits ceased, conception rates lifted to 98% and earthworms reappeared. After three years, he stopped spraying duck manure in response to complaints about the smell. Mr CS1's next step was to attempt to eliminate the odour from the compost. Early attempts involved duck manure and old telephone books (as sources of nitrogen and carbon). The results were excellent. The odour was eliminated and pasture responses were as good or better than applying straight duck manure. Mr CS1 then started using the food component of liquid waste processed in Melbourne. The duck manure and telephone books became unobtainable and Mr CS1 sourced sawdust from nearby mills and other supplies of liquid waste from the cities and factories. These are liquids that cannot go into landfill or the effluent and storm-water systems. He first started using the process to make his own compost but has experienced considerable demand to take and treat liquid waste. Mr CS1 has developed systems and machinery to make compost using liquid waste and sawdust on a large scale. The process is now certified organic with the National Association for Sustainable Agriculture Australia (NASAA). He is currently dealing with major regulatory hurdles that prevent him from manufacturing and selling compost. At the same time, he has had inquiries to establish similar systems dealing with liquid waste and sawdust and other organic materials from other parts of the country. Mr CS1 spreads the compost on his own pastures and has used no superphosphate on the property since switching to duck manure. The pastures and the cattle have responded well. Compost is spread onto the pastures using a manure spreader and usually achieves a covering of 2–3 cm. The compost supplies nutrients directly to the soil but also stimulates earthworm activity and activates the microflora of the soil. Mr CS1 also believes that the microorganisms actively suppress many soil and root diseases, therefore minimising the need for chemical spraying.

Derivation of innovation: Low productivity, poor livestock health and the requirement for increasingly expensive inputs of artificial fertilisers, insecticides and weedicides convinced Mr CS1 that the current agricultural systems were not sustainable. He sees these systems as linear, while natural systems are circular in nature. Mr CS1 says, "The produce from our farms is consumed in the cities and the waste products from this consumption are either pumped out to sea or dumped into landfill with negative environmental consequences. This 'linear' system deprives the farmer of his minerals and organic materials and causes embarrassing excesses of organic materials in the cities, requiring expensive disposal of this 'waste'." Mr CS1 has devised a system of "closing the circle and returning large volumes of this organic resource back to primary production and sustainable agriculture". Mr CS1 is also an innovator in other areas and the tractor he uses on the farm is fuelled by waste cooking oil through a system he developed himself. Mr CS1 says that the tractor runs well and economically with similar power to diesel and has "the added benefit of smelling like a barbecue".

Case study 2

Location: central coast of New South Wales.

Type of enterprise: market garden.

Agro-ecological zone: 7.

Climate: temperate coastal.

Innovation: Mr CS2 operates a community-supported agriculture (CSA) enterprise. He grows staple fruits and vegetables for a number of subscribers who live in Sydney. He operates his garden on a share-farming basis on land that belongs to his share-farm partner who has a partnership agreement with each subscriber. He used demographical information to select a target area in Sydney and marketed his enterprise through a local natural health clinic. Each subscriber signs a 12-month contract, paid monthly in advance with a four-week trial period. Each subscriber receives a box of vegetables and fruits every week. The boxes are delivered to a central drop-off point. Each subscriber receives the same mixture and quantities of fruits and vegetables in their box. Exchange of work and time is also part of the contract and the group has a farm visit planned for September. Mr CS2 produces a newsletter that goes out with every box of produce.

Derivation of innovation: CSA systems are quite widely used throughout the United States of America. Mr CS2's subscribers are interested in the concept because of: food integrity issues, healthy lifestyle concerns, and concerns about being disconnected from the food chain.

Case study 3

Location: 30 km east of Hyden in the eastern wheat belt of Western Australia.

Type of enterprise: the major enterprise on the property was cereal grain production — wheat and oats — but is it now changing to meat and wool.

Agro-ecological zone: 10.

Climate: arid Mediterranean.

Rainfall: 310–325 mm, primarily winter.

Soils: clays, clay sandy loams, gravel soils, and deep sand and yellow sand.

Proportion of perennial vegetation: currently 20% of the property is bushland.

Topography: gently undulating.

Water — creeks, dams, bores etc.: stock water is supplied by run-off dams.

Water balance: there are considerable areas of salt scald on the CS3 property and on neighbouring properties and crown land. Mr and Mrs CS3 have been monitoring the salt scalds on their property using aerial photography and on-ground observation. They believe that these photos demonstrate that between 1994 and 1999 there has been a reduction in the areas affected by salt. On-ground observations also show the salt scalds receding. These observations will need to be continued over a range of seasons and time to produce conclusive evidence.

Innovation: Mr and Mrs CS3 run a self-replacing flock of merino sheep producing meat and 20–21.5 micron wool. They also grow approximately 400 ha of wheat. Mr and Mrs CS3 have been farming using biodynamic techniques for 10 years. They spray BD500 over all the arable land once each year after the first rains of the autumn break when the ground is sufficiently moist. Mr CS3 uses mechanical methods of weed control and ground preparation. He likes to plant after two frosts when the weed infestation has been reduced. He relies on the BD500 and the microbial health of the soil to prevent hard pan formation. Mr CS3 makes a lot of the machinery they use on the farm and also does a considerable amount of the building. The sheep graze temperate, annual pastures — primarily clovers and ryegrass. Sheep are run in four mobs and are supplemented according to the Annutriculture system provided by Hin Gee Rural Pty Ltd in South Australia. Under this system, a range of mineral and trace element supplements is made available to the sheep. Consumption is measured weekly and information on consumption, along with information on pastures, seasonal conditions and dung properties is sent to the supplier in South Australia. The supplier replies with recommendations on the amounts and types of supplement to feed. The system aims to balance the metabolic processes in the digestive tract of the sheep. Mr and Mrs CS3 are happy with the results in terms of animal health and production. The system is, however, time-consuming and supplements can be expensive.

Derivation of innovation: 15 years ago Mr CS3 was one of the leading users of chemicals in his farming systems. He found, however, that every year he had to use more and more chemicals, salinity was increasing, and a range of other problems appeared. He stopped using chemicals and read books on biodynamic farming systems by Alex Podolinsky and Creative Land Management by Arden

Anderrson. He visited other farms, liked the biodynamic approach and introduced it onto his own farm. Mr and Mrs CS3 do not appear to seek support from the agricultural institutions or from local groups or neighbours but rather from like-minded people located elsewhere. This is interesting in relation to what might be the best basis for group formation to facilitate communication and innovations. Mr CS3 is a highly capable, self-taught engineer and builder. He is able to and enjoys manufacturing and modifying machinery in innovative ways.

Case study 4

Location: close to Birriwa, 40 km north of Gulgong, New South Wales.

Type of enterprise: primary — cereal cropping; secondary — cattle and sheep production.

Agro-ecological zone: 9.

Climate: cool temperate.

Rainfall: 600 mm, non-seasonal

Soils: primarily granite-based sandy loams with an endosite base; 1,000 ha arable land, up to 800 ha sown to oats every year.

Proportion of perennial vegetation: Mr CS4 has planted over 15,000 trees over the last 10 years along fence lines and in water ways. Perennial pastures form an important part of the management system.

Topography: undulating.

Water — creeks, dams, bores etc.: dams and waterways.

Innovation: Mr CS4 uses a combination of pasture cropping and cell grazing to produce cereal crops and wool. Pasture cropping is a system whereby cereal crops are planted directly into native pastures. Preparation is primarily grazing and some chemical weed control. Under the cell grazing system sheep are maintained in one or two mobs and moved around the property. Mr CS4 believes that the combination of pasture cropping and cell grazing has driven significant changes to the soil on his property and hence to the pasture composition and growth, and to stocking rates. He has observed a build-up in organic matter in the soil and mulch on the surface and postulates that this has contributed to improvement in water infiltration, water use and biological activity.

Derivation of innovation: Mr CS4 has had to develop innovative systems in order to manage a farm that is non-economic by conventional standards. His family was not particularly innovative and he believes the property was degraded when he purchased it from his father. He has always worked off the farm. His work as a timber cutter gave him an appreciation for trees and helped him to realise that he needed to be planting and maintaining trees as well as harvesting them. Mr CS4 now works off-farm in a full-time job. These positions are complementary to his innovative work on his own farm and also enable him to contact a broad range of other farmers.

Case study 5

Location: near Kyabram in northern Victoria.

Type of enterprise: dairy.

Agro-ecological zone: 10.

Climate: temperate.

Rainfall: 650 mm.

Proportion of perennial vegetation: the entire property is highly improved with small tree lines and trees around the house.

Topography: flat.

Water — creeks, dams, bores etc.: supplied by irrigation channels.

Innovation: Mr and Mrs CS5 began with a conventional system but not for long, as Mrs CS5 began to suffer from chronic fatigue. Mrs CS5 did an influential course at Dookie College where she was the only enrolled female. They now run what is basically an organic dairying enterprise, using the Albrecht monitoring system, soil testing with SWEP, Melbourne. They milk a small herd of Jersey, Friesian and Aussie Red cows. A bull is used and the calving period is from July for seven weeks. The cows dry off at the end of May and have a period of no milking until calving starts. It is a low-cost and reduced-input approach to farming that suits them, as they both work in off-farm enterprises. Unfortunately, they could not supply organic product (to Sandhurst-Bendigo), as they do not milk all year round. Mr CS5 tests the soil every two years with the Albrecht system, balancing calcium, magnesium, sodium and potassium, and uses these results to balance the soil with a range of appropriate soil conditioners which include lime, gypsum and dolomite. The results of the Albrecht test are also used to develop the supplementation system for the milking cows. Cows are fed minerals as well as a small amount of grain in the bail. They are also fed copper sulfate and sulfur to control internal and external parasites. Other animal health problems, such as grass tetany, milk fever, calf scours etc. are prevented through the application of homoeopathic preparations in their drinking water. They use whole grains (not crushed) so as not to lose vitamins. Through this system costs can be kept low, as inputs are low and veterinary costs are minimised. Production levels are reasonable compared with the district averages, but high production is not the main aim of the enterprise. Mr and Mrs CS5 aim to achieve a balance of farm work, off-farm work and leisure time, and production and input levels in the dairy are organised to achieve this aim.

Derivation of innovation: Mr and Mrs CS5 left Melbourne six years ago and bought the farm to change to a rural lifestyle. Mrs CS5 became quite sick with chronic fatigue syndrome and an important part of the healing process for her was an organic diet. This led Mr and Mrs CS5 to think about organic farming. The final straw was provided when they lost 30% of their cows to nitrate poisoning during a lot-feeding operation. They began to question the conventional, high-input systems and needed to develop an approach that would enable them to overcome the financial burden caused by the loss of their cows while also balancing their other important aims. Organic farming combined with the use of the Albrecht system and off-farm income are providing the balance Mr and Mrs CS5 seek. The farm is not merely a business. Mr and Mrs CS5 have moved on from farming as a business to a farm life. They see their roles as farmers as providing quality (no chemicals) food, to help other organic-minded farmers, and to make a living.

Case study 6

Location: pastoral country at Meekatharra in the Gascoyne region of Western Australia.

Type of enterprise: beef cattle breeding and fattening, and meat marketing — certified biodynamic with Demeter.

Agro-ecological zone: 10 (finishing country); 11 (pastoral country).

Climate: Mediterranean (finishing country); arid (pastoral country).

Rainfall: predictable (finishing country); unpredictable (pastoral country).

Soils: sand plain (finishing country); highly varied (pastoral country). The Gascoyne River runs through the property.

Proportion of perennial vegetation: the pastoral country is in a natural state. The Eneabba farms are largely cleared and planted to annual pastures with some perennial plants.

Innovation: the CS6 family has integrated all the steps in beef production, from production to marketing, into a management system:

Production (rangeland)

↓

Finishing (farmland)

↓

Nutrition (nutritional program on farmland plus biodynamic practices)

↓

Marketing (marketing under their own label).

Production: the base of the production system is a 3,000-head breeder herd run on pastoral country north of Meekatharra. The cattle are managed on an open-range system and mustered and handled on the waters. No fertilisers or chemicals are used in this operation and a rangelands monitoring program has been established. Mr CS6 has worked with the Demeter group to establish a set of certification protocols for rangeland production.

Nutrition: as a broad rule, sale cattle spend 12 months on the Eneabba properties, finishing the last 6 months before slaughter on the finishing property. This property is a certified biodynamic property and is sprayed once a year with BD500. While on this property, cattle are also fed a range of mineral and trace element supplements according to a self-selection system in which cattle are given access to a range of supplement mixtures. Intake is measured, recorded and reported every week and the supplementation mix and management regimes are adjusted according to intake levels. The aim is to balance the metabolism in the digestive tracts of the animals and to monitor the fattening and finishing processes. The use of this system and biodynamic practices over the last six years have built up the humus content of the sandy soils and changed the properties and production capacity of the soil. Mr CS6 believes the soils have become less compacted, become more biologically active, and increased in water-holding capacity.

Marketing: cattle are slaughtered once a month on a contract basis at an abattoir at Harvey, south of Perth, and slaughters are attended by one of the family. All meat is ‘cryo-vacced’ and aged before being marketed under a brand name for which Mr CS6 has established a reliable market over a number of years. Most meat is sold domestically through a range of retail outlets in Western Australia, Victoria and New South Wales.

Derivation of innovation: Mr CS6 originally left farming in the south of the state because he made a moral choice not to become involved in chemical agriculture. He read *Silent Spring* by Rachel Carson and moved north to a pastoral property. Securing economic and employment opportunities for family members within the family business was the primary motivation for the innovations involved in this enterprise. As Mr CS6 attempted to integrate the business down the value chain, he realised they were producing a unique, healthy, clean product from the pastoral country. He began to investigate ways of maintaining these qualities and found that the Demeter biodynamic system fulfilled the criteria.

Case study 7

Location: 100 km north-west of Injune on the Carnarvon Gorge in central Queensland.

Enterprise: primary — youth education; secondary — beef cattle.

Agro-ecological zone: 6.

Climate: subtropical.

Rainfall: 575 mm.

Soils: light sandy soils (80%) and red basalt soils (20%).

Proportion of perennial vegetation: there has been virtually no clearing or timber treatment except for a small area around the house, therefore the proportion of perennial vegetation is virtually 100%.

Topography: undulating to rugged with frontage to the Carnarvon Gorge.

Water — creeks, dams, bores etc.: dams, springs and creeks.

Innovation: Mr and Mrs CS7 run a youth eduction program and the property is used as the bush education component of the program. Groups of 'at risk' youths spend 10–14 days at the property during which they walk and camp for 3–4 days and work at the base establishment for 7–10 days. They then spend some time learning about the indigenous inhabitants of the area, their customs and resource management approaches. The program has been operating for 12 years and Mr CS7 believes the experience provided by the land is integral to the process of helping these young people address a range of issues within their lives. Mr CS7 and his family operate a cattle-breeding enterprise on the property to generate income and because the terms of the lease stipulate that it is for pastoral purposes. The nature of the country makes livestock management difficult and traditionally cattle enterprises in the area have been harvesting operations.

Derivation of innovation: Mr CS7 grew up with a balance of rural and urban living. In his early twenties, he was engaged in a deep search for meaning and experiences with the bush and the context of his relationship to land were crucial in this search. He now aims to make this experience available to others. Mr CS7 strongly believes that a spiritual connection to land is vital for the health and wellbeing of individuals and communities. In the youth education program, Mr CS7 aims "to keep well out of the way of the interaction between these youths and the land" and "let the land work its magic".

Case study 8

Location: Echuca, Victoria.

Type of enterprise: in transition.

Agro-ecological zone: 10.

Climate: ethereal.

Innovation: Mr and Mrs CS8 ran a biodynamic dairy farm in the Echuca area for 10 years. They milked up to 170 cows on a 129 ha farm and sold their milk as certified biodynamic milk for a 20% premium over conventional milk. They used homeopathics to address herd health issues, however they found it difficult to make a living and Mr CS8 suffered from a farm accident. They sold their dairy farm four years ago and are in the process of developing a small farm (providing agistment and haymaking) before they move on, possibly to northern New South Wales.

Mr CS8 works as a flame-weeding contractor, mostly on organic farms, now using steam rather than flame. Weeds are a major problem during the conversion process from conventional to organic farming and there is an important role for flame-weeding as an organic weed control process.

Mrs CS8 works in the areas of healing, people, land and livestock. She has been using alchemy and colours to control pests and to keep the soils healthy on their own farm. She also works for a number of clients, and has achieved significant success in controlling pests on grapevines. Mrs CS8 believes that a combination of alchemy, colour, sound and kinesiology will be the healing modalities of the future for people, animals and the land. She is doing work off-farm to control orchard pests using colour and alchemy.

Case study 9

Location: Walpeup — Mallee Research Station, north-western Victoria.

Enterprise: the research projects are all involved with cereal grain production, primarily wheat. The research projects will be conducted on four sites in the Mallee region.

Agro-ecological zone: 10.

Climate: semi-arid temperate.

Rainfall: average April–October, 30–35 mm/month, 210–245 mm total; November–March, 20–25 mm/month, 100–125 mm total; total yearly average, 310–370 mm.

Soils: sandy loams.

Topography: gently undulating.

Water and nutrient balance: rising watertables and salinity are major issues in the Mallee district of Victoria.

Innovation: novel farming systems — these propose to grow crops at wide row spacing across the whole farm, and rotate into the inter-row instead of between paddocks, termed wide row systems (WRS). The current Mallee system is typically a cereal–fallow (mechanical or chemical) rotation in paddocks. The fallow phase provides a disease break, mineralised nitrogen, some water storage and feed for sheep. However, when a full profile of soil water is stored, mineralised nitrogen is in danger of leaching beyond the root zone, and soil water likely to be evaporated. The quality of sheep feed is quite variable. WRS ideally use all water each year without trying to carry water from season to season, and thus putting mineralised nitrogen at risk of leaching. The disease break is obtained by either keeping the inter-row space free of weeds and relatively dry at the surface (to minimise host root growth in the top 10 cm of soil where pathogens are active) or by using the relatively larger amount of water available to each plant at the wide row spacing to grow break crops successfully. WRS would be a radical change on Mallee farms where the crop intensity is quite low. Sowing and weed control would be conducted on a much larger area each year, but at a lower intensity, because only the row or inter-row would be managed in most operations. The whole farm would be harvested each year, and the area available to run sheep would drop, although feed quality might also increase. This type of farming will require precision planting and cultivation. The project is in the process of building a specialised wide-row seeder and will use satellite navigation devices to maintain the high precision that will be necessary. It is a high-technology, high-input system.

Derivation of innovation: Mr CS9, the researcher responsible for this project, grew up on a Mallee grain farm not far from Walpeup. He left home to further his education and experience and now is back in the Mallee region, currently living on his parents' farm and helping his father during critical periods.

Case study 10

Location: 30 km south of Theodore in central Queensland.

Type of enterprise: pasture management; beef cattle growing and fattening

Agro-ecological zone: 6.

Climate: subtropical.

Rainfall: 700 mm.

Soils: brigalow clay soils; some soft wood scrub soils; some sandy spotted gum type forest soils; 60% of the property is sandstone gorge country.

Proportion of perennial vegetation: 60% (4,740 ha) of the property is unused and is in its native state. 30% of the balance of the property (1,000 ha) is now covered with regrowth. The total perennial vegetation is 5,740 ha (73%). The balance of the country is planted to buffel grass monoculture.

Topography: undulating to hilly in the sandstone country.

Water — creeks, dams, bores etc.: all surface-water dams.

Water and nutrient balance: there are areas of salt scald on the property, primarily in the scrub soil country. When Mr CS10 first came to the property in 1982, the watertable in this country was 1.8–2.4 m below the surface. Dams in the area would drop to this level and no more in a dry time. As the regrowth has increased, the salt scalds have grassed over and the watertable has dropped so that the dams now empty completely in a dry time. Mr CS10 believes that the regrowth has played a role in lowering the watertable but he also believes that grazing management (cell grazing) has promoted better and deeper root growth in the grasses and this has contributed to lowering the watertable. There are a number of salt scalds developing on other properties in the area.

Innovation: all the brigalow country on the property was cleared by Mr CS10's father in the late 1950s and early 1960s. Regrowth then was controlled with fire until it got to the point where fire would not burn because there was no grass on the ground. In 1982, Mr CS10 and his family came back to run the property. They arrived to a wall of suckers. Share farmers cleared, ploughed and grew crops on 800 ha. In 1983, Mr CS10 blade-ploughed regrowth in strips, clearing 60 m strips and leaving 20 m strips of regrowth. This was done over an area of around 81 ha. In 1988, more blade-ploughing was used and this time 6 m-wide strips were cleared leaving 6 m-wide strips of regrowth. This was done over an area of 162 ha. Since then, no more regrowth control or clearing has been done and the regrowth is gradually returning over all the cleared areas. In 1993, Mr and Mrs CS10 started managing the grazing on the basis of a cell grazing system. The property has now been fenced into small paddocks (average 30 ha) and cattle are in three mobs moving around these paddocks. Cattle are generally in a paddock for 1–4 days. Mr CS10 analyses grazing yields as grazing days/ha/year and grazing days/100 mm of rain. He has found that the presence of timber has no negative effect on grazing yields and, in fact, the timbered areas often provide a better yield than non-timbered areas. Mr CS10 has noticed that the cattle prefer to graze the grass under trees. He believes the grass under the trees is more palatable because the soil is healthier due in part to the recycling of nutrients by the trees. The grazing management system is now aimed at managing these grasses. Native grasses such as brigalow grass are starting to appear. Mr CS10 believes that resting the paddocks is crucial to the survival of the highly palatable grasses under the trees and also for the native species throughout the paddock. The cattle operation is primarily a dealing enterprise — purchasing cattle and selling on an opportunity basis, mostly based on pasture availability.

Derivation of innovation: Mr CS10's father and uncle were innovators, primarily in cattle breeding. Mr CS10 spent some time out of the agricultural industries and became involved in permaculture and gardening. This has given him a good understanding of the importance of soils and a view of agriculture from outside. Mr CS10 and his wife have moved from considering themselves as cattle managers to pasture managers to soil managers.

They consider themselves to be grass growers and the cattle are used to harvest the grass they grow. Mr CS10 now aims to manage what happens on top of the soil (cattle, pasture, trees, shrubs, and wildlife) in a manner that best maintains the biodiversity within the soil. These changes in mindset have changed the ways they manage their property. As grass managers, they do not overstock and if it gets dry they sell cattle to maintain pastures. A by-product of this practice has been the fact that, based on turnover, this system has proven to be more profitable. Mr CS10 sees his role as a farmer as a landscape manager — he is managing the landscape to pass it on to someone else. His personal aim is to explore, to work with different systems, and to play a role in developing a more sustainable approach to resource management.

Case study 11

Location: processing work in Launceston, harvesting throughout Tasmania.

Type of enterprise: game meat processing and harvesting — wallaby, possum, rabbit, hare, duck and turkey.

Agro-ecological zones: 8 and 9.

Climate: cool temperate.

Innovation: Mr CS11 operates an export-registered game meat processing business selling game products to local and domestic markets. Product is supplied by a number of accredited harvesters who operate throughout Tasmania. The harvesters operate on private land through arrangement with landholders. Wallabies, hares, rabbits, turkeys and ducks are supplied to the processing plant, killed and cleaned. They are sold on the domestic market to restaurants and to game meat suppliers throughout Australia. Possums are trapped alive and supplied live. They are then processed and sold to export markets in China, destined for the restaurant trade. All processed game meat is sold for human consumption. Domestic consumption of game meat has increased 50-fold in the last 10 years, while exports of kangaroo meat have increased by 30% in each of the last 2 years. Mr CS11 is president of the Kangaroo Harvesters Association, the peak organisation for kangaroo processors in Australia. He states that the kangaroo industry has grown at an annual rate of 5%/year for the last 15 years. Kangaroo numbers are monitored regularly and harvesting numbers are controlled by a quota system. Currently the harvesting quota is five million kangaroos and an average of three million are harvested annually.

Derivation of innovation: Mr CS11 worked in Tasmania as an extension officer for the Department of Agriculture and saw an opportunity for a game meat processing and export business. He left the department to establish this business. This farming system is largely deriving income from native Australian wildlife. Impacts on numbers of target animals and therefore on biodiversity are continually monitored by State Wildlife Departments.

Case study 12

Location: 70 km south-east of Cunnamulla in south-western Queensland.

Type of enterprise: Merino sheep.

Agro-ecological zone: 5.

Climate: semi-arid.

Rainfall: 350 mm.

Soils: 30% cracking self-mulching soils, Mitchell grass country; 30% sand hill soils; 30% clay with intermittent gidgee, white wood and leopard wood trees.

Proportion of perennial vegetation: there has been no tree clearing carried out on CS12.

Topography: flat.

Water — creeks, dams, bores etc.: stock water is supplied by dams and bores.

Innovation: Mr CS12 uses old man saltbush as a management tool to improve sustainability, productivity and profitability. He has planted old man saltbush in small paddocks or cells of 16–20 ha. The saltbush is planted in rows 10 m apart and with a spacing of 2.5 m between the plants. This is a wide spacing to allow for a diversity of plant growth between the saltbush plants. Mr CS12 believes the saltbush plants enhance plant growth through: forming a windbreak, recycling nutrients such as nitrogen through leaf matter, possibly increasing the availability of water in the root zone by raising water from the watertable or by storing rainwater in the root zone. Currently Mr CS12 has six cells in operation and is planning to plant a further ten larger cells of 60 ha each. There are ten 2,000 ha paddocks on the property and Mr CS12 aims to have a 60 ha saltbush cell in each paddock.

Mr CS12 has developed innovative systems to propagate and establish old man saltbush. He has used the saltbush plantations to develop a flexible grazing system, which allows him to rest his larger paddocks in response to a variety of events such as rain, flowering, dry spells etc. He aims to be able to spell all his large paddocks at critical times to allow the native salines in the paddocks to build up and act as a drought reserve. In Mr CS12's experience, the saltbush can provide a critical extension to the decision-making when entering a dry time. He also uses the saltbush plantations for a range of livestock management options, such as: lambing ewes, supplementary feeding of twin-bearing ewes, flushing ewes and rams before joining, maintaining ram fertility, and having a high protein supplement close to the woolshed to facilitate sheep handling.

Derivation of innovation: Mr CS12's father was an innovator who worked with scientists from the CSIRO. He was also a Tiger Moth pilot and used his plane on the property. Mr CS12 believes his innovative system really began in a drought in 1982 when he noticed that when the saline bushes disappeared, the sheep deteriorated. A spelled paddock had saline bushes surviving in it — he grazed sheep in that paddock and benchmarked their performance, recording a 30% improvement compared with other paddocks. He then set out to devise a system to manage the saline bushes in his paddocks.

Case study 13

Location: 30 km east of Braidwood, New South Wales.

Type of enterprise: primary — forestry; secondary — goats, nursery.

Agro-ecological zone: 9.

Climate: humid temperate.

Rainfall: 750–1,000 mm.

Soils: the soils are all granite-based soils in a degraded condition. The area has been developed and farmed for over 100 years and the farm was quite degraded when Mr and Mrs CS13 first purchased the property.

Proportion of perennial vegetation: the proportion of perennial vegetation (trees and perennial pastures) was very low when the property was first purchased (below 5%), but has increased dramatically with the planting of trees, shrubs and perennial pastures.

Topography: undulating with waterways.

Water — creeks, dams, bores etc.: the farm is in a high rainfall area and there is ample surface water for stock.

Innovation: the aim of the enterprise is to regenerate a healthy ecosystem and to derive income from a mixture of forestry products and livestock. Mr CS13 has also been using a Yeoman's plough to deep rip-the soil. The ripping has improved water infiltration and clovers appear generally within three months of ripping. Slashing, deep-ripping and goats are initially used as tools to control woody weeds and to regenerate the soil. Exotic tree, shrub and pasture species are then planted as intermediary income earners and as part of the process of repairing the ecosystem. Native timber species are planted for long-term timber income. Mr and Mrs CS13 have used goats (a mixture of dairy and Boer goats) very successfully to control broom bush and blackberry and will continue to use goats as a tool to control regrowth in new areas and between the trees.

Derivation of innovation: Mr CS13 grew up on a small horticultural farm that made extensive use of chemicals to grow a high-value crop. He witnessed the damage caused by chemicals to people and the land and has aimed to live his life differently. He studied forestry at the Australian National University with an aim to develop the knowledge and skills necessary to use an integrated forestry approach to turn around and restore degraded landscapes. After leaving university, he aimed to establish a business that could be run from a country town near a farm. He established a successful business in Canberra and then searched for a ruined dairy farm (he was looking for degraded land in a high rainfall area). Mr and Mrs CS13 purchased the farm near Braidwood, moved the business to Braidwood and set about restoring the land.

Case study 14

Location: 15 km south-east of Daylesford, central Victoria.

Type of enterprise: all enterprises operated on the farm are certified organic. A range of small enterprises on the 80 ha farm is operated by the family, as follows: one family member — potatoes, Chinese cabbage, broccoli and lettuce; another family member — chestnuts, walnuts, hazelnuts, apples, potatoes, sheep and cattle; and another family member — grapes/wine, sheep.

Agro-ecological zone: 9.

Climate: cool temperate.

Proportion of perennial vegetation: the farm is fully developed, some parts are planted to fruit and nut trees and two of the family members have planted windbreaks to protect the vegetables from wind and chemical drift from neighbouring chemical farms. The proportion of perennial vegetation is less than 20%.

Topography: undulating.

Water — creeks, dams, bores etc.: water for stock and for irrigation is provided by bores.

Innovation: two of the family members both grow and market organic vegetables, fruits and nuts. They use organic fertilisers and a rotation with stock. They use a flame-weeder to control weeds when this is appropriate. One grows vegetables according to a reasonably conventional cultivation system — he has only recently moved from full-time off-farm employment. The other grows a mix of fruits, nuts and vegetables with the application of permaculture principles. Another family member grows wine grapes and produces and markets organic wine. He uses stock and flame-weeding to control weeds and pests and his principal occupation is off-farm.

Case study 15

Location: approximately 30 km west of Narromine, New South Wales.

Enterprise: fattening and backgrounding cattle on native and improved pastures and forage crops.

Agro-ecological zone: 10.

Climate: semi-arid.

Rainfall: 500 mm, non-seasonal, ie. any time of year.

Soils: primarily red and red–brown earth (80%) with some clay loams and sandy clay loams, gilgar clays and cracking clays; some yellow podzolic soils; 1,000 ha arable land; up to 800 ha sown to oats every year.

Proportion of perennial vegetation: Mr and Mrs CS15 are aiming for 30% coverage with perennial vegetation. They also aim to have 15% vegetation cover on the 1,000 ha of arable land and have established a number of tree lines (trees established are native species that Mr and Mrs CS15 propagate from local trees and grow out in their own nursery before transplanting) and wildlife corridors. There are a number of existing roadways that are vegetated and waterways that are now fenced off. This is all part of a 20-year whole-farm plan. Their conservation efforts are driven principally, if not entirely, by a sense that it is the right thing to do.

Topography: basically flat with a chain of waterholes and lagoons.

Water — creeks, dams, bores etc.: 22 dams; 2 bores; access to irrigation water from a channel.

Water balance: the changes resulting from farming systems and grazing practices have greatly reduced water run-off and the chain of waterholes and lagoons now fills much less regularly and seldom runs. Mr CS15 says he now has trouble filling dams.

Innovation: Mr CS15 uses a combination of what he calls “advance sowing and cell grazing”. Paddocks to be planted are heavily grazed before planting. There is no mechanical preparation. Planting is accomplished with a machine Mr CS15 has developed. Planting is always done dry and Mr CS15 plants as much area as he can between mid-February and the autumn break. No fertilisers or chemicals are now used. Stock are kept out of the paddock until Mr CS15 needs the grazing — sometimes the crop is allowed to seed and he considers this as a standing feed source. Seed that spills onto the ground can then germinate next year. Mr CS15 has planted old man saltbush in widely spaced rows and forage crops between the rows. The saltbush alleys are 2 m wide and 20 m apart. The livestock operation is a finishing and fattening operation and Mr CS15 is constantly buying and selling, which results in a very flexible system where numbers can be changed quickly depending on feed availability. Cell grazing enables him to plan 3–4 months ahead for pasture availability. Mr CS15 is aiming to regenerate a mixed grassland and is allowing the system to evolve. It took 2–3 years before changes to pasture availability and biodiversity became apparent. He finds the oats are very competitive with perennial and annual weeds and cell grazing helps with weed control.

Derivation of innovation: pushed into a reassessment by the drought years of 1994 and 1995, the system has gradually evolved through minimum till to zero till to advance sowing. Cell-grazing systems and learning have also been important. The innovation has been largely self-directed with family support but no great local community or agency support. In fact, initially there was little local interest. However, they had seven field days in 2000. Conservation farming awards have led to useful connections. Mr CS15 is conscious that there is a commercial advantage in not talking but he does so for conservation facilitation reasons. He believes communication is essential to change mindsets, eg. about getting a crop every year. Now he expects two to three harvests over a 10-year period and the crop is used for forage in other years (enabled by a lower cost base). Since 1996, harvests have been possible in 1996 and 1998. Mr CS15 strongly believes in the need to develop agricultural systems that are based on natural systems. This system gives him considerable flexibility now that the expectation of a crop every year has been eliminated.

Case study 16

Location: south-east of Bruce Rock in the eastern grain belt of Western Australia.

Type of enterprise: wheat and sheep.

Agro-ecological zone: 10.

Climate: arid Mediterranean.

Rainfall: 325 mm.

Soils: heavy red loams, grey clay, conglomerate/gravel, yellow sand plain.

Proportion of perennial vegetation: approximately 25% tree coverage with more planting of trees planned. Mr CS16 has planted over 100,000 trees over the last 12 years, primarily for wind speed and watertable control. Fodder shrubs and oil mallee trees have also been planted.

Topography: undulating.

Water — creeks, dams, bores etc.: stock water is supplied by run-off dams. The aim is to capture as much water as possible through the use of cultivation practices, contours/keylines and dams.

Water balance: there are areas of salt scalds on the CS16 property. Mr CS16 has controlled one area of hillside seep by planting trees about the seep. Water-use efficiency is increasing as a result of a change in farming methods to keyline systems.

Innovation: in the late 1970s, Mr CS16 realised he had problems with erosion, soil structure and water balance. He started an earth works and ploughing program based on keyline principles in 1978/79. He has built banks on the contour and now does all his cultivation on the contour. The banks, built on a slope of 1/2000, are important but it is what happens between the banks which is important in terms of ploughing on the contour and cultivation practices. This system improves the efficiency of water utilisation in the cropped and pastured land between the banks and also increases the amount of water that can be harvested and stored. In addition to the banks, Mr CS16 has been applying soil conditioners (eg. gypsum, lime, dolomite) in response to soil test results. As a result of these efforts over 20 years, Mr CS16 has been able to control soil erosion, increase water-use efficiency and improve the soil structure on his farm. Organic carbon levels in the soil are now 1–2%, while the average levels in the wheat belt are 0.5%. High levels of organic carbon lift the water-holding capacity of the soil. Mr CS16 believes that 1% of organic carbon can double moisture-holding capacity. Mr CS16 is achieving wheat yields of up to 2–2.5 t/ha. He believes he will be able to lift production levels to 3 t/ha as he fine-tunes the system and believes he will have to do this to remain profitable. The average protein levels he is achieving in Durham wheat are around 14% — considerably higher than neighbouring properties using different systems. Merino sheep are run for wool production on the fallow paddocks. Medics and clovers generally respond after cropping. This year, Mr CS16 is planning to plant serradella and clovers into some pasture paddocks to improve the pastures.

Derivation of innovation: in the late 1970s, Mr CS16 realised he had economic and environmental sustainability problems. He approached the Department of Agriculture but did not consider their approach to be useful. He then read P.A. Yeomans' book, *Water for every farm*, and has successfully applied keyline principles to his farm.

Case study 17

Location: 30 km north-west of Hamilton in western Victoria.

Type of enterprise: wool-growing and cattle.

Agro-ecological zone: 10.

Climate: cool temperate.

Rainfall: 650 mm.

Proportion of perennial vegetation: the CS17 family became involved with the Potter Farm Plan in 1985. Through the Potter Plan and later activities, Mr CS17 and his family have planted native trees and shrubs over 15% of the CS17 property and have restored a wetland. Tree planting is carried out in corridors along waterways and creeks, boundary fences and along some fence lines.

Topography: undulating.

Water — creeks, dams, bores etc.: a major wetlands restoration project is under way on one of the recently purchased farms. Mr CS17 has built a number of small, dam-like structures to recreate a chain-of-ponds effect and has planted a variety of trees and shrubs in the surrounding area.

Innovation: Mr CS17 and his wife manage a portfolio of properties, one of which is Mr CS17's original family property. The management system on this property and the aggregation of properties involves allocating 30% of the land for tree planting and habitat provision while intensifying production on the remaining 70% of the land. Pastures have been extensively renovated and an intensive fertiliser program is applied to these areas: 25 units of phosphorus are applied to pastures each year and lime is applied at the time of pasture renovation at a rate of 2.96 t/ha. Through renovation and the use of fertilisers, Mr CS17 has been able to lift production on the pasture areas. To maintain an economic level of production while also taking 30% of the area out of production, Mr CS17 has calculated he needs to lift production from the current level of 15 dry sheep equivalent (dse)/ha to 20 dse/ha.

Derivation of innovation: Mr CS17 believes it is important to allow other species to share the land and resources. Selling the property to an ethical investor was a major decision for Mr CS17 and family. A number of factors helped Mr CS17 to deal with the 'ownership' ethic:

- he has been involved in a project in Nairobi providing assistance to displaced people
- he believes the purchaser will be able to look after the land in a better way than he would be able to
- the displacement of Aboriginal people from this land has always concerned Mr CS17 and caused him to think about 'land ownership'
- Mr CS17 and his wife have purchased a small block with a house on it not far from the property.

Before the property was sold, it was run as a family enterprise with all family members involved in decision-making (Mr CS17 and his family, Mr CS17's brother and his family, and their father). As a family they have been prepared to do things differently. Mr CS17's wife and their two sons are very supportive of the direction of the enterprise.

Case study 18

Location: Braidwood, south-eastern New South Wales.

Type of enterprise: vermiculture.

Agro-ecological zone: 9.

Innovation: Mr CS18 uses earthworms to produce a range of biological soil-conditioning agents, which he sells to gardeners and farmers. The process involves using earthworms in rumen and gut material waste from an abattoir in central New South Wales. The material is spread in long windrows and left for the worms to decompose and compost. The decomposed/composted material (worm castings etc.) is collected, packaged and sold as a range of products. Liquid is also extracted from the decomposed/composted material and sold in a variety of forms. It is claimed the products supply a biological, active, soil-conditioning agent that enhances the relationship between the root system of the plant, many soil-borne nutrients and other essential nutrients that may not generally be available to the plant. The material contains a large amount of soil-forming bacteria. This process could be replicated in other abattoirs and locations with excess organic material.

Case study 19

Location: 224 km north of Gulgong, New South Wales.

Type of enterprise: primary — wool-growing and stud sheep; secondary — wheat and oats grain production, Kelpie dog breeding.

Agro-ecological zone: 9.

Climate: temperate

Rainfall: 600 mm, non-seasonal.

Soils: primarily granite-based sandy soils with some basalt-derived soils.

Proportion of perennial vegetation: the farm is largely cleared with few remnant trees. Mr CS19 has planted trees in blocks across the farm as part of a Landcare project. Trees are starting to appear in the paddocks but the area covered by trees and shrubs would be less than 20%.

Topography: undulating with a wetland running through the middle of the property.

Water — creeks, dams, bores etc.: dams.

Water balance: salinity problems have been detected in a drainage area in the middle of the property. This area has been planted to salt-tolerant grasses and Mr CS19 does not see it or salinity on his property more generally as a problem.

Innovation: Mr CS19 uses a combination of pasture cropping and cell grazing to produce cereal crops and wool. Pasture cropping is a system whereby cereal crops are planted directly into perennial pastures. Mr CS19 is increasing the proportion of native grasses in the pastures. Preparation is primarily grazing and some chemical weed control. Under the cell-grazing system, sheep are maintained in one or two mobs and moved around the property. Mr CS19 believes that the combination of pasture cropping and cell grazing has driven significant changes to the soil on his property and hence to the pasture composition and growth, and to stocking rates. He has observed a build-up in organic matter in the soil and mulch on the surface and postulates that this has contributed to improvement in water infiltration, water use and biological activity.

Derivation of innovation: Mr CS19 is a fourth generation farmer in this district. His father was an innovator, being one of the first to use super- and sub-clover systems in the district. Mr CS19's father has been very supportive of Mr CS19's innovative approaches. The need to take an innovative approach was driven, in general, by economic necessity and by a bushfire in 1979, which destroyed the farmhouse, sheds and 30 miles of fencing. Superphosphate at 1 bag/acre (0.4 ha)/year became too costly. Mr CS19 now uses no superphosphate on the pastures and has as many sheep as before. However, it did take 10 years for the system to adjust to the new management regime. It would appear that an innovative nature combined with economic hardship and a supportive neighbourhood Landcare-based group has driven a quest to find a better way to farm. Mr CS19 has contributed to and drawn on a supportive Landcare group, as well as on regular contact with a researcher, Dr Christine Jones, at Armidale.

Case study 20

Location: 10 km north of Kybybolite in south-eastern South Australia.

Type of enterprise: organic cropping and grazing — lentils, chickpeas, oats, safflower, linseed, fenugreek, sheep and cattle.

Agro-ecological zone: 10.

Climate: Mediterranean.

Rainfall: 525 mm.

Soils: sandy loams, black clay and clay loams.

Proportion of perennial vegetation: the property is highly developed and is largely cleared of native vegetation. Approximately 3% of the area is fenced off for tree regeneration and/or wetland.

Topography: flat.

Innovation: the enterprise is certified organic with NASAA and Mr CS19 receives a considerable premium for certified organic crops such as green lentils and other coarse grains. The green lentils are sold bagged. Mr CS19 also produces meat from sheep and cattle according to organic management systems but at this stage he is unable to sell the meat as a certified organic product. Mr CS19 uses the Albrecht system to test the soils on his farm and to derive a soil-conditioning regime. The Albrecht system is based on achieving an appropriate balance of anions and cations in the soil. According to Albrecht, the appropriate balance is essential to ensure availability of nutrients, minerals and trace elements. Soil conditioners such as gypsum, lime and dolomite and reactive rock phosphate are frequently used. The initial cost of using these conditioners can be high but once that stage is past the average cost of soil conditioners applied compares favourably with the cost of traditional fertilisers (Ashby 2000).

Derivation of innovation: Mr CS19's first wife became ill with cancer and as part of her treatment regime she adopted an organic diet that alleviated a number of the symptoms and problems she experienced. Mr CS19 nursed his wife until she died and became convinced of the benefits of organic food. He then changed his production systems to organic systems and has followed this process since. Mr CS19 believes it is possible to resolve the food production and health problems of the world through the production of healthy, organic food. He believes he now has the tools to do this.

Case study 21

Location: 20 km east of Warrnambool, southern coast of Victoria.

Type of enterprise: dairy — mixed Friesian/Jersey herd.

Agro-ecological zone: 8.

Climate: cool temperate.

Rainfall: 675 mm, primarily winter

Soils: primarily sandy loam soils with some areas of black soil flats.

Proportion of perennial vegetation: the entire property is improved and planted to improved, introduced pastures. There are some windbreaks consisting of rows of pine trees along fence lines.

Topography: gently undulating, approximately 5 km from the coast.

Water — creeks, dams, bores etc.: all water comes from bores and is provided to stock in troughs. There are two bores that are used for irrigation.

Innovation: Mr CS21 grows 35 ha of irrigated pasture, which is planted to rye grass and white clover. He generally irrigates through summer, from November until the autumn break (usually March/April), irrigating each area every 9–10 days with a travelling irrigator. He assesses the frequency of irrigation needed by observing the pastures and the soils. Mr CS21's neighbours, growing the same pastures, irrigate every 5–7 days. Mr CS21 believes that if he were to deep-rip the irrigation areas, he could stretch his irrigation interval out to 11 days. He has lengthened the rest period to encourage more root growth in the pasture plants. He believes that this results in a stronger plant and also produces more organic matter below the ground. In order to lengthen the rest period, he has had to decrease the number of cows grazing that area. Mr CS21 uses a biodynamic preparation (BD500), which is sprayed onto the pasture in autumn and spring. BD500 is a soil conditioner made from cow manure. The theory is that BD500 enhances the biological life of the soil. He also uses biodynamic preparations (502–507) in making the compost that he applies to his pastures. Mr CS21 uses the biodynamic preparations to work with the biological activity of the soil and he also applies minerals and trace elements to maintain a physical balance in the soil. Lime, rock phosphate and dolomite are used at times and he feeds a nutrient mix to his cows on a self-selection system.

Derivation of innovation: Mr CS21 contracted a chronic illness. While he was ill and then recovering, he established a link between healthy, organic food and his personal health, particularly biodynamically produced food. He then set about producing high-quality, healthy food. Mr CS21's wife and his father have been very supportive throughout this process. Mr CS21 feels the role of the farmer is "to produce food as healthy as possible for people to consume".

Case study 22

Location: 40 km south-west of Narromine, New South Wales.

Type of enterprise: primary — Merino sheep (20.5 micron wool); secondary — cropping of wheat, canola, barley, oats.

Agro-ecological zone: 10.

Climate: semi-arid temperate.

Rainfall: 500 mm.

Soils: sandy clay loams and red self-mulching clays.

Proportion of perennial vegetation: an area of 12.5% of the property is a conservation reserve and the remainder of the property is cleared with scattered trees. Changing farming practices and lighter stocking rates have seen changes to perennial vegetation levels and in some places belah regrowth, largely due to the reduction in rabbit numbers, may become a problem.

Topography: undulating with a central ridge. The conservation area comprises most of the central ridge, which runs through the property. There is also a recreated wetland area in the conservation area.

Innovation: Mrs and Mr CS22 have created a wildlife refuge and conservation area in the middle of their property. The conservation area is an area of 400 ha, which was previously used to run 300–500 wethers and has never been cleared or cultivated. It has been fenced off, beginning in 1993/94 with fox- and cat-proof fencing. There are 8 km of fencing costing $60,000 for materials, notwithstanding considerable sponsorship from various manufacturers. This area is a ridge basically running through the centre of the property and has been fenced as part of a Landcare project. The members of the Landcare group are all neighbours who support the project in a range of ways, including an ongoing campaign to bait foxes and cats. The aim of the project is to establish an off-reserve conservation area and to re-introduce endangered fauna and flora. Initially there was overgrazing by kangaroos because of the availability of water but these are now managed.

Derivation of innovation: Mr and Mrs CS22 both grew up on the land and the property has been in Mr CS22's family for a number of generations since the turn of the century. Mr CS22 studied biology and geology at university and spent some time in South Africa where he saw off-reserve conservation in action and also observed farmers deriving income from native fauna and flora. Mrs CS22 came from Cooma. Chris Williams, a PhD student at Melbourne University, has been very helpful in his studies of the social dimensions of the Landcare movement. Initially, the New South Wales National Parks and Wildlife Service (NPWS), unlike the Western Australian Department of Conservation and Land Management (CALM), appeared to be reluctant to help. Mrs CS22 believes they had difficulty in accepting that things could be done differently. Both Mr and Mrs CS22 believe passionately in the goal of integrating commercial production with conservation.

Case study 23

Location: Port Stephens on the central coast, New South Wales

Type of enterprise: primary — fish farming; secondary — hydroponic lettuce.

Agro-ecological zone: 8.

Climate: temperate coastal.

Water — creeks, dams, bores etc.: water is supplied by a bore. At this stage, the fish operation uses 50,000 L/day.

Water balance: the enterprise uses very little water and aims to use this water efficiently by recycling it through the fish tanks and then using surplus water in the hydroponics. Nutrients are also recycled, as the nutrient-rich water from the fish tanks is used in the hydroponics. They claim zero discharge of water or nutrient.

Innovation: the enterprise is an established aquaculture venture focusing on growing out barramundi using recirculating aquaculture technology. It supplies live barramundi to the Sydney market and fresh fish to local outlets. Waste-water is used to grow lettuce and herbs hydroponically and these are largely sold locally. The partners are also considering the production of field crops, also using waste-water, as they have some available land. They are also interested in using this technology in irrigated agricultural or horticultural systems.

Derivation of innovation: the enterprise is a partnership of 12 shareholders, including 2 builders, 2 marine biologists, a marketing manager, an electrician and a project manager. The impetus for the development of this project was a failed fishing trip of two keen fishermen who are now shareholders in the company. Much of the technology used in the aquaculture enterprise has come from other industries such as waste-water treatment and extensive chicken and pig industries.

Case study 24

Location: 40 km south-west of Kojonup in south-western Western Australia.

Type of enterprise: sheep (wool); coarse grains (canola, lupins, oats); carrots, onions, olives (3 ha block-rotational cropping). All produce is certified organic.

Agro-ecological zone: 10.

Climate: Mediterranean.

Rainfall: 580 mm with practically all of it falling from April to October.

Soils: duplex soils; gravel loams over clay; top soil 2 cm deep.

Proportion of perennial vegetation: 15% increasing to 25% with more tree planting.

Topography: undulating — average slope 6%.

Water — creeks, dams, bores etc.: stock and irrigation water are supplied by run-off dams.

Innovation: integrated whole farm planning. The evidence of encroaching salinity prompted Mr CS24, in 1975, to begin a process of integrated whole farm planning. He redesigned the layout of the farm to control and harvest surface and sub-surface water flow to improve soil structure and create a large volume of stored water. Mr CS24 has used and adapted the keyline system and has built drains with a fall of about 1:400 over the property. The drains are deeper than usual in order to collect seepage water flowing on the clay layer in the duplex soils. Drains are fenced off and planted with trees — mostly acacias and eucalypts. Trees have been planted at 1,000 trees/ km. Mr CS24's intention is to increase the width of tree belts and the number planted per km. Water collected and stored through the use of this system is used to irrigate a small area of organic horticultural crops. The system recognises that although water management is the basis of the plan, environmental care cannot be single issue-directed (wind erosion, bird life, salt, soil health etc.). Fertiliser regime: Mr CS24 tests the soil using the Albrecht system and applies soil conditioners such as lime, gypsum and dolomite based on the Albrecht system. The family uses compost preparations and microelements on the horticultural crops. Mr CS24 believes that with his farm planning approach he has worked on the macro level and has protected his farm from the extremes of climate. He believes it is now time to work on the micro level — the soil. Tree planting on Payneham farm now covers 15% of the area and this has increased the biodiversity on the property. Through his involvement with the Australian Land Management Society, Mr CS24 has developed a farm monitoring kit, which includes tests for soil structure, salinity, pH, earthworms, wind erosion, water quality and more. Mr CS24 uses this kit on his own farm and he also regularly monitors bird life on the farm.

Derivation of innovation: Mr and Mrs CS24 both have a strong Christian spiritual base and believe that God created the land and the resources. At the end of his time on this Earth, Mr CS24 would like to be able to stand before God and say that he has played his part in making the world a little better. Mr CS24 began working on the farm in the 1950s and salinity, including visible salt in dams, was the trigger for commencing changes to his farm practices in the mid-1970s. This was reinforced by the learning he gained as a result of a Churchill Scholarship in 1989.

The move into organics and the Albrecht system was initiated by the CS24's son, following his studies at Muresk College. When Mr CS24 made the decision not to get big, he began to look at the water resource and the property. He saw the problems caused by too much water in the wrong places — salinity and waterlogging — and then estimated the amount of water running off the property. He reasoned that if he harvested some of the water running off the property he could use it for irrigation. He read P.A. Yeomans' book, Water for Every Farm, and in 1980 invited P.A. Yeomans to visit, which he did for five days.

Mr CS24 also became involved with the WHYSALTS movement, which was attempting to address salinity issues throughout Western Australia. Harry Whittington began the WHYSALTS movement in the late 1960s to early 1970s and the movement had a difficult interaction with the Western Australian Department of Agriculture. As part of this process, Mr CS24 dug a hole on a hillside and sat and watched what happened to the water flows. He noted where the sub-soil water flowed and built drains that were deep enough to intercept the water. All these inputs have come together in the development of an innovative approach.

Mr CS24's father was a conventional farmer — not particularly innovative. His mother always loved the land and instilled that love in her children. Mr CS24 always wanted to be a farmer.

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