Integrating Conservation and Agricultural Production: Fantasy or Imperative?

David C. Goldney and Johannes J. Bauer

Two one-time protagonists are in the process of a belated but essential reconciliation. On the one hand the green movement in its more rational forms is recognising that biodiversity and land system conservation can only succeed through co-operative initiatives with the largest group of Australian land managers–farmers and graziers. On the other hand there is a growing awareness among Australian landholders, often catalysed and focused through lost production, that agricultural land systems are experiencing signs of system collapse (judged by absolute increases in land degradation), processes leading to desertification (i.e. non-sustainability in the longer term) and significant biodiversity losses. At the farm 'coal face' this rapprochement is seen in: many long-term best practice farms whose owners or managers have long recognised the interdependence of nature conservation and production agriculture, in the fledgling Landcare Movement (driven often by issues rather than system understanding), in the Total Catchment Management process (struggling to find a balance between 'top down and bottom up' approaches) and through shifts in policy and practice in numerous agencies (private and government). However, the evidence on the ground suggests that the prevailing policy of significant numbers of landholders in implementing green outcomes is 'too little too late'. Given that:

- *the developing crisis in land degradation is our most pressing environmental problem which is well understood and researched;*
- *most of the solutions are available at least in principle; and*
- *there has been an increase in landholder awareness about global and on-farm environmental issues;*

what is stopping the implementation of the greening of Australian farms and catchments? The barriers to on-farm conservation initiatives are discussed and practical solutions suggested.

1 INTRODUCTION

Australian farmers and graziers are regarded as some of the most efficient in the world, with overall production outcomes still increasing as new technologies are implemented or marginal lands brought into the production stream (Chisholm 1992, 1994; Alston *et al.* 1993). After almost 200 years of European land management practices, we can reflect on our successes and failures as land managers in terms of economic profit and environmental outcomes. Clearly, all is not well. Millions of dollars of public money are now being poured into land restoration programs by governments of all political persuasion and in every state/territory of the Commonwealth. The Landcare movement, an idea forged between 'green' and 'brown' ideologies, has grown rapidly in less than a decade and now has some 30% of Australian farmers as members (DEST 1996; Curtis and Lockwood, Chapter 8 this volume). Land degradation is now recognised as a mainstream issue. It is estimated that about 70% of agricultural land suffers from some form of land degradation (Conacher and Conacher 1995). In contrast about 0.04% of the Australian land surface is committed to mining programs. The mining industry operates under significant environmental constraints and consent conditions associated with their activities. It is required to carry out extensive rehabilitation and restoration programs. Extensive agriculture which occurs over more than 15% of Australia is subjected to relatively few formal environmental constraints.

The list of problems associated with the management of farm natural resources is formidable: salination, waterlogging, overgrazing, erosion, feral invasions, loss of soil fertility and structure, acidification, soil compaction and changed hydrological dynamics, to identify just a few (Hobbs and Saunders 1993; Conacher and Conacher 1995; White 1997). Unwanted outcomes such as these not only cause losses in production and income but leave a legacy for future generations of farming families that becomes more difficult to finance. The underlying degradation process at work on many Australian farms is now acknowledged as 'desertification', a complex process, occurring at different rates across the agricultural system (Conacher and Conacher 1995; Williams *et al.* 1995; Young 1996; White 1997).

Farming using non-sustainable practices by inference means the degradation of the resource base. Two outcomes occur concurrently with the processes of land degradation. (1) There is a loss of system resilience (Fig. 1). The twin implications are that productivity increases become more expensive (in terms of effort, energy inputs and financial resources) as landscape resilience decreases. Farming is reduced to a mining exercise. (2) Malfunctioning or cessation of critical and interrelated system and landscape processes takes place. The mind-set and cultural conditions producing such unwanted outcomes cannot be easily summarised. We now understand that our European heritage and our forebears' desire to subdue and conquer the land to create a 'useful' landscape were contributing factors. Indeed the mind set was often encouraged and demanded by a range of government incentives, standing orders and legislation. There was also a failure to appreciate the limitations that Australian land systems impose on agricultural practices. There was also a belief that what any particular landholder did was inconsequential given the abundance of available land. Consequently,

extension personnel, governments and the scientific community now point out to the rural community in the era of land restoration, that land degradation outcomes were almost inevitable given the psyche and sociological environment of our farming forebears. A few prophetic voices were raised in the past to question on-farm practices (Hobbs and Saunders 1993), but very likely, given the opportunity, we all would have farmed in a similar manner and with the mind set of that age.

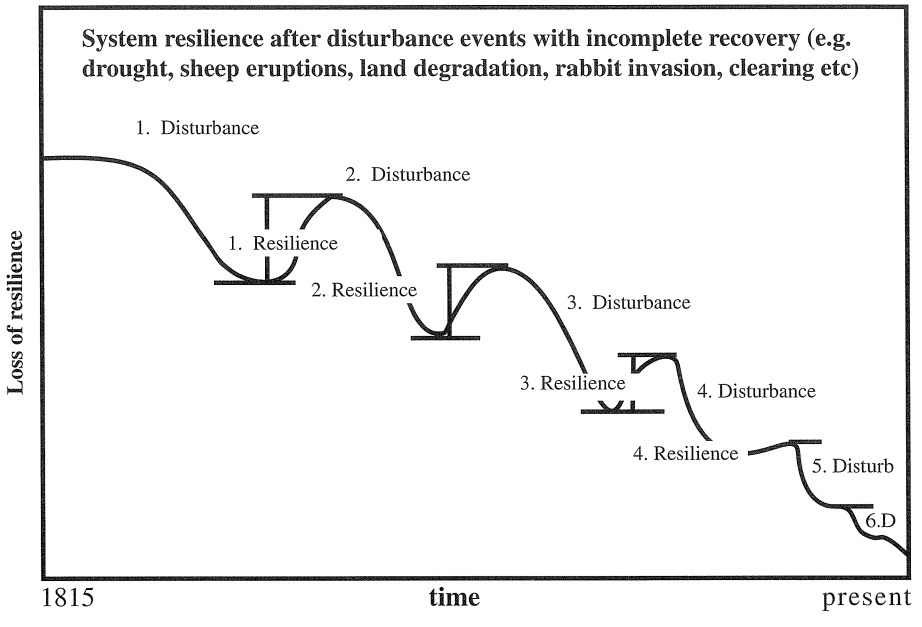

Fig. 1. Hypothetical changes in system resilience after disturbance events present in land systems supporting agricultural production.

Parallel and associated with increasing land degradation and the loss of system resilience are significant losses in pre-European biodiversity, increases in native organisms that have adverse impact on agriculture and an increase in exotic species that has yet to plateau (DEST 1996). The loss of biodiversity is reasonably well understood in Australia, at least for the more conspicuous elements. It has been estimated that only 15% of species have been formally described (DEST 1996), so losses may be much more extensive than is currently believed to be the case. Agricultural land uses (pastoralism and cropping) are carried out on about 70% of the continent. They have resulted in significant land clearing and loss of habitat, the conversion of native grasslands to pasture improved–fertiliser dependent landscapes, the threatened loss of a number of plant alliances, and the degradation of waterways (Kirkpatrick 1994; Conacher and Conacher 1995; DEST 1996). Reasons for maintaining the biodiversity in our agricultural lands include its role in maintaining ecosystem processes across land systems, including the role in particular of native vegetation in providing landscape stability. The maintenance of the quintessential agricultural landscape and the associated aesthetic qualities adding to the market values of particular properties are also important. The

potential for the native genetic resource to be of significant value to the overall economy is increasing, as researchers continue to unlock secrets from our flora, fauna and microorganisms. Biodiversity conservation will continue to be largely dependent on maintaining suitable habitat across Australian farmlands.

A case study in the Central Western Region of New South Wales

The Central Western Region (CWR) of New South Wales (Fig. 2) contains Australia's oldest inland agricultural lands. It exemplifies many of the unhappy associations between agriculture and nature conservation (Goldney and Bowie 1990). It contains examples of most agriculture landuse practices in the 350 km east–west transect from the Tablelands to the Western Plains. Seventy-six percent of the total land has been substantially cleared, with the greatest deforestation occurring in the Slopes. The remnant woodland is confined mainly to land unsuitable for agricultural use. About 29% of the remaining woodland occurs on private land and most of these remnants are less than 5 km^2 in area. At least 25 vertebrate and 10 plant species have become extinct since European settlement, almost all in response to agricultural practices (Goldney and Bowie 1990). Goldney *et al.* (1995) estimated that half of the marsupial species in the region are also likely to become extinct given current land management practices. Fisher (1997), in his landscape study of avian distribution and abundance across the Bathurst Basin, estimated that about half of the existing bird species are likely to become locally extinct in the next few decades under current land management practices. Fisher and Goldney (1997) identified the importance of the riparian vegetation in the extensively fragmented Bathurst landscape for the conservation of the diverse avian fauna in farm landscapes. In catchments immediately west of Orange, Massey (pers. comm., 1995) has estimated that 70% of the riparian system is very degraded. Our own observations suggest this to be the case across the CWR. In respect of the sustainability of remnant woodland across agricultural landscapes in the region (63 000 km^2), it is estimated that up to 0.6×10^8 woodland trees are at risk of premature death. Additionally, the scattered farm tree scape cannot be sustained. These account for an estimated further loss of 25×10^6 trees. Major plant alliances, particularly the box woodland communities, are at risk of extinction (Goldney *et al.* 1997; Prober 1996).

Hodgkins *et al.* (in press) have demonstrated that although landholders in the CWR are environmentally aware, they do not necessarily carry out needed actions on the ground (Goldney *et al.* 1995). Bauer and Goldney (1998) present evidence that a slow process of desertification is demonstrable across the region. They further argue that many land degradation phenomena (e.g. salinity) follow exponential dynamics. The combined effects of biodiversity losses acting synergistically with increasing land degradation phenomena are having an adverse impact on the resilience of agricultural land systems. Awareness about land degradation issues and their ability to have a very negative impact on agricultural production continues to increase. But in spite of this increase in awareness, Goldney *et al.* (1995) and Goldney *et al.* (1997) produce evidence that given the scope of degrading processes associated with agricultural lands in the

region, one indicator of land rehabilitation, the numbers of native trees planted, suggests that little is being done. Given this less than optimistic assessment of Australia's oldest inland agricultural lands, can agriculture as it is currently practised survive, given that land systems are under significant environmental stress or in danger of imminent collapse?

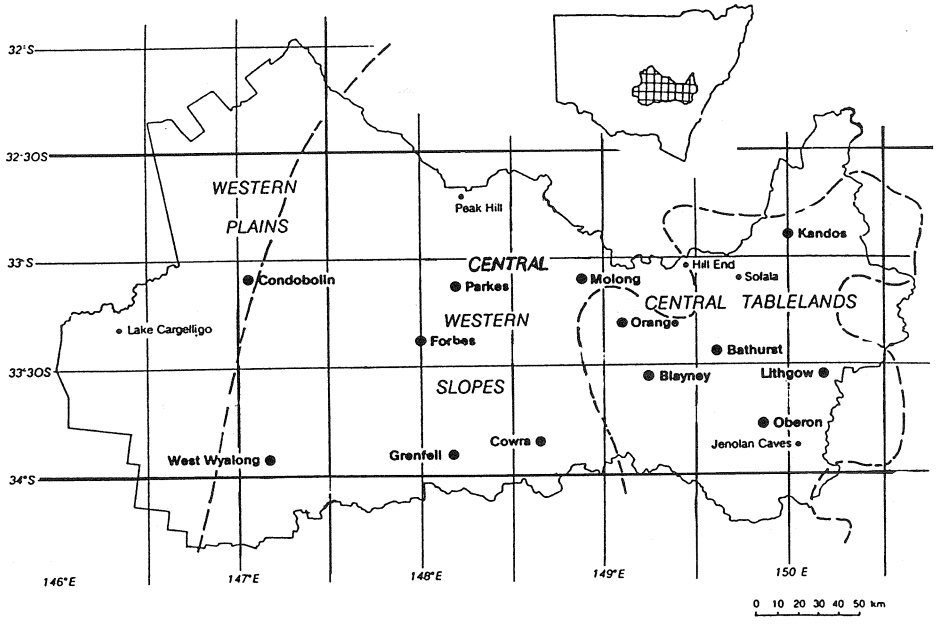

Fig. 2. The Central Western Region of New South Wales.

2 FROM PROBLEM IDENTIFICATION TO SOLUTIONS

In discussions with hundreds of landholders in the Central Western Region over the past decade, we have found it a useful approach to ask farmers to compare their own situation with a worst possible case and one which they could perceive as a best practice or near best practice outcome. Figure 3a identifies a farm at West Wyalong (Fig. 2) under drought conditions in 1993 where the process of desertification can be observed. The bitumen road adjacent to the property is covered by sand. Figure 3c illustrates the magnitude of past soil erosion. The dead box tree is extant in the Tarana area (Fig. 2) on the erodible Bathurst granite. It was possibly a young tree at the time of European settlement. Few such trees remain which bear silent witness to aspects of the eco-history of the Bathurst Basin. This tree reminds us of the significant loss of system resilience caused by past and continuing soil erosion. Landholders readily distance themselves from what they perceive as worst practice outcomes. In contrast Figure 3d is an aerial

Fig. 3. (a) A 'worst scenario' wheat–sheep farmscape photographed under drought conditions in 1993 near West Wyalong, on the Central Western Slopes of NSW, where the process of desertification is advanced.

(b) Aerial shot (1997) of a White Box (*Eucalyptus albens*) half hectare enclosure, one of 72 in a landscape experiment on farmland across the Tablelands and Slopes of Central NSW to find optimal conditions to regenerate the Yellow Box (*E. melliodora*)–White Box woodlands. Goldney *et al.* (1997) estimated that millions of trees in these eucalypt alliances will disappear within a generation due to inappropriate land management practices.

(c) Dead standing tree on a Tarana grazing property near Bathurst (1995) in the Central Tablelands of NSW. This tree may well have been present in the landscape at the time of European settlement. It provides clear evidence of aspects of the farm's eco-history in relation to soil loss on Bathurst Granite.

(d) Aerial photograph (1997) of a Potter Plan cattle property adjacent to the Duckmaloi River near Oberon in the Central Tablelands of NSW. In excess of 50 000 native trees and shrubs have been planted and positioned in an intentional effort to maximise agricultural output. It is one of the few properties in the Central Western Region where substantial tree plantings can be seen from the air.

photograph of one of the few examples of a Potter Farm Plan in the region being developed near Oberon (Fig. 2). A decade ago this was a near treeless property with high lambing losses due to the inclement Oberon climate. A complete repositioning of fencelines to soil types and topography has been carried out. Over 50 000 trees have been planted to stabilise drainage lines and to ameliorate the extremes of winter climate. These plantings have been positioned in the landscape to maximise agriculture and nature conservation outcomes. The substantial costs of rehabilitating and restructuring this farming enterprise have been born by the landholder. Figure 4 identifies the continuum between best practice and worst practice farming-land system scenarios and a range of characteristics, both biophysical and personal, which indicate some of the complex interactions occurring along this continuum. Underlying the rapprochement of the coming together of nature conservation and agricultural objectives in farming systems is one assumption and two self evident observations:

- Sustainable agricultural practices must include the integration of remnant vegetation or its surrogate (revegetation outcomes) into farm, catchment and land system planning (assumption);
- Australian farmers have a pivotal role to play in the conservation of native flora and fauna and in the restoration of degraded ecosystems (observation); and
- the achievement of best practice outcomes will require long-term cooperative planning and implementation of those plans by all stakeholders (observation).

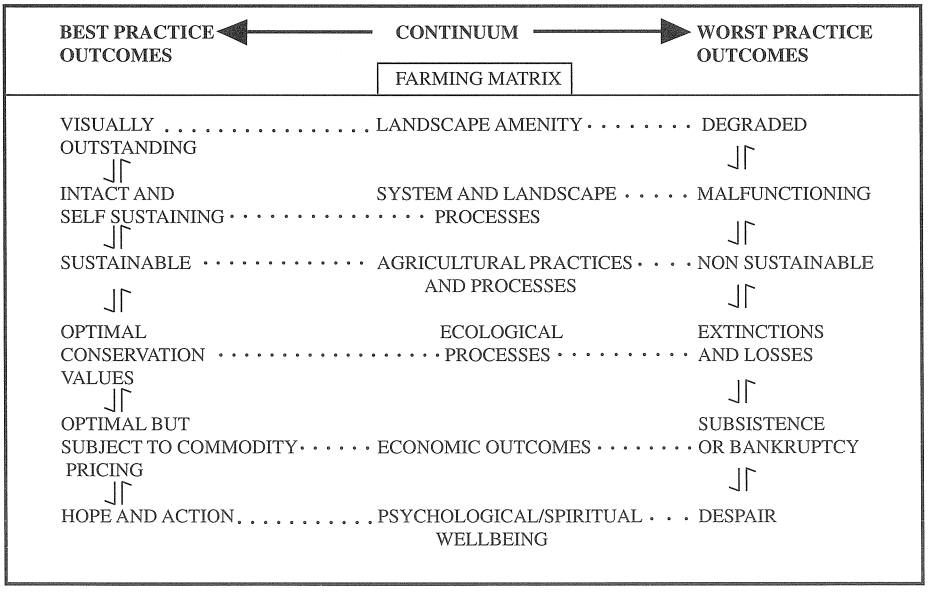

Fig. 4. Farming land system scenarios.

New approaches are needed in landholder education

Goldney *et al.* (1995) argued that there needs to be a paradigm shift by ecologists, agricultural scientists and land managers to culturally appropriate extension outreaches to landholders to enable them to integrate nature conservation and agricultural production outcomes. They suggested that there was a need to move away from technocentric extension paradigms and to embrace 'empowerment' paradigms as the basis for developing extension programs for landholders. Technocentric paradigms foster approaches which result in a one-way flow of information from the 'information rich' scientific culture to the 'information poor' landholders. Empowerment paradigms emphasise processes and content, requiring cooperative approaches between landholders and extension personnel in the development and implementation of relevant programs. This approach values landholders as 'owner researchers' whose behaviour and attitudes will change positively as a result of their observations and enhanced understanding, enabling them to initiate action plans for farm conservation in a production matrix. The empowerment process should be integrated with two marketing strategies (Goldney *et al.* 1995):

- representatives of the client group should be involved as coproducers of extension materials, providing feedback on aspects of the design and suitability of the developing education material;
- the second marketing concept is the need for 'user testimonial' to ensure that clients have an extremely positive experience with the service that is provided and that they then encourage other landholders to use the product.

In July 1997, Charles Sturt University and Orange Agricultural College launched the 'Save the Bush Toolkit' (Wakefield and Goldney 1997) with nine individual integrated kits to enable landholders to assess their farm's natural resources. The Toolkit enables them to begin the process of integrating nature conservation and production agriculture. Fundamental to the design philosophy is the key involvement of landholders in simple observation, reflecting on what these observations mean and the development of strategies to implement restoration programs. Kit nine is the end point of the process and enables landholders to produce a farm plan which integrates nature conservation and agriculture outcomes. This approach complements traditional farm planning strategies and more recent innovations in New South Wales by the Farming for the Future program, a joint initiative between NSW Agriculture, the Department of Land and Water Conservation and the National Parks and Wildlife Service.

Landscape restoration is beyond science, technology and policy

It is probably true that we already have the critical understandings needed to undertake the significant ground works required to rehabilitate degraded farm land and land systems in Australia (Saunders *et al.* 1993; Saunders 1994). Much of this knowledge is not easily available within the scientific culture as it is located in journals or in other places that landholders can not easily access. There is also a

significant pool of knowledge and experience within the network of that innovative group of landholders who already operate near best practice. Information transfer *per se* has not been a particularly successful extension technique. There are exceptions in our short agricultural history. For the most part the serious soil erosion problems which created shifting sand dunes, fog-like dust storms and massive sheet, rill and gully erosion have generally been reduced in intensity largely due to the dedicated work of scientists and extension personnel from the various departments of agriculture and soil conservation across Australia. Groups of scientists operating from the broad premises and world view of landscape ecology have had some successes in influencing on-ground practices (e.g. Hobbs and Saunders 1993).

However, the ground breaking work of CSIRO scientists in understanding how our rangelands function (Ludwig *et al.* 1997) does not appear to have produced sustainable changes in land management in the arid zone. Important new technologies such as 'minimum tillage' have not been universally adopted for many reasons. Societies in general need to move beyond the narrow confines and understanding of science, technology and policy to embrace holistic approaches that take account of sociological, cultural, psychological and spiritual factors in communities where changes need to occur. A continuing close association between land managers and scientists is essential.

Community wisdom is required

In the past decade there has been a spectacular increase in the number of Australian farmers joining the Landcare movement. However, it seems likely that only 30% of landholders will eventually join the movement and then with varying degrees of personal commitment. 'Joining' a movement is very different from being an agent of change on the ground. The movement has, however, captured public imagination and the interest of mainstream media. Green groups have been prominent in the formation and nurturing of the movement as they slowly recognise the pivotal role of Australian farmers in conservation outcomes. Green groups have also begun to focus their attention away from flagship priority conservation interests confined largely to the eastern coastal strip and Tasmania. Various combinations of landholders, researchers, environmentalists and extension personnel have formed alliances throughout the country to seek appropriate land management outcomes. Facilitating agencies such as Land and Water Resources Research and Development Corporation have been particularly strategic in identifying and funding key research and extension areas and in best practice research management. They have also demanded that researchers effectively communicate their results to the community. The World Wide Fund for Nature is an international conservation charity that has been both innovative and strategic in funding on-ground research and extension. The sale of government assets to fund the National Heritage Trust has generally been well received in the community, although only time will tell whether political 'pork barrelling' will become a barrier to developing a strategic and practical response to land degradation (see Curtis and Lockwood Chapter 8 this volume). Other major

government initiatives are being facilitated through Federal funding (e.g. the Murray Darling Basin Commission and its activities) and by the more traditional state and local government agencies. The Total Catchment Management initiative of the New South Wales Government is a precarious balancing act between 'bottom up' and 'top down' approaches, with the community members and government agencies often struggling to find common ground (Bryant 1993; pers. obs.).

Genaren Hill Landcare group is in the CWR, north-west of Peak Hill (Fig. 2). 'Genaren' is run by Michael and Kylie Sutherland, a fourth generation farming family, within the wheat–sheep belt. The property has always been conservatively managed, contains land that has never been ploughed and a biodiversity resource that would be the envy of many dryland nature reserves (Woodhall and Sutherland 1995). Eighty percent of the vertebrate species known to be present in the surrounding 1:100 000 map sheet are present on the property. Well managed native grasslands are in excellent condition and over 400 native plant species have been found on the property to date. The natural resources on the property include remnant bushland and scattered trees from a range of pre-European plant alliances.

The centrepiece of the Landcare group's focus is the 6 km^2 bushland patch which has been fenced off with cat- and fox-proof electrified fencing. In April 1998, the Brush-tailed Bettong (*Bettongia pencillata*), until then extinct in New South Wales, was reintroduced to 'Genaren' within the safety of the fox-proof fence, after an absence of over 150 years from the region. The Landcare Group is now one of two in the Central Western Region which has purchased the 'Save the Bush Toolkit' for all its members and is using it interactively to help integrate nature conservation and agriculture outcomes on working properties. Hard-nosed economic decisions drive this Landcare group but its underlying philosophy is matched by a willingness to seek help and advice from a range of universities, government agencies (Commonwealth and across States) and conservation groups. At the same time they remain in control of their destiny and add their own creative insights to eventual management strategies they adopt. But what on earth has the reintroduction of the Bettong got to do with the quest for landscape sustainability? The following two points need to be made:

- Part of Bettong feeding behaviour is to utilise hypogeal fungi (Strahan 1995). The loss of Bettong from the wheatbelt of Australia and the arid zone was accompanied by unknown losses in ecosystem health, particularly in the spread of mycorrhiza necessary to maintain healthy tree root function. Although this one-off action is unlikely to address major imbalances caused by the loss of one small marsupial from a specialised ecological niche, it is a message that 'wholeness' in Australian agriculture will be most adequately addressed when our farmlands are more in balance with nature and we seek restoration of the many unknown feedback loops once operating in complex land systems.
- The process of reintroduction, while an innovative conservation initiative, is indicative that the Landcare Group is thinking through a philosophy of restoration and management of their natural resources and how this is linked with the production matrix.

Understanding how land and water systems work

Australia is now entering the era of landscape rehabilitation of its agricultural lands. The process is being driven by a combination of circumstances, not least amongst them that land degradation is having an impact on productivity. Many Landcare groups form and progress around a single 'issue' such as soil erosion or salinity. In our opinion there is a general lack of understanding of how agro-ecosystems operate. Without such an understanding, there is little likelihood that restoration activities will be well formulated and implemented. Berry (1977), in words that now have a prophetic ring about them, wrote: ... 'if the farm is to last and remain in health, the wilderness must survive within the farm. That is what agricultural fertility is: the survival of natural process in the human order'.

Hobbs and Saunders (1993), in their seminal publication based on their experiences and those of others in the Western Australian wheatbelt, emphasised the need to see and integrate the twin goals of 'sustainable agriculture' and 'nature conservation' as one integrating principle. In our experience, few landholders and many agriculturalists and extension personnel in the agricultural industry have the ability to see the extent of land degradation around us within a systems context (Savoy 1988). It is the major thesis of this paper that the long-term potential impacts of contemporary agriculture can only be understood and responded to in terms of an agro-ecosystem model (Savoy 1988; Hobbs and Saunders 1993). The model must incorporate energy, nutrient and water flows proceeding by interdependent and well defined biophysical processes and which over time will attain a new equilibrium. The ecosystem/land system model offers the following advantages in developing appropriate management strategies (Goldney *et al.* 1997*a*):

- When the key operational pathways of a complex ecosystem are understood, the outcome of perturbations and disturbance within the system can be predicted with acceptable levels of confidence. Key pathways are associated with the atmospheric–climatic system, hydrological system, the energy flow system, the biogeochemical system, the terrestrial and aquatic ecosystems.
- Conversely, the design of effective impact mitigation and ecosystem repair strategies can only be initiated if the whole of system processes are understood.
- Proposed mitigation actions may prove ineffective in the long term unless a catchment approach is adopted, since isolated repair initiatives may be overwhelmed by system processes driven from outside individual farm boundaries (for example salinisation).
- Hence, repair and mitigation strategies requiring long-term outcomes associated with perturbation should complement optimal rehabilitation design strategies (actual or planned) in the catchments or regions.

Creating a shared vision of the future agricultural landscape

Biblical wisdom reminds us that: 'Where there is no vision the people perish'. What is the vision of the Australian community as a whole for a sustainable agricultural

landscape? The very strong sentiment expressed by many Australian farmers is that they want to leave their land in a better condition for future generations. This is a nebulous but powerful sentiment which in our own extension program we often harness to help focus our audiences on what vision choices may be available to them. No farmer wants to leave a 'desert' (Figure 3a and 3c). Most farmers desire to operate under best practice. One such attempt at vision creation is identified in the Potter farm in Figure 3d. If we accept that nature conservation and agriculture production are irrevocably linked then we will look to visions of an authentic Australian landscape rather than persisting with inappropriate European models from another age. Lefroy *et al.* (1993) provide a number of stylised representations for the central wheatbelt of Western Australia of the transition processes needed to create sustainable Australian farms. In the end it will be community wisdom aided by governments eager to facilitate sustainable outcomes with 'carrot and stick' approaches, that will determine what the Australian landscape will look like. Given that land degradation has still to 'bottom out' after 200 years of European land management, it is likely that the time needed to implement effective long-term rehabilitation strategies will be in the order of 150–200 years.

Identifying barriers to on-farm conservation behaviour

Awareness of environmental issues is relatively high amongst landowners and yet there is an apparent dysfunction between pro-environmental beliefs and conservation action by farmers (Barr and Carey 1992; Carey 1993; Goldney *et al.* 1995; Hodgkins *et al.* in press). Despite the Landcare movement, it is not at all certain that the battle to win the hearts and minds of Australian farmers to integrate nature conservation and production outcomes, has been particularly successful (Goldney *et al.* 1995).

In a recent aerial survey of the highly degraded Lake Cowal catchment, Goldney *et al.* (1997*a*) estimated that in a relatively small catchment (9500 km^2), only 20 000 trees have been planted in the past decade where 95×10^6 are required. The finding that we do not always realise our best intentions is a powerful one. In that regard landholders are no different from the wider community. However, for landholders the reasons for failing to carry out on-ground actions are probably more complex. Figure 5 identifies some of the barriers and filters preventing landholders and other stakeholders from creating optimal visions and adopting best-outcome practice. The social, political and economic realities operating in our society are critical components in determining best or worst practice outcomes. Of equal importance is the farmer's or Landcare group's or agriculture adviser's world view of the underlying biophysical processes at work in the landscape. If land degradation processes are not understood within a systems framework, then land degradation outcomes will be perceived as environmental noise and on-ground responses are likely to be inadequate. In contrast, a systems approach will yield patterns of understanding that allow previously unrelated pieces of the farming environment jigsaw to form the basis for best outcome responses.

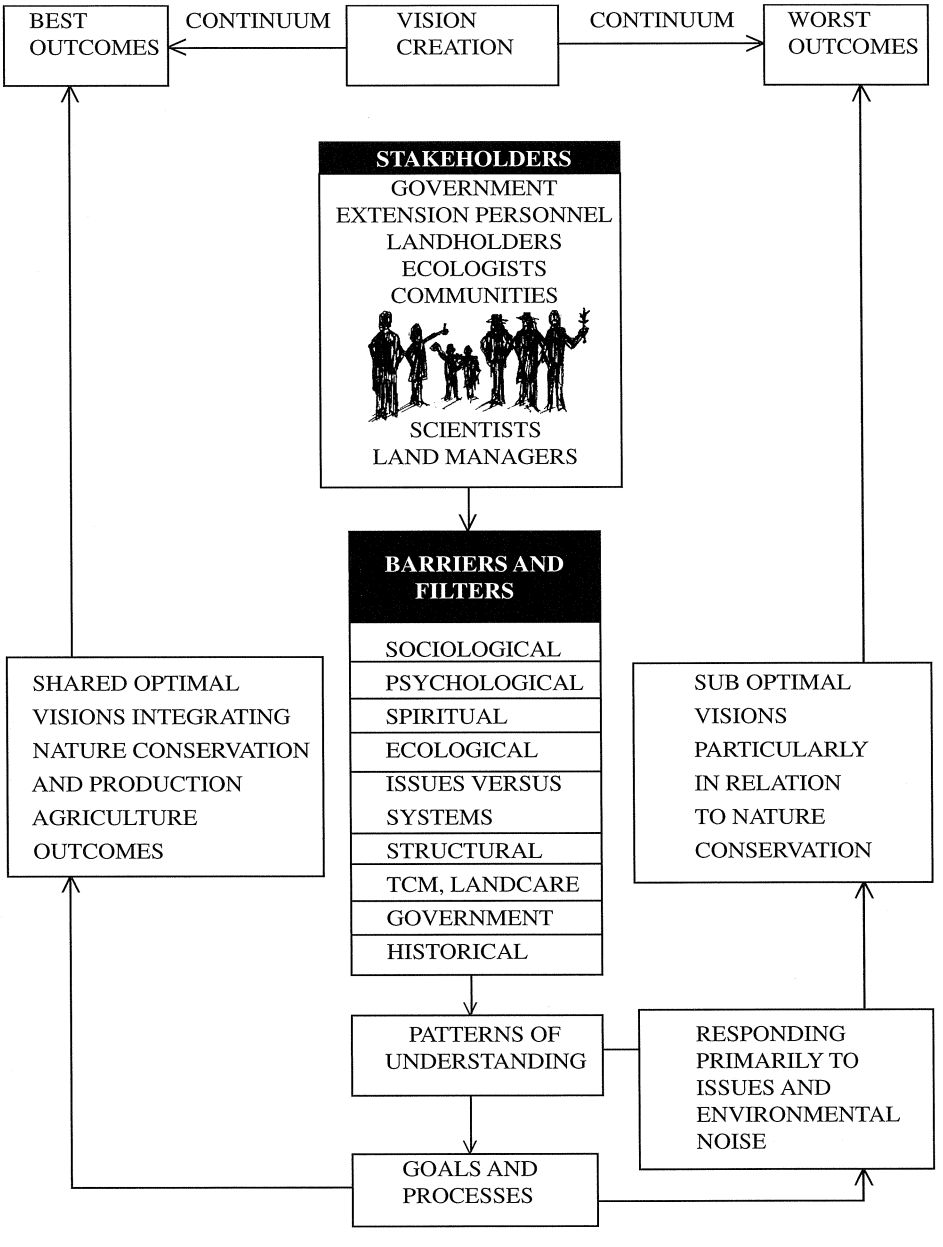

Fig. 5. Processes involved in vision creation of future Australian farming land systems.

3 TEN PRINCIPLES FOR INTEGRATING NATURE CONSERVATION AND AGRICULTURAL PRODUCTION

Although we have a good understanding of the nature and extent of land degradation in Australia, we do not yet have general agreement in the community as to the end point of landscape restoration (Saunders 1996). Even if we believe in the need to integrate nature conservation and production agriculture, we cannot offer landholders a blueprint to develop optimal farm designs in a catchment context. Research, computer modelling and on-ground demonstrations are all needed. Nor can we be certain that where working examples exist and higher levels of productivity are being achieved, a cause and effect relationship holds. The situation is complex (Figs 4 and 5). Nevertheless, a fair reading of existing data and expert opinion (lay and professional) suggests the need to accept as a working hypothesis the integration of conservation and agriculture production (Saunders 1994). Landscape ecology is in its infancy in Australia. Schools of the production-based sciences (agriculture, veterinary etc.) are only now significantly modifying their curricula to engage with holistic environmental models. Conservation groups have not easily embraced the notion of cooperating with Australians who make their everyday living from the land. The majority of the farming community remains to be convinced that yet another change in direction by governments will mean a better dollar return in the long run. Given this sociological milieu, are there integrating principles which can help us to create the basis for change and the development of sustainable landscapes across Australia? The 10 identified below seem to us the most probable candidates, based on available research, common sense and reasonable management expectations.

1. Working as an agriculturalist in a broadacre system without reference to ecology is a recipe for short- and long-term disasters

Agriculture is an ecological enterprise. There are ecological boundaries to endeavours which seek to increase or maintain productivity. For example, destroy habitat and there will be a loss of helpful insect-eating birds. If fertiliser is allowed to drift over remnant woodland, tree decline will probably occur. The more we know about ecology, the more links of this kind are discovered. The extreme climate variability in Australia also imposes limitations on agricultural production.

2. No property can be farmed independently within the system

Every property is under the influence of the land surrounding it and the ecological processes operating over the landscape. No property is an 'island'! Dryland salinity can be induced in upland valleys by excessive clearing in neighbouring recharge areas; overclearing in the upper catchment together with increasing soil compaction and overgrazing will induce soil erosion and changes in the water flow system. The downslopes river valley or ephemeral streams will experience flows of water from time to time, which are likely to impact adversely on destabilised native riparian woodland or forest, resulting in scouring and loss of stream bank

integrity. For the irrigation farmer, thinking beyond farm boundaries has become a necessity due to water allowances. It will be important to expand this systems approach to other production elements. Equally important are system approaches to weed and feral animal ecology.

3. Since no land-manager can be an 'island', all should participate in developing local and regional catchment management plans

Within catchments, remnant bushland should be regarded as a key component in the agro-ecosystem, on ridge tops and slopes, in valleys and along waterways. Bushland is not only native tree cover but a complex response of plant communities to biophysical conditions. The ideal structure includes a range of trees of all ages, including regenerating and old growth trees with well developed hollows; native understorey which may be predominantly grassland or shrubland or a mixture of both; fallen log and dead standing trees; leaf litter and other plant material. This complex structure and floristic diversity provides the resources for a range of animals and plants. We know that many of these species play important roles in maintaining the health of land systems. The precautionary principle would suggest that it is essential to maintain them. Bushland is not rubbish land but provides measurable benefits in the quest for sustainable agriculture.

4. Within the context of catchment planning, each land manager should seek to develop individual farm plans

Such plans will have two overriding principles at work:

- farms should be worked as a collection of separately fenced units based on the range of soil types and topography present;
- every farmer will be an agro-ecologist and will work with nature and within its limitations, not against it.

Particular design criteria must seek to address production outcomes, land degradation issues, climate amelioration and species and biotic community conservation outcomes.

5. Adverse environmental effects are incremental

Common sense can sometimes lead us astray! It seemed common sense to our forebears that they should increase productivity in a manner that we with hindsight may now perceive as overclearing. Overclearing in conjunction with other land management practices in the past has led to sheet and gully erosion, loss of critical top soil, siltation of river systems, changes to flood regimes in our rivers and cities, and to dryland salinity. The use of excessive amounts of chemicals initially led to outstanding successes. The process was compromised by residue and contamination problems, target plants and pests becoming resistant, as well as the loss and forsaking of traditional skills.

6. There is a need to balance technological solutions against more natural solutions

Excess ploughing can break down soil structure and heavy machinery can compact soils; the inappropriate use of non-target sprays can reduce the level of

useful organisms. Introduced grasses can replace valuable natives. Learning to live with acceptable levels of insect damage, as with the technique of integrated pest management, is a revolutionary step forward; native birds and animals can provide important pest control provided we allow them places to live on the farm. The reed systems once prevalent along the drainage lines were important water distribution and filtration agents in creek and river flats, but have been destroyed by stock. Technological solutions are usually expensive. The current debate between sustainable agricultural proponents is partly between those who see excess technology as 'the enemy' and advocate organic practices and those who see modern technology as the only way ahead for agriculture. There is no doubt some truth in both sides of the argument.

7. The most fundamental expression of farming in balance with nature is the presence of a well planned or conserved bushland/surrogate bushland web integrated with active agriculture processes

Ideally, bushland on farms will be interconnected, well managed remnants intentionally left by far-sighted forebears. But in most cases, what remains results from less ideal circumstances and is badly degraded or long since gone. Tree planting and attempting to recreate approximations to the precursor bushland (surrogate bushland) is time consuming and expensive. Hence there is a need to value existing remnant vegetation as the basis for a regeneration program. It requires too that neighbours work cooperatively in vegetation management at farm and landscape scale. We now understand that in most cases a property without trees or bushland is less productive than one with strategic plantings of well placed bushland. No trees and bush or appropriately designed windbreaks means the loss of stock from adverse weather conditions, loss of meat production and value because of chilling winds, loss of insect control, loss of control of water recharge and watertable hydrology, to name some examples. Research is by no means adequate to say categorically how much bushland or surrogate bushland should be left or recreated on properties, but a consensus is developing which suggests that around 5–10% may be desirable. This will differ from property to property, depending on the nature of the agricultural enterprise, prevailing winds, climate, topography, soil types and other biophysical constraints such as local hydrology. We must also concede that some properties should not have been cleared at all and may need to be retired from farming and revegetated.

8. Native flora and fauna act as indicator species about the health of our land

Our forebears used indicator species such as yellow box (*Eucalyptus melliodora*) as evidence of quality agricultural land. We should understand our agro-ecosystems well enough to recognise most species present, both native and introduced. We are all aware of the presence of indicator weed species which come onto land which has been overgrazed or is undergoing salinisation. Do we know the names of native bird species that are insectivorous and are saving us money as a free pest control agency? The absence of significant groups of fauna can be a cause for concern. Sugar Gliders (*Petaurus breviceps*) may be quite important in

the control of dieback by preying on Christmas beetles (*Anoplognathus* spp.) and other related species, but they are unlikely to be present if suitable habitat is missing. Echidnas (*Tachyglossus aculeatus*) need logs and stumps to breed and to hibernate. Sometimes the very tidy habits of Australian farmers can destroy what is important habitat for native animals on the farm. The occurrence of frogs can give us valuable information about the health of our dams and our waterways as they are particularly sensitive to a range of pollutants.

9. Drainage lines and ephemeral waterways are critical nutrient areas for farm flora and fauna and should be rehabilitated and fenced off as part of long-term planning

Drainage lines and waterways should form part of the web of bushland that integrates with whole farm planning. They can be multi-use areas providing woodlots, windbreaks and stock shelter. Drainage lines will bring concentrated nutrients to these areas and help provide the buffering and purifying capacity to help safeguard our river systems. But they will also ensure the presence of native plants with the most nutritious leaves which will also enable particular species to be present and hence increase the species richness of a property. There is a real potential for a win-win situation when fencing off waterways. Ecosystem processes will be maintained or improved and better quality water (via piping and troughs) can be provided which in turn will increase animal production.

10. Environmental costs of agricultural production must be factored into the market place

At present we do not count the costs of degradation or rehabilitation in agricultural production costs. There needs to be a meaningful response from the community to help solve this problem. By adding an environmental tax to agricultural commodity prices within Australia, significant long-term funding for rehabilitation and development of sustainable farming strategies, could be made available. It would also help consumers to connect more realistically with the environmental issues associated with farming. We cannot at this time in Australia define exactly how we can achieve sustainable agriculture. We may always be faced with a non-equilibrium situation where our management practices will have to change continually as new challenges arise. Whatever the outcomes, bushland or its surrogate will play an important, often unseen but hopefully not unsung, role in this quest.

4 CONCLUSIONS

Two contradictory situations are being worked out in our agricultural lands. On one hand the level of environmental awareness is continuing to increase and is being accompanied by significant action to combat land degradation. At the same time, an honest assessment of the state of the agricultural environment indicates that an already serious situation is getting worse. Where governments have

intervened to prevent over-exploitation of resources by, for example, introducing anti-vegetation clearance acts or water use rationalisation, they have been forced to retreat or modify their proposals in the face of well organised opposition. Mining companies utilising about 0.04% of the Australian land surface at any one time are subject to constraining legislation which clearly identifies environmental limits and through consent conditions identifies further limits or rehabilitation pathways. In contrast, agricultural practices are subject to few constraints. Even when limits on behaviour such as vegetation acts are put in place, they can be easily circumvented. With the best will in the world, it is difficult to see how Landcare, Total Catchment Management initiatives and other greening processes can deliver within the time frame needed. Nor will the use of the resources being made available from the privatisation of government assets produce optimal outcomes unless more strategic guidelines are developed. Perhaps it is time to invoke a series of more radical measures. These could include:

- placing a blanket ban on all clearing of native vegetation for 10 years, other than for very prescribed conditions; this will provide a breathing space to enable coherent land management strategies to be developed;
- requiring all landholders to develop integrated farm plans within 10 years and/or when properties change hands either through deaths or sale;
- developing relevant training programs for landholders based on the empowerment paradigm;
- developing a series of hard-hitting advertisements and media programs to help educate landholders about land degradation issues (perhaps in the same genre as the 'quit smoking' or road safety campaigns);
- allowing access to government funding for only those landholders who have developed appropriate farm plans;
- initiating a process of property rationalisation across Australia concurrent with a farm retirement scheme associated with massive tree plantings and/or regeneration; a major objective of such a scheme would be to create viable farming units;
- developing a national Landcare farming magazine to be distributed free to all landholders on a regular basis.

We are not writing from a doomsday perspective and remain hopeful that creative solutions will be adopted. Only time will tell.

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