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Concepts of Landscape Redesign

A Background Paper

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January 2001

Enduring Questions in the Landscape Redesign Debate

1. Is landscape redesign the right choice of words? When should the community contemplate redesign and when is redesign inappropriate? Are there cases where incremental change or landscape preservation are more desirable?
2. Can a set of objectives and guiding principles for landscape redesign be developed? What should these be?
3. Should landscape redesign concern itself solely with agricultural land uses? If other land uses are important how should these be incorporated into a conceptual framework?
4. What are the options for landscape redesign?
5. How can the impacts of landscape redesign options be simulated? Can current farm, catchment and regional models provide the answers we require?
6. Is the overriding objective of landscape redesign to develop and implement systems of food and fibre production that mimic natural systems?
7. What is the appropriate spatial scale to manage redesign? Does it require change to individual paddocks, farm properties, catchments or larger regions?
8. How should landscape redesign options be evaluated? What are the key trade-offs in social, economic and environmental terms?
9. What are the policy and institutional mechanisms that will permit landscape change? For example, does the conceptual framework need to concern itself with cost sharing arrangements? If so, how?
10. Why do we need landscape redesign or even change? Are salinity and water quality the driving factors? Are there other factors that prompt a need for change?

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This paper has been produced under a project titled "Conceptual Framework for Landscape Redesign". The project is funded by Land and Water Australia and is being undertaken by CSIRO. Any comments or input related to this paper are most welcome. Please contact:

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PART A: SETTING THE SCENE

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"It is essential that we find new ways of managing and using our land that are more in tune with the needs of our valuable environment"
(Madden *et al.* 2000, in a report prepared for the Australian Conservation Foundation and National Farmers Federation)

"*We can have the landscapes we want, or we can endure the landscapes we let happen*"
(1999 Fenner Conference on the Environment, Hamblin 2000, p1)

Introduction

Agricultural industries have been a major driver of Australia's economic and social development over the past two centuries. Today, the rural sector contributes around AUD$26 billion (22.5%) to Australian exports and employs around 422,000 people, 4.9% of the workforce (ABARE 1999). Agriculture also characterises many Australian landscapes, being an important part of the national cultural identity.

However, there is a growing consensus amongst diverse community groups, scientists and policy makers that agriculture needs to adapt to meet new challenges. This need has been highlighted by improved information on salinity, water quality and other land degradation problems.

A recent report prepared for the Australian Conservation Foundation and National Farmers Federation (Madden *et al.* 2000) states that there is a need for the development of new production systems that are in tune with the needs of the natural environment. It is this need that has prompted the concept of landscape redesign, a challenge to develop profitable and environmentally sustainable land use options that help attain desired future landscapes.

Natural resource managers are only starting to grapple with how Australian landscapes can be managed, or where appropriate redesigned, to achieve improved outcomes. There are many unanswered questions relating to landscape redesign, as listed above. These represent the range of *unknowns* that need to be addressed to permit effective scientific research, policy formulation and on-ground change. These questions resurface throughout the remainder of this paper.

Is "*Landscape Redesign*" the Right Choice of Words?

Landscape redesign is the current terminology chosen for this project, although may not necessarily be used in the final report. The phrase "landscape redesign" helps emphasise the nature of change required to deal with significant land degradation problems that minor changes to individual farm properties or fields are unlikely to address. For example, in some cases effective salinity control may only be possible by revegetating over half a catchment. If this option is pursued, it involves a far-reaching redesign of an entire landscape.

However, landscape redesign may have connotations that are distasteful to some. The phrase could be perceived as describing top-down land management changes imposed by government. In some cases, communities may not want 'redesign', preferring instead incremental changes or preservation of the current landscape. Could the mere terminology of landscape redesign alienate such groups before they take time and effort to be fully acquainted with the concept?

The challenge for those involved in developing the concept of landscape redesign is identifying terminology that is both accurate, marketable and engenders a sense of urgency about the need for change. For landscape redesign to obtain widespread support and interest it needs to appeal to a diverse range of stakeholder groups. If the phrase holds negative connotations for such groups they are unlikely to become involved or render support.

What is Landscape Redesign?

The most accurate answer is that we don't really know - at least not yet. As evident above, we don't even know if it should be called *landscape redesign*. It will only be through a series of workshops and broad consultation that a suitable definition and terminology for the landscape redesign concept emerges. However, to provide a background we suggest that landscape redesign is any significant redirection or reshaping of landscape scale policies, practices and land uses aimed at attaining improved economic, cultural and ecological outcomes.

From a biophysical perspective, redesign options are most likely to be considered where salinity, biodiversity, soil erosion, water pollution, groundwater depletion or environmental flows are issues. From a community perspective landscape redesign is most likely to be considered where incomes are declining and/or communities feel they lack opportunities.

Currently the scope for landscape redesign is very broad. It is potentially relevant to all of Australia, although is likely to focus on agricultural land. It is also of potential relevance to all forms of land and water degradation. Through feedback from this background paper we hope to narrow this focus.

What is a Conceptual Framework for Landscape Redesign?

The final product from this project is a conceptual framework for landscape redesign. A conceptual framework is a tool to aid thinking. Typically, a conceptual framework structures the underlying methodologies, principles and rationale for a particular concept or project. Good frameworks tend to be simple, they show what is important. They also inspire people to take actions to address complex and challenging issues. In the context of Australian Landscapes, a conceptual framework would be of much value to:

- the communities who live in them and use them;
- researchers interested in contributing to their improvement; and

- those responsible for governance.

The conceptual framework for landscape redesign should help scientists, policy advisers, farmers and community groups work through the complex processes of determining desired changes to land use and land management activities at the landscape scale and how such changes might best be achieved. It should give clarity to seemingly intractable problems.

The Evolving Impetus for Landscape Redesign

The history of Australian agriculture and land management is one of continual redesign and adaptation. The first landscape redesign works are often traced back to indigenous Australians who farmed not with fences and ploughs, but with fire (Davidson 1986). Evidence for this type of farming comes from accounts by early European explorers, and archaeological research (Barr and Cary 1992). It is suggested that through the use of fire, indigenous Australians opened up areas of grassland that attracted kangaroos and other wildlife, making for easy hunting. In so doing, they redesigned parts of the Australian landscape to better suit their purposes. The modified landscapes occurred through processes of learning, experimentation and adaptation.

In an account of Australia's agricultural history, Bromby (1986) traces the first European attempts at agriculture in Australia to Governor Arthur Phillip shortly after the first fleet's arrival in 1788. These early beginnings saw hopelessly inadequate agricultural production techniques and the colony facing starvation as a real possibility. Crops often failed and yields were mostly inadequate. Ships were dispatched to India and other places to obtain much needed rice, wheat and other grain (Bromby 1986).

Since these beginnings Australia's agriculture and its landscapes have undergone continual change. New farming practices, crop rotations and technologies have led to significant jumps in yields and production efficiency. For example, figure 1 shows changes in mean wheat yields since 1870. After an initial decline in yield from nutrient exhaustion, wheat yields grew from around 860 kg/ha/yr in 1870 to 1,375 kg/ha/yr in 1990 (Hamblin and Kyneur 1993).

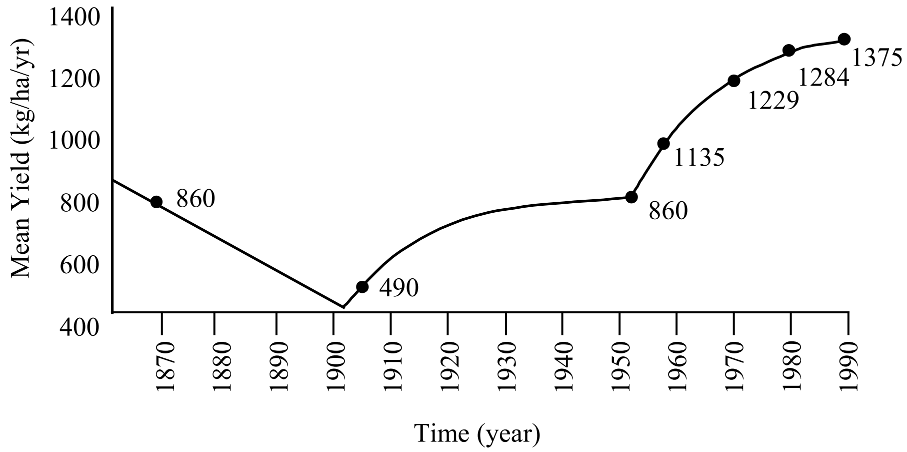

Figure 1. Increase in mean wheat yields since 1870 in Australia (Hamblin and Kyneur 1993).

While there has been tremendous improvement in yields at the farm level natural resource management has been less successful at the landscape level. Over the past several decades the impetus for redesign has shifted from production to environmental and long-term sustainability issues. The land management debate is being increasingly driven by concerns relating to rural quality of life, water quality, soil health, biodiversity and landscape aesthetics. Whilst a great many factors prompt the need for landscape redesign four major factors continually re-emerge in the debate:

- Firstly, land resource productivity problems such as salinity, acidity, acid sulphate soils, sodic soils, soil compaction, soil erosion and soil contamination have generally increased in area over the past century and some are likely to continue to increase. For example, it is estimated that dryland salinity nationally affects 2.5 million hectares and that this may increase to 12 million hectares without intervention (NDSP 1998). The need to halt or reverse these problems is prompting the need for landscape scale change.
- Secondly, there is much anecdotal and scientific evidence to suggest that Australia's surface water resources are deteriorating in quality. Examples

of water quality degradation problems include changing environmental flows, increasing levels of salinity, algal blooms, eutrophication, turbidity, acidity and increased nutrient loads. Many of these problems have been linked to current and historical land management practices.

- Thirdly, there has been a significant loss of biodiversity and landscape amenity. The Australian State of the Environment Report (SEAC 1996) presents data on pressures to biodiversity suggesting that agriculture is the major cause of 78 species extinctions and is placing a further 105 species at "*present or future threat*". The Western Australia State Salinity Strategy (2000) forecast the potential loss of 450 species of plants to dryland salinity in the absence of intervention.
- Fourthly, farm incomes in many rural regions have not kept pace with other parts of Australia. The decline in profitability of some agricultural enterprises is having negative effects on whole regional communities. Through landscape redesign, such as the adoption of new industries, farming practices or technologies, it may be possible to help improve the profitability of agricultural enterprises. This will help sustain employment in the agricultural sector and will have many other community benefits.

The challenge for landscape redesign today is primarily one of implementing new systems of food and fibre production and regional-scale patterns of land-use that perform well not only financially, but ecologically and socially. In meeting this challenge researchers, policy officers, farmers and the general community will be able to draw upon a wide range of technological advances, knowledge of natural resource management issues and institutional frameworks that have hitherto been unavailable.

PART B: TOWARDS OPERATIONAL GUIDELINES

Before a broad policy objective such as landscape redesign achieves on-ground implementation it requires clear operational guidelines. For example, the concept of sustainable development was eventually translated into a set of principles (the Rio-Declaration, 1992) only through many years of debate in both academic and policy forums. Even now many would consider the operational meaning of sustainable development somewhat elusive. This section looks at some of the issues that will need to be resolved in making the concept of landscape redesign operational.

Guiding Principles for Landscape Redesign

For landscape redesign to be given operational definition it will require a set of objectives and guiding principles. It would be premature for this paper to propose these objectives and principles now. Rather, these will be developed through the process of consultation and feed-back that will occur throughout the project (concluding in late June 2001). It may also be possible that this paper does not develop another set of principles, instead using well established principles developed by other authors and organisations. Some examples of objectives, principles and guidelines developed in other reports with potential relevance include (refer to the appendix for extracts of these):

- *The National Strategy for Ecological Sustainable Development (ESD)*. Since its inception in 1992 this document still guides much natural resource management policy in Australia at a broad level. The strategy is proceeded by an overall goal of ESD, three core objectives and six guiding principles.
- *The Summary of the National Action Plan (NAP) for Salinity and Water Quality*. This contains a list of several tasks to be implemented under the NAP. These could be seen as broad stages for landscape redesign.

- *Ten principles for integrating nature conservation and agricultural production* (Goldney and Bauer 1998). These are a set of principles to help create a basis for change and the development of sustainable landscapes across Australia.
- *Repairing the Country: A national scenario for strategic investment by the National Farmers Federation and Australian Conservation Foundation* (ACF and NFF 2000). This document proposes an approach to a national natural resource management strategy guided by several principles.
- *Ten point guideline for future directions in landscape renewal* (Saunders and Briggs, forthcoming).

The Importance of Agriculture

Of all Australian land uses agriculture covers by far the largest area. Figure 2 shows the national extent of crops (including horticulture), sown pastures and native pastures derived from a land use map produced as part of the National Land and Water Resources Audit. From this map, agricultural land uses cover around 470 million hectares, 62% of Australia's land surface area (NLWRA 2000).

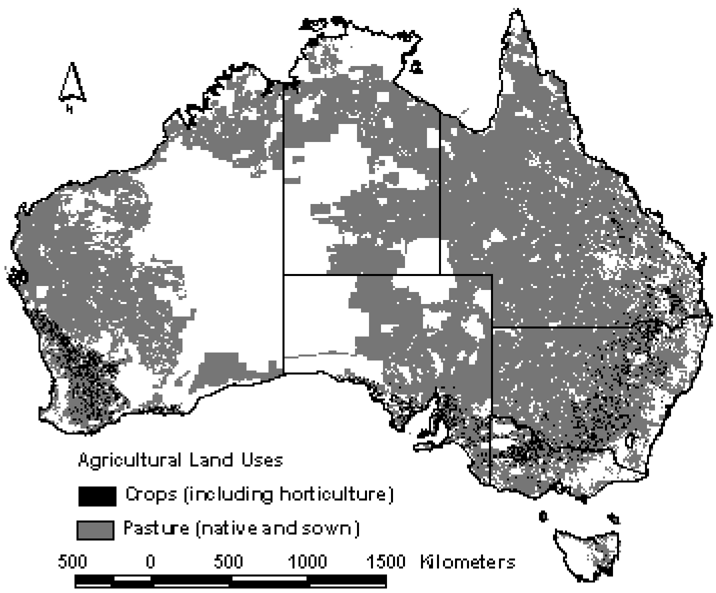

Figure 2. Extent of agricultural land uses in Australia (NLWRA 2000).

Partly from its sheer size, agriculture is a dominant factor characterising most Australian landscapes. Therefore, one of the most effective ways to change Australian landscapes is to change agricultural practices and land use patterns. Accordingly, agriculture may be the focus of landscape redesign strategies. Nevertheless, many other non-agricultural land uses such as urban settlement and mining have significant, or potentially dominant, impacts on the economic, social and ecological condition of a landscape.

A question facing those involved in landscape redesign is the extent to which agriculture, as opposed to other land uses, should be the focus of redesign efforts. It is possible that as landscape redesign evolves the focus in some regions may shift to the redesign or restructuring of urban settlement, tourism and extractive industries. In some cases these activities may have greater impacts than agriculture.

Salinity and Water Quality: The Major Drivers of Redesign?

Much of the landscape redesign research and development work to date has been driven by concerns about salinity and water quality. This is evident in both the scientific community and the broader natural resource management community.

Within the scientific community many researchers are looking for plant-based production systems that reduce leakage of water and nutrients beneath the plant root zone for application in those landscapes where such leakage is detrimental. These strategies are aimed at tackling salinity and water quality problems.

Leakage of water refers to the amount of water that seeps through the root zone and enters the groundwater system. This is a major cause of dryland salinity because increased recharge to groundwater mobilises and redistributes water and dissolved salt in discharge areas. As water evaporates directly or through plants in these discharge areas salts concentrate near the soil surface and plant root zone. These salts can also enter streams and rivers. Leakage of water under most natural systems on landscapes with the potential to salinise in the 250-600mm annual rainfall zone was around 5mm/yr (Walker *et al.* 1999). Much of this area has now been turned into dryland cropping and grazing. With the introduction of annual crops and pastures into these landscapes average leakage rates have significantly increased to around 20-50mm/yr, causing problems of dryland salinity. In a number of areas, dryland salinity and river salinity is aggravated by leakage from irrigation areas.

Leakage of nutrients can also lead to water quality problems. All intensive cropping and grazing practices will at some stage require addition of large amounts of nitrogen and phosphorus based fertilisers. With current fertiliser practice, the plants will use only part of the nutrient supplied to the soil. Some remains variously available within the soil, while the rest enters the groundwater system and/or runs into waterways. This can potentially contribute to water quality problems such as eutrophication and algal blooms.

Although clean water and minimal salinity problems are some of the most important attributes Australians seek from their landscapes, there may also be other landscape services that need to be considered in landscape redesign. Hamblin (2000) points out that landscapes are social constructs. The values people derive from landscapes are diverse including financial, recreational, spiritual and aesthetic. In some cases the major purpose for landscape redesign may be to preserve biodiversity or create a visual environment that people enjoy.

The question for landscape redesign is whether it concerns itself solely with salinity and water quality, which for good reasons have captured scientific, social and political attention. Alternatively, landscape redesign could embrace a broad range of sustainability criteria defined by local community groups. Walker and Reuter (1996) list a set of key environmental and economic indicators that can be used to make an assessment of catchment health. In a redesign process indicators such as these could be used as criteria to judge the relative desirability of multiple redesign options.

Requirement for Landscape Scale Change

A significant principle driving the notion of landscape redesign is that minor changes to individual farms or paddocks will be insufficient to tackle serious land degradation problems facing Australia, such as salinity and water quality. Scientists and innovative farming managers are starting to find that effective solutions may require changes to land use patterns and activities over whole catchments and drainage basins. Some relevant findings include:

- In a survey of 80 Western Australian sites George *et al.* (1999) found that extensive plantings, covering as much as 70-80% of a catchment are required to achieve significant reductions in water tables and salinity control.
- Using hydrological models to study the Wanilla Catchment in South Australia Stauffacher *et al.* (2000) found that a 50% reduction in recharge, involving revegetation of a large area, prevented around only 3% of the catchment area from being salt affected over a twenty year period.

Effectively addressing non-point source pollution problems such as fertiliser and pesticide run-off, is also likely to require adjustment of land use practices over an entire catchment. This creates a challenge for landscape redesign to adjust land use activities over an entire catchment or other region.

Achieving landscape scale change may be a costly exercise. Hajkowicz and Young (2000) used Stauffacher *et al.'s* modelling of salinity to undertake a benefit cost analysis of revegetation for the Lower Eyre Peninsula Drainage Basin, also in South Australia. For the best economically performing option they obtained a benefit cost-ratio of 0.68, and a present value of losses at around AUD $173 million. It is questionable whether non-market benefits of an additional 3% of non-salt affected land (achieved by revegetation) would be deemed equal to this amount.

Biomimicry: An End or Means of Redesign?

Initiated in 1996, the Redesigning Agriculture for Australian Landscapes research and development program represents a major research effort related to landscape redesign. An early question guiding this program was "*Can we design agricultural farming systems which mimic natural systems*?" (Clarke 2000).

In various forms, this question has shaped much thinking relating to landscape redesign over the past few years. In part, it emerged from suggestions that many of the negative impacts of current agricultural production systems have arisen from their fundamental conflict with longer term natural processes of the Australian landscape. Land degradation problems such as salinity provide evidence suggesting some current Australian agriculture may be fundamentally ill-suited to the Australian environment in the medium to long term. A logical inference is that by making current agricultural practices behave similarly to natural ecosystems, many land degradation problems could be avoided. In other words, agriculture should seek to mimic the natural environment where possible. The challenge is to maintain or improve profitability whilst mimicking the natural system.

The proposition of developing agriculture that mimics natural systems shares much in common with the broader concept of *biomimicry* (from the Greek bios, meaning life, and mimesis, meaning imitation), suggested by some as a new science or paradigm relevant to all natural resource management issues. Benyus (1997) defines biomimicry as "*a new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems, eg solar cell inspired by a leaf*". From some perspectives, biomimicry is based on a belief that through billions of years of evolution, nature has developed systems far more capable of sustaining life than can be achieved through human innovation.

The concept of biomimicry is starting to receive attention in Australian agricultural research. A key development has been a set of operational guidelines for the development and adoption of agriculture that mimics natural ecosystems (Lefroy and Hobbs 1997, *vii*) as listed in appendix A. These guidelines emerged from an interdisciplinary workshop convened in Western Australia that brought together agriculturalists and ecologists from around the world.

There is a broad spectrum of perspectives on the biomimicry concept. Some see biomimicry as desirable solely because humans should seek to better integrate with nature due to its intrinsic value. Others take a more pragmatic approach. Lefroy *et al.* (1999), having undertaken pioneer research in the field, state that their interest in the biomimicry concept is one of improving the sustainability of agriculture. The starting point for their work was research seeking to incorporate the diversity ecosystem functions into agricultural systems for improved persistence, resilience and efficiency of resource use.

If a pragmatic perspective is adopted it becomes important to think about the means and ends of biomimicry. If mimicry of natural systems is solely to achieve sustainable natural resource use, should it be compared against alternatives that potentially achieve the same end without mimicking natural systems? In other words, can something other than mimicry be done to achieve preferred economic, ecological and social outcomes?

For example, in some catchments the most effective means of reducing stream/river salinity levels may be the construction of salt interception schemes that pump salty ground water to an evaporation basin before it enters the watercourse. These are engineering works that clearly do not mimic the natural system. However, they may be capable of providing a much more direct and tangible benefit to river water quality than revegetation options that reduce water recharge to levels similar to that under native bushland.

Another key consideration in the application of the biomimicry paradigm for landscape redesign is the degree to which changes in the landscape are hysteretic. Using the dryland salinity example, once the groundwater systems are filled with the excess water arising from conventional agriculture, will introducing new farming systems that mimic the recharge values under native vegetation restore the original hydrological condition of the system? Or has the system undergone a fundamental and largely irreversible change of state, implying that mimicry of the original biological component is no longer appropriate?

Integrated Tree, Crop and Pasture Designs

An aerial view of most Australian agricultural land reveals countless fields organised in rectangles or regular geometric shapes. Generally, the fields comprise a single land use, sometimes with vegetation along the perimeter. There are few examples of paddocks where crops, pastures and trees are closely integrated.

Can this design be improved? It is possible that the development of integrated tree, crop and pasture designs could emerge as the major objective for landscape redesign. New research into crop yield over an individual paddock is showing that this may be economically efficient, as well as environmentally preferable. This creates a window of opportunity for the concept of landscape redesign.

Several research projects (*eg* Bramley and Cook, 2000 and Bramley and Proffitt, 1999) have shown that yield and gross margins vary considerably over an individual farm paddock. Importantly, gross margins, the net returns of agricultural production excluding fixed operating costs, often vary from negative to positive values within a paddock. This means that farming in some parts of the paddock is creating a loss for farmers. Examples of gross margins showing this variation within an individual paddock for grape growing are shown in figure 3. It can be seen that significant parts of the paddock are creating a loss. Overall profits would be increased if these areas were removed from production, or subject to alternative management practices.

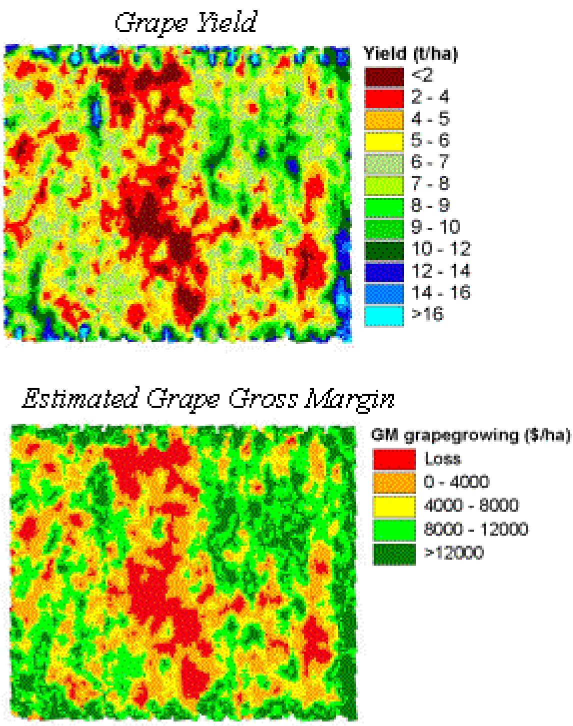

Figure 3. Variation of crop yield (grapes) within a single vineyard in Coonawarra in South Australia (Bramley and Proffitt 1999).

Strategic Revegetation

Farmers are already taking up the revegetation challenge. In a survey of around 2000 broadacre farms in 1994 Wilson *et al.* (1995) found that 35% of farmers planted trees on their properties between 1991 and 1994. It was also found that 35% of farmers had tree belts and corridors, 14% had tree blocks, 6% had alley belts of at least two strips of trees with cropping or grazing in between and 6% had widely spaced plantings. Through the tools of precision agriculture and development of industries based on tree-products it may be possible to design better integrated tree-crop-pasture farms.

An important issue related to strategic revegetation is the competition between trees and crops/pastures for limited water and nutrients. This has been well researched in alley farming (also known as alley cropping), which is defined as "*a farming system where crops and pastures are cultivated in the alleys between rows of trees and shrubs*" (after Kang *et al.* 1990, cited in Stirzaker and Lefroy 1997). Ong and Leakey (1999) describe resource capture in integrated systems as either competitive, neutral or complementary. Which of these three conditions prevails will depend on a complex interaction of many factors such as climate, soil type, plant species and stage of tree development.

The level of competition will influence the design of the tree crop interface. If the relationship is complimentary and trees increase yields of neighbouring crops, it makes sense to maximise the perimeter to area ratio of new plantations. Conversely, if trees have a negative impact on crop yield it is better to plant trees in blocks with minimal perimeter to area ratios. Six alternative designs of integrated tree-crop/pasture fields with the same area but different perimeters are shown in figure 4. The shape of planted areas will also be influenced by the nature of within-paddock yield and profit variation. Clearly it makes sense to plant in areas that have lower and/or negative returns.

The spatial arrangement of land uses within a paddock or farm can be designed to complement a broader spatial arrangement of land uses within an entire catchment. As with an individual paddock there will be spatial arrangements of trees across the catchment that are more economically and environmentally efficient. For example, Stirzaker *et al.* (2000) suggest that convergent or concave hillslopes that with slopes exceeding 3-5% may be ideal locations for planting trees to control groundwater recharge and salinity problems.

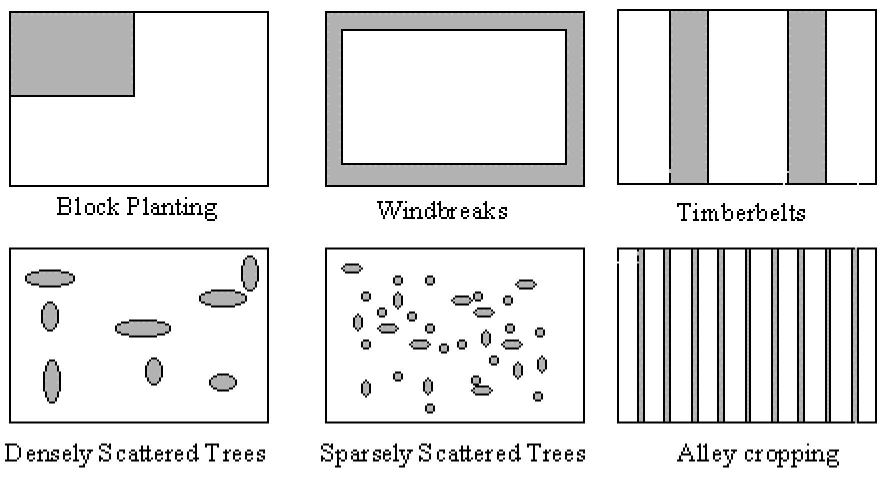

Figure 4. Six alternative integrated tree, crop and pasture field designs (after Young 1987, cited in Stirzaker and Lefroy 1997).

A key question for landscape redesign is whether it has the spatial arrangement of revegetation options as a primary focus. Is landscape redesign fundamentally about how we spatially arrange different trees, crops and pastures throughout a catchment? From this perspective landscape redesign at the catchment, regional and national level has much in common with the concept of land use planning. Land use planning has long been employed by Local, State and Commonwealth government in both cities and rural areas. The fundamental concern of land use planning is developing a spatial arrangement of human activities that contributes towards sustainability or quality of life in general. Could landscape redesign have a similar purpose?

Tools and Options for Landscape Redesign

The nature of landscape redesign will be given definition by the range of options it considers. In this section a broad range of options for landscape redesign are described. These represent physical changes to the landscape that could potentially lead to economic, social and environmental benefits.

Landscape Preservation (no redesign)

Landscape redesign need not necessarily involve an *a priori* assumption that landscape scale change is necessary or desirable. Some landscapes are highly valued by the community in their current state and their preservation is an objective for many people. This is evidenced by strong community opposition to development proposals in environmentally sensitive areas that have remained undisturbed. Some agricultural landscapes also have high cultural value and change may not be seen as desirable by resident populations. There are strong grounds for all those involved in landscape redesign to consider landscape preservation as a real option.

Alternatives to Agricultural Land Use

A question for landscape redesign is whether it seeks only to develop new systems of agricultural production or whether it considers alternative (non-agricultural) land uses. In some parts of Australia there may be non-agricultural land uses that reach higher levels of environmental and financial performance. If such areas were found to exist would landscape redesign search for non-agricultural land uses?

Genetic Improvement of Plant Species

A range of genetic technologies are available to improve the environmental and economic performance of plant species including selection, cross breeding and selection, selection using genetic markers and selection following genetic modification using recombinant DNA (Clarke and Downes 2000). Whilst some short term opportunities are available through genetic improvement, longer term research (10 - 20) years is required to understand the gene activities involved in the basic processes of water and nutrient uptake (Chu *et al.* 2000). It may be better to postpone some landscape change until technology provides improved landscape redesign options.

New Industries

New agricultural industries that meet requirements for improved environmental performance whilst maintaining acceptable levels of profitability are starting to emerge. Agroforestry and native bush foods are two examples. Both these industries involve tree planting that can have a range of environmental benefits such as reduced recharge (salinity benefit) and habitat provision. In a case study of 10 farm forestry projects Zorzetto and Chudleigh (1999) found that 8 produced direct positive economic returns. The Australian native bushfood industry is also showing positive early signs, with an estimated value in the order of $10-12 million (Graham and Hart 1997).

Another area of new industry development is in the productive use of saline land. Yensen (2000) describes a range of halophilic crops that actually have yield gains under conditions of impermeable soils, waterlogging and high salt levels. A range of other industries may also be possible including inland saline aquaculture and harvesting of salt products.

Habitat Reconstruction

In some cases land may have sufficiently high ecological or cultural value to justify the establishment of habitat with no market benefit. A suite of landscape redesign options may relate to the reconstruction of natural habitat in this manner.

Changed Cropping Grazing Practice

Significant environmental benefits, mostly water and nutrient leakage control, can be obtained by adopting new cropping and grazing practices. Stirzaker *et al.* (2000) describe the following cropping/grazing practices as options to manage dryland salinity:

- Opportunity cropping. This involves opportunistic sowing of crops in both winter and summer, according to rainfall and soil water conditions. Through opportunity cropping it may be possible to reduce drainage to 50% of that under current land management.
- Phase Farming. In this approach a perennial deep-rooted pasture phase is introduced into a cropping rotation.
- Companion Farming. This is a practice in which annual cereals are oversown into a perennial pasture system.

Simulating the Impacts of Redesign Options

Landscape redesign options are likely to carry risk for farmers and the general community. The risk will be in economic, social and ecological terms. In order to manage the risk it will be important to simulate the impacts of redesign options prior to their implementation. This is generally done through computer modelling, based on sound conceptual models, that can simulate the impact at field or catchment scales. Simulation of redesign options will also allow for more informed decisions relating to the selection of redesign options.

Currently, there are a wide variety of computerised models available that can be used to predict the impacts of salinity management strategies, changed cropping practices, changed fertiliser treatment practices and other changes to land management. A comprehensive directory of Australian models for predicting farm production and catchment processes (Hook 1997) describes 93 models and decision support systems under the categories of:

- plant and animal production (22);
- whole farm (8);
- soil processes,, including erosion (13);
- surface material and or energy balances (9);
- catchment and in-stream processes (12);
- groundwater (5);
- plant, animal and whole farm decision support systems (10);
- land and soil decision support systems (4);
- catchment decision support systems (3);
- economic models and decision support systems (4); and
- overseas models being trialed in Australia (3).

Models used to simulate the impacts of landscape redesign options are likely to draw upon many of these existing models. There is a need for integrated modelling that can bring together the diverse social, economic and ecological functioning at farm, catchment and regional levels. A challenge for researchers developing these models will be ensuring they can operate under conditions of poor data availability and can return results meaningful and appropriate to decision makers.

Structured Planning for Redesign

Urban and regional planners have long grappled with complex questions relating to how towns and cities should be designed. Good cities are designed to attain optimal environmental, social and economic outcomes whilst adhering to the aspirations of their residents. The design (or redesign) challenge facing planners shares much in common with landscape redesign. Consequently, there is room for landscape redesign to adapt and apply planning methodologies that have evolved over centuries.

The process of urban and regional planning has its basis in the rational planning model as shown in figure 5. It is generally based on setting goals and objectives, identifying alternative designs to meet those objectives, evaluating which design performs best against the objectives, making a decision and implementing and monitoring that decision.

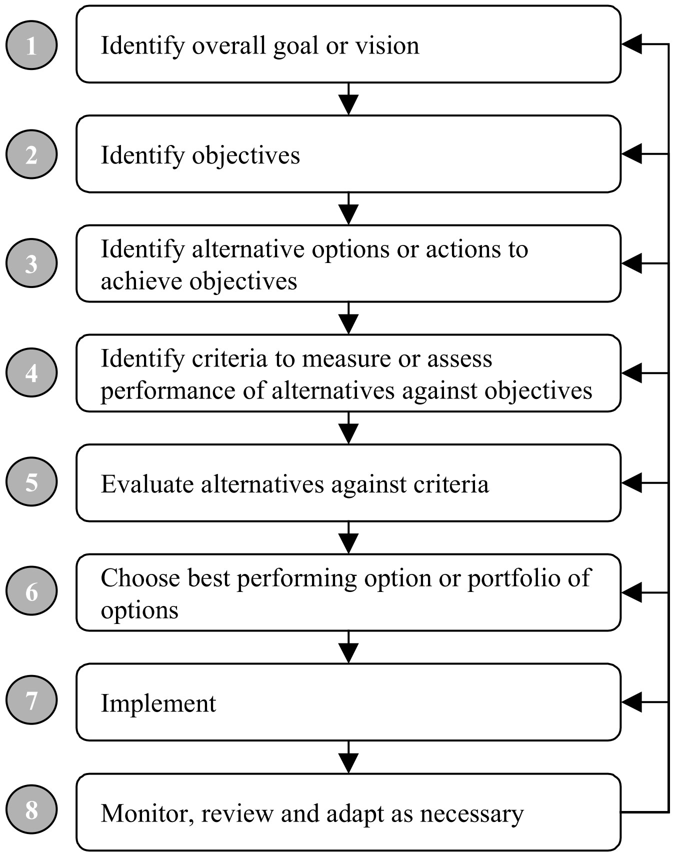

Figure 5. The rational or structured planning process.

Whilst the model seems neat, in reality there are many external factors that require repetition or skipping of various stages, a change to the sequence of stages and/or addition of new stages. There are countless papers providing evidence of the real world failing to adhere strictly to a unidirectional and rigid rational model. Some papers provide more "fuzzy" models that claim to give better representation of real world processes. However, as a model the rational framework provides a useful starting point for strategic and planned activity aimed at achieving pre-determined outcomes. It could form a basis for developing a landscape redesign strategy. Already natural resource management strategies pursued by many community groups follow the rational model in some form. A question for the conceptual framework for landscape redesign is whether it adopts the planning process in part or in full.

Design Criteria and Targets

In the broader field of design new products, developments or policies are often required to meet a set of performance criteria. For example, car manufacturers are required to meet a set of performance criteria before releasing new cars on the market (eg safety). Could a set of environmental criteria or targets apply to land use activities? Will it be possible to develop a set of universally applicable criteria relevant to all agricultural areas and industries? The development of criteria to evaluate the acceptability of land use options could be a major focus of landscape redesign. Such criteria could also relate to environmental accreditation schemes and further development of market based mechanisms.

Examples of targets for land management are contained in the South Australian Draft State Dryland Salinity Strategy (PIRSA 2000). This documents sets as goals keeping River Murray salinity levels below the guideline value of 800EC for 95% of the time at Morgan. It also seeks to prevent the area of land affected from dryland salinity increasing beyond the current area of 400,000 hectares. Targets of this nature raise a major issue relating to the extent to which governments, local communities and private land holders should be held accountable for their delivery.

Institutional Arrangements and Mechanisms

Approximately 570 million hectares (74%) of Australia is under private freehold and private leasehold ownership (NLWRA 2000). This means that for real landscape scale change, proposed redesign options must be preferred to alternative land use activities by land holders and farmers. It is not sufficient for society to merely want a new land management practice adopted. Pannell (1999) describes four conditions that must be met for farmers to adopt new innovations:

1. Farmers must be aware that the innovation exists and has potential practical relevance to their situation.
2. There must be a perception that it is feasible to trial the innovation. Farmers generally prefer low investment trials with low risk.
3. There must be a perception that the innovation is worth trialing. If farmer perceptions of the innovation are not sufficiently positive they will be unwilling to take the risk of a trial.
4. The innovation must be perceived to promote the farmer's objectives. The farmer's objectives are likely to include a range of factors such as profit, risk, leisure and environmental performance.

Of all the requirements placed on a new farming system or land use by private landholders, profitability is often one of the most important. Pannell (1999) notes that the hurdle of profitability is sometimes higher than recognised by scientists. A profitable system not only generates benefits in excess of input costs, but also performs financially better than alternative systems (ie covers opportunity costs).

Whilst farmers will tend to select a farming system that best meets their objectives, the adoption of less profitable but environmentally superior systems may still occur through the use of social and institutional policy mechanisms.

Adaptation of some economic modelling of salinity on the Lower Eyre Peninsula by Hajkowicz and Young (2000) shows that revegetation options need to be 75-90% as profitable as current land uses to deliver social benefits in excess of social costs. The policy question is whether the total cost of filling the shortfall in profits (between the current system and the revegetation option) is worth the non-market benefits of reduced saline land and water salinity. If society considers the non market benefit worth this amount then it will be in their interest to bolster the profitability of revegetation options (eg through incentive payments) to obtain the desired land use change.

Incentive payments are one of many options for increasing the adoption of environmentally superior land uses that may not be more financially profitable than current practices. Following is a list of the major social and institutional policy mechanisms that could be applied to facilitate land use change:

- *Environmental accreditation of agricultural produce.* There is a growing area of research looking at ways to accredit the environmental performance of agricultural produce. Already organic foods have a significant local and international market. Environmental accreditation systems could be expanded to encourage farmer adoption of sustainable practices.
- *Development of markets for ecosystem services.* The system of carbon credits for trading in greenhouse gas emissions has already received widespread attention. There is also a possibility of developing a similar system of salinity credits. The development of markets for ecosystem services could lead to more efficient use and protection of natural resources.
- *Financial incentives.* Financial incentives, either through direct payments or taxation instruments, could be used to make new systems of agricultural production and land use more attractive to landholders.

- *Regulation.* In some cases potentially harmful land use practices can be controlled through government regulation. Often regulation is tighter for new (as opposed to existing) developments due to the changing information and policy environment.
- *Publicly funded programs.* Through public funding such as the Natural Heritage Trust and other programs significant landscape redesign may be possible. Often public funding will need to occur through a cost sharing framework.
- *Philanthropic funds.* Through effective partnerships delivered via private conservation trusts and improved incentives for philanthropic contributions it may be possible that private sector contributions to nature conservation could exceed public sector contributions by the year 2020 (Young and Binning 1999).

Where to From Here?

This paper has discussed a range of unresolved issues relating to landscape redesign. We hope to have asked more questions than provided definitive answers.

The project will hold a series of workshops on landscape redesign around Australia in late March and April 2001. We will use input from these workshops, and any other input received throughout the project, to develop a conceptual framework for landscape redesign. We will be seeking guidance on what the conceptual framework should contain and how it should be written to be of most use to its audience.

Thank you very much for taking the time to read this background paper. We hope you have found it interesting and informative. We look forward to receiving any comments you may have or meeting you at one of our workshops. Please contact us (details are given on the front cover) for information on where and when the workshops will be held.

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APPENDIX A: GUIDELINES FOR MIMICRY

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These guidelines by Lefroy and Hobbs (1997, *vii*) emerged from an interdisciplinary workshop convened in Western Australia that brought together agriculturalists and ecologists from around the world. They represent stages that can be undertaken to develop agricultural production systems that mimic natural systems.

1. *Identify the system functions which are currently suboptimal in the managed system.*
2. *Identify the suite of species which carry out these functions in the natural ecosystem.*
3. *Within this suite of species, identify those with key functional roles, or identify analogs of these, ie well adapted species from elsewhere with the same functional roles.*
4. *Identify the likely range of environmental conditions and disturbances, and select the array of species needed to confer system resilience.*
5. *Consider how many of these species are required for the managed system, in the context of trading-off environmental risks versus long and short term costs and benefits. For instance, is it essential to install the full suite of species immediately, or can a phased approach be employed?*
6. *Decide whether it is most appropriate to integrate or segregate these functions with production, that is to have diversity at field or landscape scales or a mixture of both.*
7. *Assemble the suite of species required to achieve functional objectives within an adoption framework that a) has clear links to end users and b) demonstrates economic viability and/or c) includes socio-economic instruments to facilitate implementation including incentives such as carbon tax trading.*
8. *Develop these systems in an adaptive management framework involving monitoring and the capacity to modify elements of the design as new information becomes available or as circumstances change".*

APPENDIX B: PRINCIPLES AND GUIDELINES

In this appendix several sets of guiding principles, objectives and stages potentially relevant to landscape redesign are listed. The following have been chosen to provide a range of community, scientific and policy perspectives.

B1. The Goal, Core Objectives and Guiding Principles of Ecologically Sustainable Development in the National Strategy (extracted from Australian Commonwealth 1992).

Goal: Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The Core Objectives:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations; and
- to protect biological diversity and maintain essential ecological processes and life-support systems.

The Guiding Principles are:

- decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations;
- where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- the global dimension of environmental impacts of actions and policies should be recognised and considered;
- the need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised;
- the need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised
- cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms; and
- decisions and actions should provide for broad community involvement on issues which affect them.

B2. Tasks to be implemented under the salinity and water quality national action plan (extracted from Australian Commonwealth 2000):

- *targets and standards for natural resource management*, particularly for water quality and salinity, with the States and Territories, either bilaterally or multilaterally, as appropriate. The targets and standards should include salinity, water quality and associated water flows, and stream and terrestrial biodiversity based on good science and economics;
- *integrated catchment/regional management* plans developed by the community, in all highly affected catchments/regions where immediate action will result in substantial progress towards meeting State/Territories and basin wide targets to reverse the spread of dryland salinity and improve water quality. The Commonwealth and States/Territories will need to agree on targets and outcomes for each integrated catchment/region management plan, in partnership with the community, and accredit each plan for its strategic content, proposed targets and outcomes, accountability, performance monitoring and reporting;
- *capacity building for communities* and landholders to assist them to develop and implement integrated catchment/region plans, together with the provision of technical and scientific support and engineering innovations;
- *an improved governance framework* to secure the Commonwealth-State/Territory investments and community action in the long term, including property rights, pricing, and regulatory reforms for water and land use;
- *clearly articulated roles for the Commonwealth, State/Territory, local government and the community* to replace the current disjointed Commonwealth-State/Territory frameworks for natural resource management. This would provide an effective, integrated and coherent framework to deliver and monitor implementation of the Action Plan; and
- *a public communication program* to support widespread understanding of all aspects of the Action Plan so as to promote behavioural change and community support.

B3. Ten principles for integrating nature conservation and agricultural production (extracted from Goldney and Bauer 1998, p28).

1. Working as an agriculturalist in a broadacre system without reference to ecology is a recipe for short and long term disasters.
2. No property can be farmed independently within the system.
3. Since no land manager can be an 'island', all should participate in developing local and regional catchment management plans.
4. Within the context of catchment planning, each land manager should seek to develop individual farm plans.
5. Adverse environmental impacts are incremental.
6. There is a need to balance technological solutions against more natural solutions.
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 agricultural processes.
8. Native flora and fauna act as indicator species about the health of our land.
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.
10. Environmental costs of agricultural production must be factored into the market place.

B4. Repairing the Country: A national scenario for strategic investment by the National Farmers Federation and Australian Conservation Foundation (ACF and NFF 2000).

A strategy for addressing natural resource management problems is proposed involving an approach that:

- envisages changed rural economies and production systems which could turn around the decline in the resource base and prosper from sustainable production;
- foresees a much larger role for trees in rural landscapes in the form of:
    - forests and forest industries, with commercial plantations and agro-forestry, and revegetation with indigenous vegetation, and
    - revegetation and management for biodiversity conservation under stewardship agreements;
- affords better protection to areas of high conservation value, including remnant vegetation, rivers and river corridors;
- provides for eradication of environmental weeds in high-value wetlands and for representative protection of habitat in pastoral rangelands;
- provides for improved irrigation practices and reduced nutrient and salt drainage from our major irrigation areas; and
- encourages the development and growth of robust sustainable production industries, particularly through leverage of private investment in forestry to areas where public gains in salinity mitigation add value to commercial investment opportunities.

B5. Ten Point Guideline for Future Directions in Landscape Renewal (extracted from Saunders and Briggs, Forthcoming).

1. VISION: Develop a vision of the landscapes of the future and how they should function ecologically, socially and economically. The vision should be developed regionally in response to the needs and aspirations of local people and ecological communities, and with an understanding of policy frameworks.
2. IMPEDIMENTS: Define the environmental, social, institutional and economic problems that need to be addressed to achieve that sustainable future.
3. ECOSYSTEM SERVICES: Determine the functional elements that were present in the landscape before development and what are there now.
4. INSPIRATION FOR DESIGN: Determine what is needed to build the future landscapes upon.
5. LANDSCAPE SKELETON: Retain, protect and manage all remnant vegetation to prevent further loss of dependent biota.
6. PLANNING: Design a reconstruction plan based on ecological zonings, and functional human and ecological communities.
7. REPORTING POINTS: Establish goals procedures, institutional, social and economic structures (or frameworks), and timelines for developing the landscapes of the future.
8. IMPLEMENTATION: Act on the plan linking human and ecological scales, using best local knowledge, science and experience available, and with understanding of policy frameworks.
9. ASSESSMENT AND ADJUSTMENT: Monitor progress and record results; adapt management accordingly and reward success.
10. COMMUNICATIONS: Lead by example and communicate widely, including with policy makers and those who influence policy.