

Influencing Improved Natural Resource Management on Farms

A guide to understanding factors influencing
the adoption of sustainable resource practices

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Influencing Improved Natural Resource Management on Farms

Overview

The purpose of this paper is to provide an overview of the factors that influence the adoption of improved natural resource management practices on agricultural land. The focus is primarily on the decision making of the individual farmer or landholder. The resource management practices referred to are sometimes termed ‘Best Management Environmental Practices’ or ‘Sustainable Agricultural Practices’. Where these phrases are used within this report, the reader should not assume the phrases are meant to imply these practices can be guaranteed as sustainable in a biophysical sense. There may be limitations to the sustainability of these practices from a biophysical viewpoint over a longer time frame. The practices generally can be considered the best available from the perspective of balancing the need for farm business profitability and the need to minimise damage to the resource base of the farm and off-site impacts. Of course, how these factors are balanced is a matter of judgement based upon the relative emphasis placed upon these potentially conflicting objectives.

Executive Summary

Australian agriculture has traditionally responded quickly in adopting new technologies and practices when suitable social and economic conditions exist. However, in regard to the current state of land degradation in Australia, the social and economic conditions do not appear to be ideally conducive to produce the rate of adoption required to overcome problems such as dryland salinity or soil acidification.

The purpose of this paper is to provide an overview of the factors that influence the adoption of improved natural resource management (NRM) practices on agricultural land by individual farmers or landholders.

This paper considers the social constraints to the implementation of more sustainable agricultural practices from the perspective of the farmer, the technology and the socio-economic structure of catchment communities. It reviews the wide range of research into factors that might limit or slow the rate of adoption of natural resource management practices.

The following are important considerations in understanding the adoption of sustainable resource practices by farmers.

- Despite a significant level of adoption of conservation cropping practices in many districts, adoption of conservation practices is still relatively low in many areas, in particular in broadacre grazing industries.
- While tree planting rates have shown significant increases on farms over the past two decades, the current rates of planting are not significant in the context of the scale of recharge problems facing many catchments. Although some habitat and aesthetic values have been captured.
- Adoption of new practices is a continuous rather than discrete process. For individuals involved in environmental and resource management practices, the process is ongoing and frequently being reassessed.
- The adoption of sustainable agricultural practices is not merely a technical process whereby a farmer will simply adopt a more sustainable practice following sufficient exposure to it. This approach to adoption dominated early diffusion and adoption studies of the 1960s. Rather farmers operate as individual agents, mindful of their own interests, and as social agents within the social and economic constraints of local communities and the broader structural constraints of Australian agriculture.

- The model of adoption – with its categories of innovators, early adopters and laggards—has fallen into disfavour as a model of how extension *ought* to be practised, due to its inherent value judgements and assumptions of the ‘generalised good’. However, commercial marketing practice and R&D funding and policy guidelines reflect continued acceptance of important elements of the model. The established empirical validity of diffusion models for *describing* differential rates of practice adoption should not be confused with differing views about appropriate extension process.
- The farming community is not homogenous. An understanding of the diversity within rural communities and landholders in regard to social and economic factors is necessary before policies can be developed to change behaviour.
- Recent research suggests that barriers to change in farming practices are overwhelmingly structural. For example, the rangelands and pastoral uplands of the Murray Darling Basin have shown strong links between the need for structural change and the capacity to implement alternative management strategies.
- The issue of inter-generational transfer or farm succession is a major contributing factor determining the adoption of new practices or investment. This is typified by landholders who are older and deferring farm exit, who have an increased dependence on off-farm income and do not expect to transfer the farm to another generation.
- There is significant potential for goal conflict in environmental extension. Family and financial security are generally the highest priority goals for Australian farm families, while increased sustainability often involves increased management complexity and financial risk.
- On Australian farms, research has shown that environmental innovations that have been profitable, or believed to be profitable, usually have been readily adopted. Such innovations are usually referred to as having a relative, or financial, advantage.
- The other key factors regarding adoption of a new NRM practice are: its complexity, trialability, compatibility, and the observability of outcomes. As well, the financial costs, the landholder’s beliefs and opinions towards the new practice, the landholder’s level of motivation and perception of the relevance of the practice and the landholder’s attitudes to risk and change are also key factors.
- While the justification of the government’s involvement in Landcare has been for public good purposes, changed NRM practices are most likely to be achieved by promoting changes that provide private benefits to the landholder. Landholder surveys indicate greater concern about economic rather than environmental impacts of land degradation. The work of regional catchment committees dominated by farming interests reinforces the Landcare focus on production.
- There is evidence to support the assumption that improved education is related to the capacity to adapt farming systems, and some recent research has shown increasing education levels of Australian landholders. However, current adjustment patterns are likely to result in a decreasing number of agriculture graduates in the broadacre industries. This is likely to lead to a stratified farming community where increasing levels of education will be evident in those industries with sounder financial prospects.
- An understanding of the decision processes of landholders is necessary to influence change. Research has identified eight stages of decision making:
 1. anticipation of degradation
 2. seeing degradation
 3. seeking information
 4. weighing the alternatives and risks
 5. making a decision
 6. undertaking a trial
 7. making a change
 8. reaffirming the decision.

Implications for NRM Policy Development

Natural resource management (NRM) practices are difficult to promote.

Because many NRM practices involve increased complexity, risk and skill, offer intangible benefits that are frequently captured by someone else, or occur a long way into the future, rapid adoption of new practices does not often occur. Change in sustainable farming systems is not speedy. While this conclusion may seem obvious, it should be noted given that funding and evaluation cycles are conducted over three to five year time spans, while significant change in some farm management practices may be measured in decades or even generations.

The limitations of reliance on a stewardship ethic.

Motivation, financial incentive, financial capacity, skill capacity and appropriate technology are necessary before changes in farm management behaviour can be expected. Policies to change motivation, for example to attempt to encourage a stewardship ethic without addressing other issues such as skills capacity or financial incentives, are likely to have only a small impact. Research has shown that the links between environmental beliefs and environmental behaviour are tenuous. Policies designed to promote stewardship ethics will rarely directly influence the adoption of new farming practices. However, they may facilitate political, cultural and legal changes which may influence the other enabling factors, but generally this will occur over the longer term rather than in the short term.

Expect a limited response to messages about future threats of land degradation.

In comparison to the hazards studied by the insurance industry, land degradation hazards are comparatively understated. They are slow to develop and are often difficult to appraise in their early stages. The limited research into perception of land degradation problems in Australia has demonstrated a tendency for individuals to underestimate the extent of soil degradation on their own farm. This tendency is often manifest in what is now called the 'proximity effect' where landholders will describe the resource problem in their region as serious, in their neighbourhood as a moderate problem, and on their own farm as being no problem. This work suggests that programs to encourage voluntary land use changes on the basis of warnings of future resource degradation are unlikely to be successful.

Landcare is a tool to promote incremental, rather than radical, change to existing agricultural systems.

Messages about natural resource management will not have universal appeal. The Landcare structure involves a substantial minority of Australian farmers, and it is probably unrealistic to expect any voluntary policy tool to achieve any greater degree of penetration of the farming community than has been achieved by Landcare. No single policy approach will appeal to all the value sets, ambitions and priorities held by people living and working on Australian farms. While some Australian research links Landcare involvement with changes in farm management practice, some of the most informed observers of Landcare have noted that its achievements in the promotion of farming systems have been evolutionary rather than revolutionary. Landcare is about incremental change, particularly in changing community norms.

Structural constraints in broadacre industries are a major barrier to change.

Part of the reason for the incremental achievement of Landcare lies in the structural constraints to change in much of the broadacre agriculture of Australia. The vast majority of broadacre farm businesses do not produce sufficient surpluses to allow for reasonable living standards, investments in the farm business and investment in resource protection and the environment. Current adjustment patterns are only slowly creating aggregated business more capable of generating appropriate surpluses. In areas such as the Murray Darling Basin, voluntary responses under the current farming structure will not make a significant difference to dryland salinity. This raises difficult social questions about what form rural communities might take in the future.

Reticence to plan for catchment structures of the future.

Rural communities and agricultural industries are constantly changing. Adjustment varies from region to region and industry to industry; but these social changes are not considered in catchment planning. Often this is because those involved in catchment management planning are emotionally or physically attached to the current structures. Catchment plans usually envisage communities as they were one or two decades ago rather than planning for the community structure likely to exist in the next 20 years. In many areas ‘sustainable agriculture’ will be as much about industry restructuring as about agricultural systems and agronomy. This raises larger questions about the acceptable rate of community change and the desirable form of rural communities.

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Different Conceptions of Practice Adoption

It is generally considered desirable to increase the rate at which new technologies are adopted. More rapid technology uptake produces improved technology and economic benefits. Excessively rapid adoption may sometimes produce economic and social distortions as markets respond to new input shortages or there is social dislocation as a result of change. Australian agriculture has traditionally responded quite quickly to new technologies and practices when conducive conditions exist. However, when confronted with the current state of land degradation in Australia conditions do not appear ideally conducive to produce the rate of new practice adoption required to overcome problems such as dryland salinity or soil acidification.

In the cropping industries there has been an impressive level of adoption of conservation cropping practices in many districts (Standing Committee on Agriculture and Resource Management 1998; Vanclay & Lockie 1993; Karunaratne, Barr & Wilkinson 1998; Karunaratne & Barr 1998a), but adoption of conservation practices is still relatively low in many areas (Karunaratne & Barr 1998b, 1998c). In broadacre grazing industries the picture is less rosy (Standing Committee on Agriculture and Resource Management 1998). The sowing of perennial pastures increased during the late 1980s, influenced by the prevailing high wool prices. However, the increased production achieved in that short period precipitated a significant oversupply of wool. The prolonged low wool prices of the 1990s were associated with a general decline in pasture sowing rates similar to or lower than that observed in the early 1980s (Karunaratne & Barr 1999a, 1999b, 1999c; Barr & Ridges 1998a). In the case of tree planting, there have been significant increases in the rate of tree planting on farms over the past two decades (Curtis 1995). However, in the context of landscape processes, it is not obvious that the current rates of planting are significant in the context of the recharge problems of many catchments (Barr & Ridges 1998a; Standing Committee on Agriculture and Resource Management 1998; Department of Natural Resources and Environment, Victorian Catchment and Land Protection Council & Environment Protection Authority 1997). One can conclude that the level of implementation of improved pasture practices and planting of trees has been too little, so far, to have had an impact upon resource sustainability, though significant aesthetic and habitat values have been captured.

The question which arises from such an analysis is 'to what degree is it reasonable to expect an increase in the use of farm management practices which are currently recognised as minimising the degradation of natural

resources?' The aim of this paper is to review research into the factors which might limit or slow the rate of adoption of these practices.

How one defines the discussion of adoption rates of agricultural technologies is inherently subjective (Martin 1995). How one defines the question constrains the solutions and conclusions one will arrive at. This issue has been a recurring debate in rural sociological and agricultural extension literature since the 1950s. Most literature on the adoption of sustainable agricultural practice is written within the framework of one or other of a number of adoption paradigms. It is important to canvas these paradigms as a precursor to considering the literature on adoption rates.

Diffusion and Adoption Approaches

Diffusion is a naturally occurring process; but it can also be a consciously encouraged activity. In extension programs, social action programs or marketing campaigns we frequently seek to speed up the diffusion—or the rate of adoption—of a new idea or practice: For example government programs to discourage smoking.

There are more than eighteen research disciplines in the social sciences which study or employ the concept of diffusion. Anthropologists have been interested in how new ideas and practices spread from one culture or society to another culture or society. Rural sociologists have studied the spread of new agricultural technology amongst farmers. Educationalists have studied the school adoption of new teaching methods. Marketers have been interested in the rate of acceptance of new products. From the study of the diffusion of a practice we can observe the *rate of adoption*. The *rate of adoption* varies for different innovations and for different situations and was first studied in the diffusion of hybrid corn in the United States.

The adoption of an environmental practice or technology is often thought of as occurring or not occurring, in other words, as being discrete. Commentators observe that a practice has been adopted or not adopted. When it hasn't occurred we ask why. In reality, for most practices and technologies, adoption is more complex. For many practices adoption is a continuous rather than a discrete process. For individuals, particularly for environmental and resource management practices, the process is ongoing and frequently being reassessed. More importantly, for populations of individuals there is a continuous process of individual (partial) adoptions of a given practice (Wilkinson 1989). At any time, such a process can be depicted as a cumulative frequency

distribution. The shape of this distribution will vary for different practices and for the same practice under different circumstances. The characteristics of these circumstances will be discussed in this paper. The different rates of adoption are reflected in the slope of the cumulative frequency distribution of individual 'adoptions'. Such frequency distributions are referred to as diffusion curves.

The extensive diffusion and adoption literature, which burgeoned in the 1960s, grew from US studies of the adoption of hybrid corn varieties in the 1950s. This work was based upon the expectation that innovations were developed on research stations and then promoted to farmers who may or may not adopt these innovations. This paradigm gave rise to two major research trends. One was the study the characteristics of innovations which affected the rate of adoption. The other was the study of the characteristics of farmers that lead to their being enthusiastic or less than willing adopters of innovations. From this, rural sociologists created the 'diffusion model' which characterised farmers with terms such as innovators, early adopters and laggards. The first two of these appellations are still in common usage in policy and business circles. The latter, 'laggards', is rarely used due to sensitivity at its judgmental overtones and a belated recognition that adoption of a given practice may not be universally beneficial to all potential adopters. However, despite this language sensitivity, contemporary policy is still very much shaped by concepts from the diffusion paradigm. Some rural sociologists have expressed concern at the continuing influence of this paradigm in policy:

Although there have been no diffusion and adoption studies done in Australia for 20 years many of the concepts and terminology are still strongly evident in R & D policy and funding guidelines today. A good example of this is the assumption that research results and information can be transferred from source to receiver using skilful communication. Closely associated with this is the notion that 'barriers' to communication of technology exist, which, if identified, should be removed by skilful communication. Thus for any set of research results adoption is still a valid and meaningful goal. Furthermore, there is a strong notion that non-adoption of scientific results is irrational behaviour which can be rectified by rationally communicated argument and explanation. Failure to adopt is seen as . . . aberrant behaviour for which someone has to take the blame—usually extension workers and farmers. The reason would be that either barriers were not identified and removed, or communication and teaching skills were at fault. (Dunn 1997)

The assumed 'universalism', the assumption of a single rational course of action along with other philosophical objections led to the increasing popularity of the adult education paradigm as a model for extension related to influencing farm practices.

The Adult Education Approach

This framework grew from a belief that farmers should be considered as autonomous, self-directed learners. In Australia this position was popularised in the work of Salmon and others at the University of Melbourne Agricultural Extension Research Unit (Salmon 1981). Research founded in this paradigm was focused on understanding the processes of learning and making decisions on farms. In a distinct change from earlier research directions, some researchers studied the characteristics of extension workers which made them more or less acceptable and credible to farmers (Anderson 1979, 1981).

Research within this paradigm demonstrated that the credibility of extension depended upon acceptance of farmers' goals by the extension agent. Accepting the goal framework of the farmer was seen as instrumental as a means of achieving extension objectives, and also desirable from an ethical perspective. The ethical perspective gained considerable influence in the extension profession, with extension being portrayed as a 'helping profession' by its practitioners, where the role of the extension agent was to assist the client to achieve the client's goals. From this perspective, it could be argued that measures of adoption were not useful as indicators of extension success.

If self-reliance means adults are treated as adults with the freedom to choose actions, there is a distinct possibility that one or a number of such adults could, as an outcome of collaborative, participative processes, choose not to adopt a particular technology. Then would you consider the extension program to be less than successful. We say not. As long as the management decision-making process is founded on criticality, then the extension program is a success. To focus solely on adoption as a measure of extension success disregards the valid aim of developing self-reliance in clients. (Roberts & Cloona 1997).

As templates for the conduct of extension work the adult education and 'adoption' paradigms are distinctly different methods of approach. At a descriptive, as opposed to a normative, level the two paradigms are both legitimate descriptors of human **processes** (in contrast

to **approaches**) that are not mutually exclusive. When individual farmers adopt practices, under whatever rationale, the rate at which the practice is adopted or, in aggregate, diffuses is a phenomenon that can be socially observed.

Environmental Based Extension: The Public versus Private Focus

In the 1980s the vision of extension as a helping profession eventually became enmeshed in policy debates over public and private benefit from government funded extension and public and private goods. The result was a move towards a clearer emphasis on public goods and public benefits from extension (Cary 1998; Macadam 1997; Marsh & Pannell 1997). The publicly funded extension profession became more and more focused upon group rather than individual extension, and on environmental (public) benefits rather than production (typically private) benefits.

The new environmental role for public extension has come to be seen by some as placing the 'helping' role of extension workers at risk by returning to the simple certainties of the linear extension model of the diffusion period (Fliegel & van Es 1983). Vanclay has observed:

the notion of a barrier to adoption only logically exists . . . [if] . . . it rests on the normative assumption that new technologies or practices ought to be adopted, and that the management practices will be beneficial to farmers or to the environment. The moment that a normative assumption is made, extension must be considered a policy instrument. (Vanclay & Lawrence 1994)

Vanclay is concerned at the potential conflict between farmer and government goals. At one level, there would seem to be little that is contentious here. If the government is employing the extension officer it ought to be reasonably assumed that there would be an implicit or explicit intention that extension is being used as a policy instrument. The more substantive concern is that the public benefits and the private benefits to be captured by individuals will not always be complementary and are frequently unlikely to be 'equivalent'. This goal conflict may be potentially serious. Tim Fisher, of the ACF, raises the question of how compatible farmer goals are with those of the perceived national environmental interest (Fisher 1995).

Such goal conflict existed during the 1960s and 70s when the emphasis of extension was mainly on improved production and profitability. However, the conflict was

more subtle, working at a macro rather than micro level. Extension funding was on the basis of the public benefit achieved by improved export performance of agricultural industries, which relied upon improved competitiveness and productivity (Prime Minister's Science Council 1974). There existed a subset of the farm population whose goals were congruent with those of extension funders, and it became clear that extension contact was only with this minority of the farm population. This was a clear redistributionary action, with increased productivity leading to increased adjustment pressure on those who were less efficient (Barr, Ronan & Volum 1979).

The potential for goal conflict in environmental extension is more obvious. Research indicates that family, personal and financial security are generally highest priority goals in Australian farm families. This hierarchy is repeated in problem listings given by farmers, with concerns over prices, weather and costs generally being higher than concerns over resource issues (Barr & Cary 1984; Ralph 1972). It is probably inevitable that, at times, there will be a conflict of interest in promoting sustainability practices which often create increased management complexity, have a significant off-site benefit and an increase in financial risk. Adopting these practices may not necessarily be in the short-term interest of the individual landowner. This clearly places environmental extension within the technology-transfer paradigm rather than the 'helping profession' paradigm. This has led some researchers to conclude that:

Who participates and with what resources are political questions which are not normally addressed (overtly) in defining extension and research priorities . . . unless this is done in such a way that farmers are shown how to recognise their interests and protect them against those of others (eg other farmers, community groups or institutions) very little will be achieved by the participatory method. (Dunn, Gray & Phillips forthcoming)

Today there are differing views over the success of environmental extension within the new environmental paradigm. One view is that most extension workers have realised that successful environmental extension can only work within the constraints of farmers' goals, leading to a somewhat cynical view of environmental extension as being a Trojan Horse for private benefit extension (Barr 1994). More generous commentators see the move to environmental extension as a resurgence of extension in a new paradigm (Coutts 1997). The Property Management Planning program can be seen as an attempt to bridge the goal discrepancies that challenge environmental extension.

Structural Critiques

More recently the rural sociological literature of Australia has entered a period of structural critique of the policy paradigms of environmental extension. At the basis of this work is a concern about issues of social justice and redistribution. The work harks back to adult education objectives, but takes a far more socially critical position. Critical analysis of the redistributionary role of extension policy is not new in Australia. In 1979 Kevin Goss criticised the assumption of simple diffusion theory that innovations are equal in their applicability to all farmers, and argued that capital is a major constraint which ensures that innovations are redistributionary (Goss 1979).

The strongest contemporary advocates of this position include Lawrence, Vanclay and Martin (Lawrence, Lyons & Momtaz 1996; Lawrence & Vanclay 1994; Lawrence 1987). The work of these writers is important in identifying structural explanations of the 'constraints to adoption' of environmental practices. Martin has concluded:

The assumption in current policy and practice is that local participation within an increasingly deregulated market environment will produce adequate forms of 'incentivated' personal conduct for a sustainable and productive rural sector. (Martin 1995)

Martin (1995), and others, believe these assumptions are indefensible. Current structural constraints to the adoption of sustainable agricultural practices will be discussed later in this review.

Factors Affecting the Rate of Adoption—Innovation Attributes

The work of E.M. Rogers (Rogers 1962; Rogers & Shoemaker 1971; Rogers 1983), has summarised the results of a multitude of adoption and diffusion studies conducted in the 1950s, 60s and 70s. The general conclusions of Rogers provide a means of analysing environmental innovations and exploring the reasons for the difficulties of promoting certain forms of sustainable agriculture. The importance of innovation characteristics has been highlighted in a recent major review of innovation adoption in Australian agriculture (Guerin & Guerin 1994). Guerin and Guerin concluded that the constraints to adoption of innovations in agricultural research and environmental management by Australian farmers are:

... the extent to which the farmer finds the new technology complex and difficult to comprehend, how readily observable the outcomes of an adoption are, the financial costs, the farmer's beliefs and opinions towards the technology, the farmer's level of motivation, the farmer's perception of the relevance of the new technology, and the farmer's attitudes to risk and change. (p. 549)

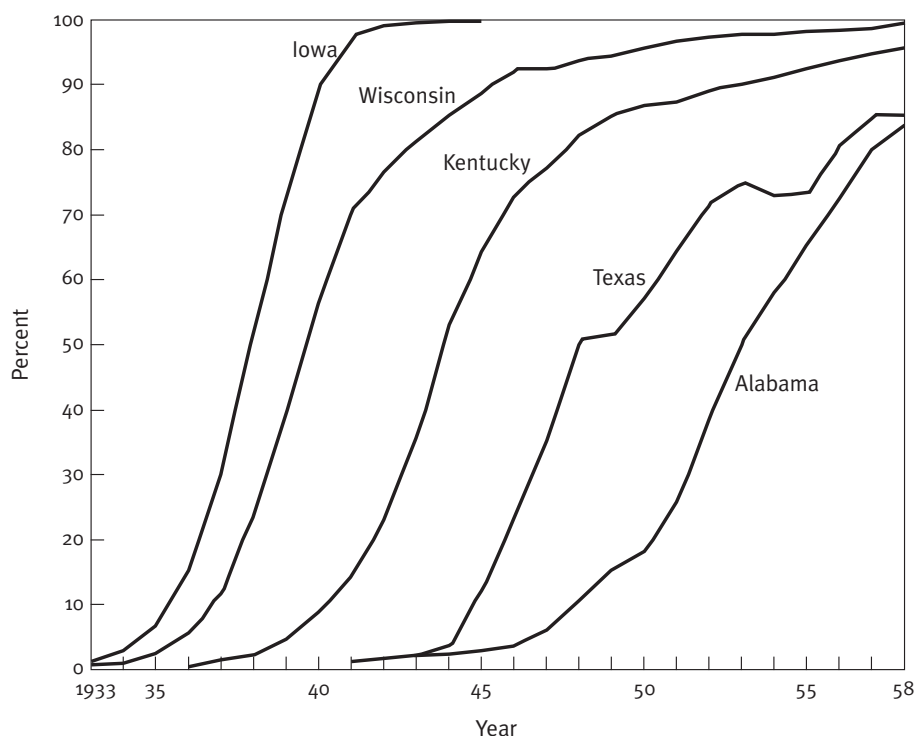
These findings, largely, restate the crucial innovation characteristics summarised by Rogers: relative advantage, compatibility, complexity, trialability and observability.

Relative Advantage

Relative advantage is normally interpreted in terms of financial advantage to the farm business or the adopter. Research has consistently shown that the perceived financial advantages of environmental innovations are one of the best indicators of their subsequent adoption. In their review of the history of environmental innovations on Australian farms, Barr and Cary (1992) concluded that the clear lesson was that environmental innovations which were believed to be profitable were usually readily adopted. Innovations which have a clear (net) financial cost were rarely adopted. Perhaps the most studied adoption of an environmental innovation is the progress of conservation cropping in the US corn belt. In a review of Ohio research Carboni and Napier (1993) concluded economic factors were the strongest predictors of adoption.

Often it is assumed, naively, that the relative advantage of an environment-enhancing practice, if positive, is of the same order of magnitude in different localities. Generally, this is unlikely to be the case. While little empirical evidence for improved resource management practices has yet been collected in Australia to support this common sense assumption, the early work of Griliches (1957, 1960) on the diffusion of the productive innovation of hybrid corn is clearly instructive.

FIGURE 1 Different rates of diffusion for hybrid corn in selected American states (Source: Griliches 1960)



Griliches contended that the differences in rates of adoption of hybrid corn for different American states were largely explained by the relative advantage possessed by different geographic regions for growing corn. This reflected productivity of soils, consequential differential profitability of the crop, and differential possession of harvesting and handling resources. As a consequence, hybrid corn was ‘an innovation which was more profitable in the “good” areas than in the “poor” areas’ (Griliches 1960, p. 280).

The explanation of this diffusion was argued between economists and sociologists (Havens and Rogers 1961; Griliches 1962). Economists explained the rate of adoption (expressed by the slope of the diffusion curve) as due to the relative profitability of hybrid corn in different geographic regions.¹ Sociologists explained the rate of adoption for a given state as reflecting the degree of social interaction, or communication, occurring between potential users of the hybrid corn. Both of these explanations are valid and explain different elements of a complex process. The important thing to note is that diffusion curves (for the same ‘innovation’) can have different shapes and, more importantly, different slopes or rates of diffusion.

Just as human behaviour is more complex than simple attitude-behaviour models, it is also more complex than the simple profit driven **Homo Economist**. There is much research demonstrating a clear relationship between beliefs about profitability and adoption behaviour. However, there is great variation in attitudes towards farm business profit. These differences could be partly summed up in the question: ‘Do you live to farm or farm to live?’ This is a question confronted in any occupation. There is strong evidence that many Australian farmers are motivated by the balance between the need for profit and a satisfaction with a comfortable living which minimises risk (Dunn, Gray & Phillips forthcoming; Rendell, O’Callaghan & Clark 1996; Frank 1995). Different attitudes to income needs, risk perception, dynastic expectations and cultural expectations of farming mean there are quite distinct groups of farmers. Some are very receptive to messages about profit maximisation strategies. Others are less receptive to such messages (Howden, Vanclay, Lemerle & Kent 1997; Barr 1996; Marks & O’Keefe 1996; Reeve & Black 1993; Barr, Ronan & Volum 1979). For these farm operators, relative advantage may be more strongly moderated by risk minimisation and minimisation of complexity.

Complexity

Sometimes innovations which appear simple to the uninitiated may in fact imply significant and complex changes to the farm production system. Such innovations are less likely to be adopted. Complexity increases the risk of failure; and it introduces increased costs in gaining knowledge (Vanclay & Lawrence 1994).

Integrated pest management is an innovation which is constrained by the management complexity of its practice. Farmers often explain non-adoption as being based upon concerns about its ease of use, speed and reliability (Bodnaruk & Frank 1997). Another example of this complexity characteristic is the planting of dryland lucerne. This is promoted in many catchment plans across Australia as a means of reducing watertable recharge. What appears to be a simple change to a system can imply major restructuring of the farm system. The complexity of adopting dryland lucerne is explored in Text Box 1.

Compatibility

Compatibility refers to the extent to which a new idea fits in with existing knowledge and existing social practice. If a new idea fits easily into an existing system it will be adopted more quickly. Is the innovation being promoted through extension services compatible with farming community socio-cultural beliefs and values? An apparent example of a sustainability innovation failing this test can be seen in the low adoption of perennial pasture sowing amongst a substantial core of wool producers in the Western District of Victoria. Pasture renovation in this region can be profitable if combined with an increase in stocking rate. Local culture firmly has held that higher stocking rates are incompatible with the region’s reputation as a producer of fine wool. This opposition is documented as early as the 1920s when sub clover was first promoted in the district (Barr & Cary 1992). These beliefs are now complemented by beliefs that improved perennial pastures and higher stocking rates are ecologically unsustainable (Marks & O’Keefe 1996). The promotion of pasture improvement has generally been incompatible with the values of this cultural grouping.

The cultural beliefs of Western District wool growers are typical of those of many broadacre farmers across Australia and New Zealand. Beliefs about ‘good farming’ tend to encompass matters such as tidiness, having

¹ Griliches, using aggregate data from crop reporting districts and states in the United States, explained between 30 and 70 per cent of the variation in the rate of adoption of hybrid corn on the basis of ‘profitability’ (or more correctly in his analysis, productivity).

TEXT BOX 1: The complexity of dryland lucerne

The watertable under the Murray Darling riverine plains has been rising since the last century. The long term solution for much of the plains is to develop a system of farming based on a productive and profitable, deep-rooted perennial crop. The most appropriate commercial plant is lucerne. Dryland lucerne has been known of for many years, yet only a few farmers grow significant areas of lucerne (Ransom & Barr 1993; Whittet 1929).

Farmers sowing lucerne do not have a guarantee they will successfully produce a crop of lucerne. The chance of failure is greater than most other pasture species. One way to minimise the financial risk of establishing lucerne, and to make up for time a paddock may be out of production, is to sow lucerne with a faster growing crop such as safflower. Farmers following this strategy may have to learn to grow new crops which are more compatible with lucerne (Barker 1992).

Lucerne requires rotational grazing management. The majority of farms are currently managed with a regime of set stocking. Wool-producing farms typically run three flocks: ewes, weaners and wethers. Some run an additional flock of maiden ewes. Under the four paddock rotation system, such a farm would need 12 or 16 paddocks. For farms previously 'set-stocked' this implies additional expensive fencing and more dams and reticulation to provide watering points in each paddock. Fencing at this intensity is likely to impede the easy management of cropping activity on the farm.

Lucerne pasture is more productive than normal pasture, but wool producers will not make money merely by growing more pasture. There are complex ramifications in the farm system. More sheep will be required to utilise the extra pasture (Ransom 1992). The increased flock size will require extra capital, more work in sheep handling and an increased workload of rotational grazing. Higher sheep densities in paddocks may mean a greater need for control of intestinal parasites and increased use of veterinary chemicals or greater attention to rotational grazing systems to minimise parasite infestation (Coffey 1992).

One means of maximising the benefit of lucerne is to abandon lambing in autumn in favour of spring lambing. This may mean a need to further re-arrange the farm timetable. Shearing will probably be moved to after the harvest season and before sowing. The risk of grass seed contamination will be higher. Grazing rotation strategies to minimise this risk will be needed. To maximise the benefits of prime lamb production, the farmer will often need to develop new marketing skills and develop relationships with export abattoirs.

These changes have to be worked in with the continuing cropping enterprise. Lucerne can imply major changes in crop management. How does the farmer combine the new grazing rotation with the crop rotation side of the business? Whereas an annual pasture may have been grazed for a couple of years before cropping, there are good reasons to maintain a lucerne paddock for its full eight-year life after successful establishment. Consequently, the farmer may have to crop paddocks elsewhere on the farm for a longer period before putting them back into pasture. Forestalling the depletion of soil nitrogen will inevitably mean introducing grain legumes into a rotation system that was predominantly based on wheat and pasture. This will require improved cropping skills, marketing skills and probably investment in cropping machinery.

A farmer considering integrating lucerne into the farming system may need to borrow capital in the early stages of the project. A bank is likely to require a business plan to analyse the financial implications of the plan before agreeing to the provision of loan finance.

fences and gates well maintained and having good looking crops or stock. Profitability and sustainable farming practices are less commonly seen as being indicative of good farming (Gray, Phillips & Dunn forthcoming; Phillips forthcoming; Wilkinson 1996; Wilkinson & Cary 1992). While these cultural values may be causing increasing frustration in industry bodies and the agribusiness sector (Clancy 1999), there is evidence that Australian agriculture is undergoing a period of detraditionalisation in which traditional agricultural occupational identities are being replaced by more complex and diverse cultures (Bryant 1999; Dunn, Gray & Phillips forthcoming). Current research gives little indication of the impact of detraditionalisation upon changes in farm management practice.

Trialability and Divisibility

Innovations which can be trialed on a small scale prior to full implementation are more likely to be adopted. Trialing enables decisions about the utility of an innovation with minimal risk. Typically, farmers can easily assess a new crop variety by sowing one paddock to the new variety before deciding upon more extensive adoption. The successful promotion of conservation cropping practices which is dependent upon major machinery changes has been encouraged by providing hire trash combines, thus allowing trialing without significant investment in machinery. In contrast, dryland salinity control is clearly not amenable to trialing. Because the benefits of salinity control may not be achievable for up to 50 years, a trial process will delay more extensive salinity control for a century. Trialability is in turn dependent upon observability.

Observability

Innovations whose advantages are observable are more likely to be adopted. A new variety or crop is often quite visible to passing observers and this visibility can be used to advantage. Irrigation watertable control is not normally an observable achievement. The development of well flags as part of water-table watch was a very innovative method of making watertable levels visible to the passing observer. Many Landcare programs have attempted to site demonstrations along major roads to enhance visibility. It is much more difficult to display improved decision making as a consequence of Property Management Planning.

Characterising the Attributes of Sustainable Agriculture Practices

The previous discussion has re-stated some tenets well-established in rural sociology. The restating highlights a fundamental observation of the sustainable agricultural and landcare practices that have featured in catchment plans across the country. Many of these practices have characteristics which can be expected to lead to slow and low rates of adoption. Many offer limited relative advantage to a farm manager. Many are associated with complex farm system changes, are difficult to trial or difficult to observe.

The issue of relative advantage bears particular consideration, as this issue is at the heart of an internal contradiction of State involvement in the Landcare movement. The justification for government involvement in the promotion of Landcare has been on the basis of the promotion of the public benefit achieved through changes in farm practice. Yet changed farm practice is most likely to be achieved by promoting changes that provide private benefits to the landholder.

There is a great diversity in the resource management situations existing in Australia. Given the importance of relative advantage, a useful way of characterising resource management practices is to assess them in terms of their environmental sustainability and their economic viability (Figure 2).

Practices which are environmentally sustainable and economically sustainable (**cell A**) should engender autonomous individual adoption (at varying adoption rates) with little assistance required to facilitate individual action other than awareness and information. This situation is usually characterised by productivity or other gains that can be captured on an individual farm property.

Where practices are environmentally unsustainable but economically sustainable (**cell B**) the situation is likely to be characterised by inherent disinclination to ameliorate or discontinue the current management regime. To discourage this management behaviour autonomously will require the presence of a more attractive alternative management regime with the characteristics of **cell A**. A change in existing practice may be encouraged by moral suasion if the individual costs are not high, but widespread or universal change is unlikely. Alternatively, external incentives or disincentives may encourage adoption. Often in situation B regulation to proscribe inappropriate management practices will be required. Well-monitored codes of practice associated

FIGURE 2 Sustainability matrix for resource management regimes confronting individuals.

	<i>Economically Sustainable</i>	<i>Economically Unsustainable</i>
Environmentally Sustainable	A Examples: planting small shelter belts; conservation cropping.	C Examples: pastoral properties producing medium and coarser wool.
Environmentally Unsustainable	B Examples: high chemical use close to waterways; effluent run-off to waterways or aquifers.	D Examples: some practices in the rangelands, irrigation practices in some salinised areas.

with product marketing that guarantees appropriate management practices may also encourage improved management practice.

A situation not uncommon in Australia is where farms may be environmentally sustainable, but economically unsustainable (**cell C**), due to extended periods of low commodity prices. In the longer term, low incomes in this situation may lead to resource exploitation (such as fertility depletion) and subsequent land degradation (**cell D**). For situations in **cell C** the initial policy responses are related to industry policy and social welfare rather than issues of natural resource management.

The undesirable situation where practices are environmentally unsustainable and economically unsustainable (**cell D**) may reflect longer-term changes in commodity prices, extended adverse seasonal conditions, or a degraded natural environment. Such management systems do not autonomously rectify because of structural inertia, asset immobility and inertia in human mobility. Hard policy decisions may be required about withdrawing support or discouraging certain farming activity. Reliance upon moral suasion to bring about widespread management change is optimistic in the situation represented in **cell D**. Decisions about other forms of intervention will require policy choices about whether public goods are present for any change in management practice.

The borderline between resource management regimes which are sustainable and unsustainable is a fuzzy area and there are many examples of resource use in agriculture which fall into this grey area. It is often difficult to define what is sustainable or unsustainable—particularly over time. An alternative, and perhaps sharper, categorisation is to assess a management regime according to whether it is causing unacceptable levels of resource degradation. For such a determination we need

to make (social and technical) decisions about acceptable levels of resource degradation.

The above discussion highlights the costs to a landholder of many conservation or resource management practices may exceed the on-farm benefits on a short-term and possibly long-term basis. The lack of immediate financial incentive in a dynamic farm economy may result in many landholders not adopting these practices. An important distinction in the discussion above is the assumption that the land degradation, and the benefits of any remedial land management, are internal to the boundaries of individual farm properties. Here profits, attributable to remedial management practices, are potentially captured by individual property owners. In situations involving externalities—where costs of management practices and remediation incurred by an individual property manager produce benefits which accrue on other adjoining or distant properties—relative advantage will be diffused, and considerably reduced for the individual adopting improved management practices. Here a self-interested perception of profitability will not be sufficient to produce an optimal level of adoption of such technologies. In these cases non-instrumental motives (such as stewardship or an environmental orientation) together with appropriate policy instruments, are likely to become more important in influencing the use of conservation practices (Cary & Wilkinson 1997).

Understanding Individuals' Decision Processes in Practice Adoption

Another means of considering the adoption of sustainable agricultural practices is to seek to understand the decision processes which we might expect farm managers to use when we recommend that they change their farm management systems. In the US Nowak (1983) hypothesised a number of stages of decision making about sustainable agriculture practices and tried to identify barriers at each stage. This section attempts to chart a similar course. There are many different conceptual models of decision making. The model developed here comprises eight sub-tasks in decision making. This model is adapted from the work of various researchers drawing most strongly on Janis and Mann (1977), and the work of Phillips (1985) who studied the behaviour of Victorian and New Zealand dairy farmers undertaking significant business decisions. In this model the eight stages of decision making are:

- Anticipation of degradation
- Seeing degradation
- Seeking information
- Weighing the alternatives and risks
- Making a decision
- Undertaking a trial
- Making a change
- Reaffirming the decision

Anticipation of Land Degradation

It is a truism to say 'Prevention is often better than cure'. In the land degradation debate, this truism is often rephrased as 'Managing your farm to prevent salting or erosion is a better strategy than reacting after the damage'. However observation consistently informs us landholders often do not anticipate land degradation (Barr & Cary 1992; Vanclay & Cary 1989; Barr & Cary 1984; Vanclay & Lawrence 1994; Rickson, Saffigna, Vanclay & McTainsh 1987). It would be simple to conclude that it is human nature to react rather than anticipate. But if this were so, there would never be any change on farms, and this is not the case. In adopting new farming techniques, farmers are anticipating the future and anticipating an opportunity to gain advantage. Some find this anticipation easier than others. But anticipating a future threat or risk to the land is different to anticipating the opportunities in new farming technology. Instead of the landholder anticipating the possibility of increased profitability, amenity or prestige, he or she is being asked to anticipate the possibility of a decreased profit, amenity

and social standing because of declining land capability. In short, the landholder is anticipating a loss rather than an opportunity.

Anticipating loss is psychologically more difficult than anticipating gain. For landholders, anticipation of land degradation requires a series of potentially unpalatable conclusions about the future of their land. In an early study of anticipation of salinity damage in a Victorian irrigation district Barr and Cary (1984) observed that farmers, in situations where salinity existed, needed to make three conclusions before they were motivated to react to salinity. They had to conclude (1) that salinity was a serious problem in itself, (2) that it was spreading, and (3) that they would be affected by the spread. The landholder had to pass each of these thresholds of awareness before being motivated to action. Some landholders believed that, although salinity would spread, the impact would not be serious. Some believed salinity was serious, but was not spreading. Others believed it was serious and spreading, but would not affect their land. Those who perceived salinity as passing all three thresholds of concern were predominantly those who owned farms already damaged by salinity.

In the anticipation of land degradation most of the irrigation farmers in the Barr and Cary (1984) study had a fixed view of the future landscape as continuing as a re-creation of the past. However, the prediction of land degradation is at best an 'inexact science'. In this study it was possible to accept with some confidence that watertables would continue to rise in the Shepparton area, but at that time for most farmers there was often little way of knowing the outcome on an individual farm. When a loss is possible, rather than inevitable, it is easy, and sometimes sensible, to forget about it or to wait for further evidence. This behaviour pattern is not unique to the farming community. Research by the insurance industry has identified the same general behaviour patterns by residents living in areas at risk of natural disaster (White 1974).

When considering off-site forms of land degradation, the same problems of inexact science are compounded by the problems of the 'commons'. It is natural to resist a proposition that one is a culprit in the degradation of soil or water beyond the farm boundary. Janis and Mann (1977) concluded in their study of health behaviours that there is strong resistance to a change in interpretation of a situation when the new interpretation has a strong affective (as opposed to cognitive) component. Blame for damaging another's farm or property is strongly affective.

Seeing Degradation

Lack of appraisal of future land degradation problems has been considered, in part, a perceptual limitation (Nicholson 1995; Vanclay & Cary 1989). In many land degradation situations 'seeing' land degradation means seeing the actual changes in the soil or vegetation and construing these changes as a management problem (Sinden & King 1990). Some forms of land degradation are easy to see. The dramatic erosion gullies and the stark salt scalds displayed on television documentaries are impossible to ignore. Less obvious are the early signs of salting, acidity or sheet erosion. In the case of rill erosion the occasional heavy loss is obvious, but the accumulation of many small losses over a number of years is relatively imperceptible. In the late 1980s cropping farmers on the Darling Downs were found to have been unaware of the amount of soil lost from their properties through rill soil erosion (Rickson, Saffigna, Vanclay & McTainsh 1987). In the same era Victorian irrigation farmers were found to be often unaware of incipient salinity damage on their properties (Barr 1999).

The two perceptual processes where landholders anticipate deteriorating land condition and 'see' or recognise the degradation are difficult to separately distinguish from each other in a cause and effect sense—either may come first. Disaggregating these two processes is difficult because they are likely to be inter-related rather than discrete and sequential. Anticipation of a land degradation problem will heighten a landholder's perception of symptoms of deteriorating land condition (Cary & Wilkinson 1997). The two-way causation of anticipation and seeing the degradation in decision making suggests that often they are better considered together (Abelson and Levi 1985).

What does it take to see the early signs of resource degradation? First, the observer will be sensitised if he or she knows they looking for a problem (the *anticipation* considered above). Second, they need to know what to look for. A decade ago in the uplands of north central Victoria Vanclay and Cary (1989) found a substantial minority of landholders did not know the early signs of salting. Many of these landholders thought bare patches would be the first warning indications of salt. They would have lost a significant part of the productive potential of the salt affected land long before the land became bare because bare ground is the obvious final stage of salinisation.

It helps to be sensitised to the possibility of the degradation on your farm. In a study of irrigation salinity, irrigation farmers were more likely to notice early signs of salt on their own properties if there was serious salting on a neighbouring property (Barr & Cary 1984). The same early signs of salt were less likely to be seen if there was no seriously salt affected property nearby.

If a farmer sees what others call degradation, there is no guarantee he or she will think that it is a problem. It depends on past experiences and the present situation. Cropping farmers often know their soil has a hard pan and is liable to crusting, but fewer interpret this as a land degradation problem. That interpretation is a relatively new perspective of soil scientists. Some farmers, especially those with a sense of history for their area, will likely say that crusting or hard pans are just part of farming their soils—'It goes with the land'. Cropping farmers in North East Victoria took this approach to crusting (Cary, Wilkinson & Ewers 1989). In Tasmania some potato farmers interpreted the erosion on their farms in the same manner (Ewers, Hawkins, Kennelly & Cary 1989).

The same reasoning can be applied to soil salinisation. In 1982 farmers along the Stanhope depression in the Shepparton irrigation area were unworried about salting in the depression, though to the passing motorist it looked extremely obvious (Barr & Cary 1984). The land in the depression had been lost by previous generations. The current generation had not borne any loss. The salt was not perceived as likely to creep out of the depression in the foreseeable future. The higher land was secure and the depression was acting as a drain, protecting the rest of the properties. From the point of view of sustaining production on these farms, it is difficult to argue against this perception. There was little to be done to reclaim the depression. Throwing good money after lost land was perceived as more of a danger than the localised salinity. For many years this was also the prevailing view in the Tragowel Plains. There salting was extensive, yet to many farmers it was not a management problem. The land had deteriorated many years previously and the challenge today was to farm it within its limitations. Tree decline on the Tragowel Plains also fitted this pattern. Migrants to the area were more likely to plant trees than those who grew up in the area (Barr 1988). Presumably they had had less time to become accustomed to the bare plains. In fact, salt was a more public issue elsewhere in parts of the Shepparton irrigation region where it had only recently appeared (Barr & Cary 1992).

Here we can come to another more general conclusion. Community concern over land degradation is likely to be highest where there have been recent losses of land. Where the degradation has been long established and is not expanding, local opinion will often accept the status quo as normal and natural.

Seeking Information

When land degradation is identified the best response should be to search out information on how to meet the challenge or tackle the problem. To the most innovative farmers, farming is a continual challenge. The implication is that farming can be a continual search for information. Phillips (1985) showed that a typical dairy farmer may embark on anything up to 30 learning projects in one year. A farmer has limited learning time, and each project must compete with the others for that limited time. A minor decision will receive minimal information time, sufficient to get some sort of solution. When contemplating a major change to their farming system, the landholder will often have a hunger for information on the particular issue. The more serious the consequences, the stronger the need for information, and for some assuredness about the outcomes. For these significant decisions the dairy-farmers in Phillip's (1985) study sought information from up to 40 people. Weaknesses in existing knowledge will be filled by going out and searching for relevant information from what are seen as expert sources. These can be other farmers, company representatives, stock agents or consultants. In this initial stage, judgement on the source of information and its credibility is often only cursory. Non-feasible alternatives are rejected, but any option or advice which may be useful will be retained (Janis & Mann 1977). Evaluation of the worth of information generally occurs later in the decision making process.

In terms of good decision making, a quick decision at this stage is not usually wise. A quick decision will be based upon only a cursory examination of alternatives. It will involve no emotional 'working through' the options and their implications. In the case of many forms of land degradation, when none of the options for change look easy or feasible, the most likely decision will be to continue existing practices.

Weighing the Alternatives and Risks

Having acknowledging the existence of a problem, and collected a manageable list of alternative responses, the next step for the decision maker is to weigh up the alternatives. Expectations of financial return play a major role in many of the decisions a farmer has to make. But financial rewards are not the sole criteria considered by farmers in evaluating alternatives. Some farmers place the desire to make more money low on their list of farming priorities (Marks & O'Keefe 1996; Hawkins & Watson 1972; Presser & Cornish 1968). In the Upper Loddon and Avoca catchment most farmers said they aimed for long term financial survival and saw short term profit as a tool to achieving the longer term objective (Wilkinson & Cary 1992). These farmers felt more comfortable about the concept of long term profit and having a good farm, and less comfortable with the concept of short term profit. The ability to take a long term perspective is not always possible, and the reconciliation of this potential conflict reveals differing farming sub-cultures which will be discussed later. If a farmer is under continuous financial pressure, long-term farm priorities will be continually deferred to satisfy immediate financial need. The future will be created from a string of short-term decisions.

Few land managers are unaware of the uncertainty they must deal with in assessing conservation farming practices. As the level of uncertainty increases, other issues besides economic factors become relatively more important in farmers' weighing of the options: the risks involved, aesthetics, the farmer's sense of independence, social approval and the sense of stewardship a farmer feels towards his land and business (Stephens 1992). Risk will be a significant factor in most decisions, and individual farmers will have different tolerances of risk. Most farmers, along with most people with families, place a high priority on family security (Dwyer 1974; Ralph 1972). Security to most farmers means maintaining adequate family income, retaining the farm and avoiding the risk of losing one's livelihood (Rendell, O'Callaghan & Clark 1996). Farmers with high equity and adequate cash reserves are in a better position to take risks to change their farm with long term benefits in mind. But most farmers in this position achieved it by not taking too many risks.

Some conservation farming methods are riskier than others. Low input, chemical-free wheat farming is a low risk style of farming. Because there are fewer costs incurred before the crop is harvested there is less to lose if there is a failure. Pasture-free continuous cropping is

a high-risk strategy because of the high costs of applied herbicide, which must be borne before the crop is harvested. A crop failure under these conditions incurs higher costs. To most farmers the way to reduce uncertainty is to find evidence of how new practices have performed on local farms, especially in the paddock. If trash cropping is seen as (technically) succeeding on a nearby farm, it is easier to decide to adopt it. However, the profitability of a conservation practice cannot be fully assessed by looking at the paddock. It is usually only by talking to the adopting farmers that the profitability of the new methods can be established. The outcomes of many conservation farming practices are, as noted earlier, often difficult to test or to observe.

Most decision makers cope with uncertainty and risk by both seeking further information and by seeking social support for decision making. Thus, the weighing up of options is in part a social task. While the initial investigation of options may be done with acquaintances and distant professionals, in major decisions the evaluation of options is done with members of the family and with close friends—the ‘significant others’. The decision maker will be looking for emotional as well as intellectual support to evaluate the options against personal and family goals. The issues will not only be ‘will this work?’ but also ‘how will these people react, and will they support me if I take any of these courses?’ According to diffusion theory, one can judge an ‘innovator’ or ‘late adopter’ by those who assist in this social reinforcement process. The innovator’s significant others will include other innovators. The late adopter’s significant others will not include innovators or early adopters but, more probably, ‘late majority’ farmers.

The weighing of alternatives can be stressful, as there is usually insufficient information to be sure of making the correct decision. There may be a fear of appearing naive to others with better understanding of the issues under consideration. The limited research into farmer stress in Australia has shown that financial difficulty does not predict stress. Stress is instead a combination of circumstances and the interpretation placed upon those circumstances by the individual. There is great variation in the psychological propensity towards the experience of stress (Weston & Cary 1979; Cary & Weston 1978). It could be argued that those with the greater tendency towards stressful interpretations of their circumstances will be less likely to undertake changes in farm business management, and that training in cognitive tools for stress management may be valuable strategies for facilitating change.

The more difficult the decision, the more the stages of information seeking and evaluation will be intertwined. The decision maker will engage in a series of sorties, engaging and re-engaging the personal support network and less intimate sources of information. The major decision will be preceded by a series of decision points along the way. At each of these points the decision maker will validate the decision with close or intimate contacts, with more time spent with closest contacts when the main options are evaluated (Phillips 1985).

Making a Decision

Decision making does not end when the selection of the best alternative has been made. It is then time to secure support for the final commitment. If social support for a decision is locked in before it is made public, then any later failure will be more socially bearable. Support will be sought from those who the decision-maker expects to give support. Opposition will be anticipated and arguments in favour of the decision will be prepared. This is an extremely important step. Without this inoculation and anticipation of later difficulties, it will be harder to follow through with the decision when not all works out as easily as hoped. During this period, the other alternatives will gradually become closed off as the decision maker makes his or her position clearer to intimates and supporters. As the commitment becomes more public, the other alternatives will seem less and less attractive (Janis & Mann 1977).

Undertaking a Trial

One method of overcoming uncertainty is to delay the time of final commitment and undertake a trial of the new management practice. If the trial is successful, then the farmer is likely to go ahead with larger scale implementation. If the trial is not successful then any financial, emotional or social loss is minimised. Practices which lend themselves to trialing and offer comparative advantage will usually be readily adopted. The adoption of subterranean clover and superphosphate was an example of the importance of trialing in establishing a new management technique in many localities. The success of each trial was readily apparent and rapid adoption followed. While the first farmers to trial the new pastures in a district often started with very small areas later adopters trialed larger areas, and took less time to quit trialing and make a final decision to adopt (Duncan 1969). The same pattern occurred more recently with laser grading of irrigation bays in pasture irrigation industries. The first farmers undertook trials on small

areas of their farm. Later farmers trialed larger and larger areas, until it was impossible for the observer to distinguish between a trial and a full adoption (Ewers 1988). In each of these cases the first trials quickly showed the productivity or labour saving advantages of the new methods. Each local success reduced the perceived risk and gave greater confidence to trial larger areas until a trial was seen to be superfluous.

Many conservation practices take longer than two or three years to demonstrate their worth in trials. Conservation cropping with trash retention may take ten years for the benefits of improved soil structure to become obvious. Changing to organic food production may take almost as long for a new stable ecosystem to develop. Salinity control benefits that may accrue from planting trees may not become apparent for 30, 40 or even 100 years. Trialing takes on a simpler meaning in these cases. Trial planting of recharge area with trees or pasture will demonstrate whether the trees or pasture can be established and will survive, and the further benefits must be taken on faith. Trials of stubble retention wheat cropping are initially tests of whether new machinery can cope with wet stubble. They are not trials to test changes in soil texture and organic matter. In the cases of these conservation practices trialing tests the means to the end, not the end itself.

Making a Change

At the stage of making a change the decision maker has completed the hard emotional work (Janis & Mann 1977). Farmers who have made their assessments and possibly undertaken a successful pilot trial will be ready to make an investment of time and money. In some circumstances, the adoption decision may be constrained by outside agents. A farmer may not be risk averse when it comes to seeking credit for a chosen practice. However a lender may be less responsive to funding proposals which merely maintain and protect existing production (for example, installing a groundwater pump) than proposals which quickly increase production (for example by top dressing and re-sowing pasture).

Reaffirming the Decision

Once a farmer has taken on a new style of farm management, continued commitment will be guaranteed if the new techniques meet the farmer's expectations. If the new methods exceed expectations, as was the case with much early laser grading, then the rate of adoption will accelerate (Ewers 1988). If success is less than anticipated, or the initial signs of success are slower than expected, then the practice may be disbanded. Social commitment and support will help maintain confidence. Peer expectations of continued commitment or personal support and encouragement will reinforce commitment. In the 1970s the conservation cropper may not have expected the difficulty of laying in bed at night hearing the neighbour's tractor busily ploughing and sowing the seeds of doubt in his mind. He or she may only then realise how much they miss the group support of the local CB radio network which keeps the tractor driving conventional farmers in contact. Some aspiring conservation croppers in this position have been known to hire private consultants to provide the support necessary to maintain their commitment. It is inevitable that this sort of support will be more important for long term conservation innovations than for short term production technologies.

Diversity within Farm Communities

Another perspective from which to examine the potential for change in farming practices is the variation in culture and socio-economic situation amongst Australian farmers. Our objective here is to highlight that the landholder community is far from homogenous. Heterogeneity has significant policy implications. Work in this field can be attributed to a number of the research paradigms described earlier in this review. Diffusion research has categorised farmers according to their propensity to adopt innovations. Market segmentation research has generally been undertaken within an atheoretical environmental extension framework. More recently, differentiation on the basis of farming styles and culture, an approach partly based within a structural critique of agriculture, has been advocated as a way of analysing community diversity. Each of these approaches offers insights of value in understanding the social structure of Australian agriculture.

Diffusion Theory and the Early Adopter

Farmers have often been categorised according to their supposed propensity to adopt farming innovations. In diffusion research the most likely to adopt innovations are called 'innovators'. Next, in order of adoption behaviour are early adopters, the early majority, the late majority and the laggards (van den Ban & Hawkins 1988). Innovators are characterised as farmers with extensive networks of distant contacts with other innovators, but often with lesser connectedness with farmers in their own district. Early adopters have been characterised as being more likely to be held in respect by local peer circles. This respect was partly maintained by not taking as great a risk with new technology as innovators. Farmers in the early majority took their lead from the farming practices of the early adopters. Past diffusion studies have investigated the networks between these groups of farmers and the means of accelerating the transfer of information between the groups.

The diffusion school of research made assumptions about innovativeness being a unidimensional characteristic. This assumption has been challenged (Presser 1969). It also made assumptions that the relative advantage of an innovation was similarly distributed across the rural community, and ignored the likelihood that innovations re-distribute benefits and advantage on the basis of skills and access to capital. As a model of the adoption of environmental practices, innovativeness with respect to commercial technologies may not be closely related to innovativeness with respect to environmental technologies. Perhaps the major reason the diffusion

paradigm fell into disfavour was because of the inherent value judgements implied by terms such as 'laggards' or late adopters (van den Ban & Hawkins 1988).

Research conducted within the diffusion model has looked at predicting adoption of agricultural practices by statistical modelling. Much of the early diffusion based research in Australia sought to find the socio-economic correlates of adoption. To date, such research has not produced tools that could be used to target extension activity. With the growth of interest in environmental practice adoption, this form of research underwent a renewed period of interest. Researchers sought to explain varying rates of adoption of environmental practices using demographic explanatory variables. This work had limited success, and led to the conclusion that correlation or regression models tend to be weak because of variability within the sample (Reeve & Black 1994).

Market Segmentation

Alternative approaches to the study of heterogeneity are segmentation analysis and 'farming styles' theory. Segmentation research is atheoretical, attempting to explain observed variations in behaviour and values. It has been based upon a number of techniques, varying from quantitative (Reeve & Black 1993; Barr, Ronan & Volum. 1979) to qualitative (Marks & O'Keefe 1996) and shades of variation between these extremes. Many market segmentation studies have been undertaken, but generally they have been of specific applicability to regions or practices. Such studies make no claim to general applicability beyond the problem, market place or context being considered; and such studies are rarely published. However they often provide useful insights into the varied assessment of sustainable agriculture messages.

In south east Australia the 'market' for medium and high input pasture systems has been extensively investigated. The research was designed to discover why farmers were reluctant to adopt perennial pastures and higher input management systems that are generally recommended to ameliorate salinity in this region. At least eight segmentation studies of farmers' sowing and management of perennial pasture have been undertaken (Marks & O'Keefe 1996; Luke, Karunaratne & Barr 1995; Shaw 1994; Ransom & Barr 1993; Condon, Coffey, Vogel, Schroeder, Bishop & Barr 1995; Baird 1993; Coffey 1992). By supplementing these segmentation studies with observations from other studies it is possible to depict the 'market' for the recommended pasture systems based upon the segmentations presented (see Text Box 2).

TEXT BOX 2: Market segments for pasture renovation for salinity control

The Committed: This group of farmers has a high percentage of their farm sown to exotic perennial pastures. They have maintained an active re-sowing program through the period of low wool prices. They top-dress their pastures regularly. Most either rotationally graze or graze strategically. Although members of this group appear in each of the segmentation studies reviewed, they rarely number greater than 15 per cent of the population (Luke, Karunaratne & Barr 1995; Shaw 1994) and often are as little as 5 per cent of the population (Reeve, Lees, Price & O'Donnell 1995; Hartley & Lincoln 1993; Ransom & Barr 1993). Members are driven by an interest in production and profit. In a qualitative study of grazing adoption processes, O'Keefe (1993) identified this sub-group as having a different decision process to other graziers. Their awareness of a farm innovation led to attitude change which then led to behaviour change. He proposed that this confident style of decision making is an outcome of these producers' good understanding of their production system and the system's profitability. These producers place a high value upon information. According to O'Keefe, there is not a strong flow of information from members of this segment to members of other segments.

The Pasture Part Timers: This group had a smaller proportion of the farm under perennial pasture, typically less than a third of the property. This smaller area of perennial pasture was regularly top dressed, and often managed by strategic grazing. Members of this group were motivated by a desire to increase productivity and increase income, but were constrained in further developing their pastures by commitment to another business or work interest. In Shaw's (1994) study of the Eppalock region of Victoria, these producers made up 15 per cent of the farm population. They generally had an off-farm job which provided economic security to the household. Richards (1995) found a significant segment of property owners on the rural fringe of Melbourne nominated pasture improvement as a high farm priority but were limited in what they could achieve by a shortage of time and information.

The Crop Focused: These producers, found only in the mixed cropping zone, saw pastures as a means to improve soil fertility for the next crop and sometimes as a means to maintain sheep until they are required to graze the next stubble. Their attitude towards grasses was often ambivalent or negative (Harrison 1992) and generally negative to perennial pastures (Luke, Karunaratne & Barr 1995; Baird 1993). A phalaris pasture was seen as a paddock of weeds waiting for a crop. Lucerne tended to be preferred, being harder to establish and easier to remove through neglect, it was perceived as less likely to become a crop weed.

Belt Tighteners: This was generally the largest group of producers identified in the segmentations, numbering between 30 per cent and 40 per cent of the population. When asked about the status of their pastures, most members of this group claimed large areas of improved perennial pasture. However, in wool producing areas most had not applied superphosphate in the last five years because of low wool prices. They were risk averse and, during a period of low income, they pull in their belts rather than try to 'spend their way out' through investment in pasture improvement. The behaviour of this group dominates aggregate investment in pasture renovation which closely follows trends in commodity terms of trade (Vere & Muri 1986). It is clear that many of those pastures identified as 'improved in name only' will be found on farms owned by members of this segment. Pasture management in this group is generally 'set stocking'. It is clear that any pasture technology which can be interpreted as entailing any element of risk is likely to be unattractive to this group. The adoption behaviour of these farmers was described in illuminating detail by Marks and O'Keefe (1996) and O'Keefe (1993). They contended that these risk-averse producers lacked an understanding of the farming system and the key influences on profitability. Their decision making style was described as being based upon a flow from awareness to action (trialing) to attitude change. Trialability within the grazing industry is a slow process. These graziers often measure a change in pasture performance through observing the impact on the sheep. This can lead to a tendency to view their success on the basis of animal performance (kgs of wool per sheep) rather than on production per hectare. O'Keefe contended that this explained the comparatively low innovativeness of grazing industries in comparison with cropping industries. Members of this group believed that conservative grazing strategies will be more profitable than innovation over the long run.

Sceptics: Members of this group distrusted the advantages espoused for pasture improvement. In areas where phalaris persistence was not a problem, these producers viewed phalaris as a weed that became rank and unpalatable, a fire risk and a toxic danger to stock. In the studies by Shaw (1994) and Baird (1993) this group comprised between 10 and 20 per cent of the sample. Advocates of phalaris would argue these farmers' perceptions of phalaris are an outcome of their unwillingness to use appropriate grazing strategies. Many in this segment held strong views about the imperative of low stocking rates (Marks & O'Keefe 1996; Baird 1993). In regions where phalaris persistence is a recognised problem another form of scepticism prevailed, expressed by a farmer in these words: 'I am satisfied with my pastures as they are. Volunteer species are sustainable species. If a species can't survive my set stocking and needs super it is not sustainable.' (Condon, Coffey, Vogel, Schroeder, Bishop & Barr 1995). Members of this group and the **comfortable** group often hold large properties which, in the past, have enabled them to produce a living despite low stocking rates (Lodge, McCormick & Dadd 1991).

Comfortable: In most segmentation studies this was the second largest group comprising between 20 per cent and 40 per cent of the population (Littlejohn, Vogel, Bishop, Schroeder & McIntyre 1997; Luke, Karunaratne & Barr 1995; Shaw 1994; Cocks 1993). Many in this group would claim they have significant areas of perennial pastures, and see no need to either re-sow, top-dress or to change from set stocking to a more labour intensive method of management. Often these farmers are older (Shaw 1994; Lodge, McCormick & Dadd 1991). Often they will recognise that their children will not take over the farm. Income from the farm and other sources is sufficient for the foreseeable future without the need to take on extra risk or extra work entailed in pasture establishment and rotational grazing. Unlike the previous group of belt tighteners who may be interested in new ideas if they entail minimal risk, members of this group have no need for new ideas. Often members of this group graze beef cattle because of their lower requirement for labour and intensive management and easier lifestyle (Lees & Reeve 1994).

Retreatists: Found around major population centres, this group is composed mainly of rural residential dwellers or absentee hobby farmers who have purchased a property predominantly for lifestyle reasons (Richards 1995; Nicoll 1994). Whilst these people may live on a grazing property, often the main criteria by which a pasture is judged is aesthetic. These property holders have little time to undertake significant management tasks, and on the weekend the management of the farm must compete with other family demands (Collier 1995). Within an hours drive of the outskirts of major cities the owners of these properties are often absentee (Nicoll 1994). Members of this segment generally see pasture improvement and management as contributing little to family objectives and are more attracted to tree planting which provides aesthetic and possibly capital gain benefits (Wilkinson & Cary 1992; Cary 1993b; Fontana 1991). This group has been excluded from many of the research studies as the members generally fail to qualify as farmers in sampling frames based on ABS criteria.

Typically seven farmer segments have been identified, each with differing rates of adopting pasture technology, differing attitudes and differing needs for pasture on their farm.

What observations can be drawn from the case studies of the 'market' for pastures? The particular segmentations are often context specific and not directly transferable to other industries or regions. Segmentations undertaken in horticultural industries would reveal different segments, featuring cultural differences based upon many other factors including ethnicity (Cumming & Hogan 1997; Steain 1997; Cumming, Erol & Mitsos 1995; Stoyles 1992). The pace of 'context' in the non-adoption of technology or management practices can often be

explained within the socio-economic and cultural context of the various segments. This is a central tenet of the farming styles approach.

Farming Styles Research

The extension approaches of the 1970s, based upon the ideology of helping relationships, placed emphasis upon the primacy of a farmer's goals. A contemporary expression of an emphasis upon personal values and goals is the work of researchers who have attempted to apply the concept of 'farming style' to the Australian context. Styles of farming are created by differentiating farmers on the basis of their "world views". Research

using styles theory is still in its early stages, with some inconsistent results (Howden, Vanclay, Lemerle & Kent 1997). However, the work that has been done can be seen as confirming the insights gained from segmentation work (Glyde & Vanclay 1996; Mesiti & Vanclay 1996). One interesting outcome of this research has been the documentation of farmers' perceptions of styles in their region using value-laden constructs which bear much similarity to the segmentations of the diffusion school of research (Howden, Vanclay, Lemerle & Kent 1997).

It is quite clear that differing farming styles will have different propensities to invest in particular farming practices. It could be expected there might be a strong interaction between farming style and innovation characteristics. Despite the seductive charm of these relationships, there is no tool available that maps the geographic spread of farming styles and relates this to potential future adoption rates.

Structural Constraints

Despite the insights gained by research into farmer and innovation characteristics and their relationship to adoption of sustainable farming practices, much of the recent rural sociological literature in Australia suggests the barriers to change in farming systems are overwhelmingly structural (Curtis & De Lacy 1996; Lawrence & Vanclay 1994; Vanclay 1992). Two regions where debate over structural limitations has become most prominent are the rangelands and (with respect to dryland salinity control) in pastoral uplands of the Murray Darling Basin. There are strong links between structural change in the rangelands and the capacity to implement alternative rangeland management strategies. In many areas in the rangelands properties are too small to allow managers the option of using tactical grazing strategies designed to sustain the fodder base. Adoption of sustainable farming systems in part of the rangelands implies significant structural adjustment (Western Lands Review 1998; Australia and New Zealand Environment and Conservation Council 1994; Jordan 1994; Lawrence, Graham & Clark 1994).

More recently, the links between the structure of agriculture and dryland salinity control have emerged in work commissioned by the Murray Darling Basin (Barr & Ridges 1998a, 1998b). This research was commissioned as a result of concern at the increasing estimates of the rate of change in farm practice required to achieve watertable stabilisation (Newman 1998; Prime Minister's Science, Engineering and Innovation Council 1998), the low rate of adoption of dryland salinity control strategies on many farms and the lack of evidence that this situation was likely to change in the near future (Karunaratne & Barr 1999a, 1999b, 1999c; Barr 1996).

Part of the reason for low rates of catchment plan implementation in the Murray Darling Basin lies in the structure of broadacre grazing industries and the ongoing financial difficulties of many businesses in these industries. In the uplands of the basin there are many small farms, many of which generate minimal farm surpluses. Farm family incomes in these areas are predominantly composed of off-farm income. One measure of farm financial sustainability, defined by the Farm Management 500 farmer group, indicates that a farm family needs to earn over \$45,000 a year from all sources to maintain investment in the farm business as well as in environmental protection. Population and Housing Census data suggests that in much of the Murray Darling Basin, fewer than a third of households with at least one farming member have achieved this benchmark (Barr & Ridges 1998b).

The neo-classical adjustment expectation is that in the situation described above, owners of poorly performing farm businesses will exit agriculture. These exits allow opportunities for other better performing businesses to expand. The proportion of larger farms will increase, with the attendant capacity to invest in both business development and catchment sustainability. Lindsay and Gleeson (1997) showed that this general pattern of adjustment is occurring in Australian agriculture. By monitoring the number of farms which are included in the ABS farm census, these researchers showed the number of Australian farms has steadily declined over the last decade, and the average size of farms as measured by EVAP (Estimated Value of Agricultural Production) has increased. However, Lindsay and Gleeson found significant differences in the adjustment of different industries, with broadacre grazing industries showing the least change and the dairy industry showing a high rate of change.

While farm families in the uplands are making significant adjustments these are not adjustments that will lead to property aggregation in the short term. Population census data suggest a significant change in the pattern of farmers exiting agriculture. There appears to be a shift to off-farm income as the major source of income for many farms. While the number of farm establishments in the Murray Darling Basin fell by 16 per cent over the past decade, the number of persons describing themselves as farmers in the Population and Housing Census fell by 24 per cent in the same period. This shift may in part be due to the fall in farm incomes in this decade, as much as to an increase in off farm work. There are also significant regional differences in adjustment patterns within the Murray Darling Basin. The number of families with at least one farmer member fell by 22 per cent. Properties in the broadacre grazing and cropping industries have been relatively tightly held in comparison with properties in regions such as the irrigation districts or the rangelands. It appears that adjustment is being deferred to the period of inter-generational transfer. At the same time, in the last 15 years the rate at which younger persons have been entering agriculture has been declining rapidly. This trend is most marked in the uplands of the Basin. The net result of this has been an acceleration of the aging of the farm population of the Basin. In some regions of the Basin, in the ten years between 1986–96, the median age has increased by nearly 5 years. (Barr & Ridges 1998b).

These trends in our agricultural lands are not unique. Similar trends are occurring across the agricultural regions of both the developed and developing world. One region with the strong similarities to the situation faced

by farmers in the Murray Darling Basin is the Great Plains region of the United States and Canada. Many parts of the Great Plains are agriculturally dependent. Farmers in this region face similar competitive pressures to those faced by Australian farmers. The region's few districts with large urban centres have grown, whilst population in the majority of rural counties has declined. Out migration has been by younger persons distorting the age profile of the region and increasing the median age of the population significantly (Cromartie 1998; Rathge & Highman 1998; Rowley 1998). Similar trends have been described in European agriculture (Potter & Lobley 1992, 1996).

These trends make it more difficult to implement current catchment plans. The limited available research suggests that investment in farm businesses is more likely to occur in farms where there is an anticipation of inter-generational transfer (Gray, Phillips & Dunn forthcoming; Gray & Crockett 1998; Barr, Ronan & Volum 1979). On-farm investment is less likely to occur where the operators are older and do not expect to transfer the farm to another family generation. Increasing commitment to off-farm work is associated with decreasing effectiveness of landcare groups (Curtis 1995, 1996; Collier 1995).

The Place of Landcare

The National Landcare Program is a relatively recent innovation by government to promote the control land degradation by landholders acting through community groups. Landcare has become the ground for debate between competing ideological positions seeking to influence Landcare policy. Support by government for Landcare, and farmer groups in general, has in part been based upon a perception that individual advice from extension officers is an inappropriate use of public funds (Heatherington, Cover, Roberts & Burchmore 1997; Barr 1994). Landcare has also been described as a tool to devolve responsibility for rural environmental problems to the local level, part of the policy of 'rural self-reliance' (Martin & Woodhill 1995). These issues are discussed in more detail in Cary and Webb (2000).

Differences of opinion over the value of community-based extension raise the question about what can realistically be expected from a voluntary movement within a market-based economy. Curtis (1997) has commented upon the strength of Landcare as a tool to promote changes advantageous to the farm system but with limitations as a tool to achieve significant outcomes in biodiversity conservation and off site impacts.

The Landcare program was intended to achieve more sustainable use of farming lands and enhance biodiversity. Whilst there is considerable evidence of program success, landholder surveys indicate greater concern about economic rather than environmental impacts of land degradation, and the work of regional catchment committees dominated by farming interests reinforces the Landcare focus on production. Despite the biodiversity enhancing work of Landcare on soil erosion, remnant vegetation, stream fencing and control of weed and pest animals, there is some concern that critical habitats such as wetlands, native grasslands and remnant forests receive little attention. Most landholders have a strong stewardship ethic but research suggests that stewardship is not linked to the adoption of more sustainable farming practices. Landcare structures need to provide for stronger representation of environmental values and Governments need to adopt a stronger mix of policy options to improve biodiversity conservation on private land. (Curtis 1997)

Achievements in the promotion of farming systems through Landcare have been evolutionary rather than revolutionary. A past national Landcare facilitator, has commented that Landcare successes have generally been in facilitating incremental change rather than systemic change (Campbell 1995, Clancy 1999).

Landcare activities seem to be options to be carried out in times of financial prosperity to repair the consequences of inappropriate past land use, rather than as integral parts of the farm system that is necessary to ensure future viability. (Campbell 1991)

Carr's (1995) review of policy-makers' and extension agents' opinions of Landcare suggested some of these limitations are recognised. Promoting systemic change through participative processes may be discouraged by 'group think', where group norms reinforce existing viewpoints. Examples of this are well documented in the literature of perennial pasture improvement for salinity control (Marks & O'Keefe 1996). Problems of power relationships and exclusion have also been identified as limiting potential change through Landcare (Curtis, Davidson & De Lacy 1997; Carr 1995; Ewing 1995; Curtis, Davidson & McGowan 1994; Gray 1992).

These problems are generally seen as minor compared to the structural limitations underlying the use of Landcare as a policy model (Curtis & De Lacy 1996; Campbell 1995). With respect to Landcare, Campbell has observed:

There is emerging evidence that the effectiveness of such approaches is limited by the social, cultural, institutional and technical constraints. [These constraints] include limited human resources in rural areas, stressed by rural decline, a lack of technically sound, practical and profitable solutions to land degradation problems, institutional cultures within research and extension agencies that mitigate against genuinely participative approaches, . . . and a feeling among farmers of being blamed for land degradation, which does not foster a stewardship ethic. (Campbell 1995)

Similar concerns about structural constraints have been expressed by other Australian social researchers (Dunn, Gray & Phillips forthcoming; Curtis & De Lacy 1995; Martin & Woodhill 1995).

Potential Policy Interventions

Having considered the research into the barriers to adoption of sustainable agricultural practices, we now review policy tools or initiatives used to promote sustainable agricultural practices. The review does not aim to be exhaustive, but to provide comment on those interventions where social research can provide some insights.

Adjusting Advantage

Relative advantage is most often associated with economic advantage. Generally, the major parameters of relative advantage—the prices of farm products and the costs of farm inputs—are determined independently of individual human intervention. Technological innovation that is directed to increasing the productive efficiency of inputs, potentially, may increase relative advantage. Some of the most common methods of changing relative advantage include changing the technology, or the efficiency of a given technology, through research and development, and providing incentives to reduce the cost of implementing alternative farming methods. The rationale for improving technical efficiency and, consequently, improving relative advantage does not need elaboration. The potential for improving relative advantage by influencing the process of research for technological improvement does warrant consideration.

Adapting research to change the relative advantage of technology

One method of increasing the likelihood that the outcomes of research will have a perceived ‘relative advantage’ is to involve producers or end-users in relevant elements of the research process. The literature of agricultural extension and rural sociology is well supplied with observations and arguments in favour of farmer contribution to research directions (MacLeod forthcoming; Shulman & Penman forthcoming; Carr & Wilkinson 1997a, 1997b). In the case of productivity related research, the link between farmer direction of research priorities and farmer contribution to research funding is clear. In the case of environmental research, the justification for farmer involvement is not based upon ‘he who pays the piper calling the tune’, but upon the need to maximise the payoff from research toward the broader societal agendas for which it is funded. It is clearly the view of farm organisations and rural sociologists that farmer involvement in setting the research agenda will maximise the chances of the research results being implemented on farm (Dunn, Gray & Phillips forthcoming; MacLeod forthcoming; Ridge &

Cox forthcoming; Donaldson 1995; Dunn 1995). Here we are faced with the necessity of combining private benefit to the farmer with public environmental benefit to seek to ensure the outcomes of research will be implemented within a voluntary compliance policy system.

In maintaining the policy balance between private and public benefit in setting research directions there will always be tensions. Ideologically driven arguments, whether based upon market theories or upon a ‘Farmer First’ position, although informative, merely heighten this tension. The need for farmer involvement in research planning, generally, is crucial to ensure adoption outcomes. Technological research also needs to respond to the changing dynamic of farm ecosystems and the requirements of regional variation. Farm managers are well placed to be aware of these variations, their importance as barriers to the implementation of new farming practices and their implicit effect on *local* relative advantage. Conservation cropping is a good example to consider. Farm ecosystems have responded to changes in cropping practice over the last 30 years. Some of these ecosystem changes have been beneficial, such as the growth of microbe populations that speed the break down of stubble residue. Others, such as the more frequent rodent plagues, white snail infestations and increased root disease have set back the success of conservation cropping. Ecosystem responses have varied significantly between regions and have at times occurred quite quickly (Karunaratne, Barr & Wilkinson 1998). Farmer involvement in setting research priorities can ensure that research will be regionally relevant, and timely, in response to these changes.

The advantages of farmer involvement need to be combined with the advantages of perspectives other than those that are farm or regionally-focused. Some argue that no current farm systems are sustainable, and new farming systems need to be developed, unconstrained by the limitations of thinking grounded in the structure of current systems (Williams 1999).

Financial incentives:

The most common justification for incentives to support farm management change is as a cost sharing arrangement to compensate farm managers for using management systems which provide off-site environmental benefits (Wilson 1995). However, linking management behaviour to incentives has generally proved administratively complex, and incentives have more often been used to fund ‘works on the ground’. History shows that the risk inherent in this strategy is

that the link between the ‘work on the ground’ and management change is often forgotten. Where this management change is not made, the full benefit of the incentive is not captured. An early recorded example of this problem was the building of erosion control structures as part of the Eppalock catchment scheme of the 1960s. The scheme failed in part because the funding body believed there was an implicit contract for the landholders to maintain the structures. This view was not shared by landholders. More recent examples of these implicit contracts can be found in subsidies for fencing of remnant vegetation, for perennial pasture improvement and for irrigation management technologies.

There have been few evaluations of subsidy schemes reported in the Australian literature. Two reports of successful schemes involved highly targeted incentives developed within the context of a community based catchment plan designed to change farm behaviour. The key to success was that the management changes encouraged by the incentives were within the capacity of existing farm systems and community, and that the incentives were coupled with education and cross compliance measures which enhanced the outcomes (Barr, Dyson & McInnes 1997; Hickey 1997). In contrast, there is evidence of the ineffectiveness of incentives schemes where the use of the incentive for farm management change was not supported by cross-compliance (Shaw 1994).

An alternative rationale for incentives is not as a compensation for off-site benefits, but as a means of sharing financial risk inherent in learning new management systems. This is considered in a later section.

More extensive experience with incentives in the United States of America suggests the importance of flexible incentives to meet the needs of different natural site characteristics, technologies and human preferences. The US experience is that a portfolio of incentives that combine penalties, rewards, regulations and education are most likely to achieve environmental policy objectives (Casey, Schmitz, Swinton & Zilberman 1999). Land degradation problems and appropriate management practices vary distinctively over geographic space due to differing landforms, climate and hydro-geological characteristics. Consequently financial incentives which are locally focused are likely to be more efficient than universally applied incentives (Ribaud & Caswell 1999).

Enhancing Trialability and Observability

The observability of watertables using test well flags has proved to be one of the success stories of watertable control in irrigation areas. The development of test well flags provided a visible demonstration of daily watertable movements. The placement of a test well flag in the main shopping street of Mildura helped raise salinity awareness in Mildura above the rural average for Victoria (Department of Natural Resources and Environment, Victorian Catchment and Land Protection Council & Environment Protection Authority 1997). Other programs to increase observability have included cropping programs such as *MeyCheck* and *Top Crop* which improved the observability of early indicators of cereal root disease.

Farmer monitoring of informal experiments and of resource condition is widespread, but tends to be informal in comparison to scientific paradigms of monitoring (Wilkinson 1996; Lawrence, Graham, Scheffe & Hall 1994). This informality is cheap and in most cases sufficient for the task at hand. However, informality can introduce heuristic and perceptual biases (Barr & Cary 1984; Tversky & Kahneman 1974). These biases are compounded by technologies which include complex interactions between fodder state and animal grazing behaviour. Observability has proved to be the key to introducing trialability to crop and pasture improvement extension and rangeland monitoring programs (Tromph & Sale 1997; MacLeod & Taylor 1994; Tversky & Kahneman 1974).

In the case of the Grasslands Productivity Program, there is good evidence that participants’ behaviour has changed significantly after involvement in the trials supported by the program (Tromph 1995). Soilcare also achieved significant changes in the behaviour of participants (Wilkinson & Cary 1993). In both cases there was little evidence of impacts of the programs beyond the farms of the direct participants. This suggests that personal involvement in trials is crucial for their success as a stimulus for behaviour change. Trials observed from a distance are unlikely to be successful where relatively complex management systems are being used.

Facilitating Decision Making

Agricultural industries increasingly require managers with greater skills as the complexity of agricultural systems and marketing increases. Any policy to expand the use of sustainable farming systems will enhance this trend towards greater complexity (Hamilton 1997). Education,

decision making training and risk sharing have been three strategies which have been used or cited as methods of meeting the demands of greater management complexity.

Education and Training

It has been generally assumed that improved educational standards will enable farm managers to manage more effectively, as well as leading to a greater capacity to implement sustainable agricultural practices (Agricultural Council of Australia and New Zealand 1998). There is evidence to support the assumption that improved education is related to the capacity to adapt farming systems (Kilpatrick 1995; Jamison & Lau 1982).

However, there has been a long-standing reticence among Australian farmers to involve themselves in formal training (Less & Reeve 1991; Hawkins, Almond & Dwyer 1974). There is evidence in some industries of significant literacy problems (Cumming & Hogan 1997; Steain 1997; Stoyles 1992; Hartley, Lucas & Hartley 1990). Australian farm managers are generally less educated than managers in comparable businesses. The recent NCPISA report has presented evidence of increasing education levels of Australian farmers (Standing Committee on Agriculture and Resource Management 1998). However, there is reason to question this evidence, possibly concluding that current adjustment patterns will result in a decreasing number of agriculture graduates in the broadacre industries (Barr & Ridges 1998b). This suggests the emergence of an educationally stratified farming community. In industries where there are decreasing rates of entry by younger persons and an increasing average age, there is likely to be little progress in average educational levels in the foreseeable future. In other industries where financial prospects are sounder, there is a likelihood of an increasing level of education over the next decade.

Facilitating decision making

Complex decisions which involve risk and substantial consequences can lead to stress. The experience of stress is in part a function of outlook and individual difference. Research among dairy farmers in the 1970s showed that while financial pressure was leading to widespread stress within the industry, there was no strong correlation between individual financial circumstances and stress (Weston & Cary 1979; Cary & Weston 1978). The work of Shrapnel, Davie & Frank (1997) studying variation in individual capacity to cope with stress, and the effect of this upon farm decision-making, makes it clear that

facilitating improved decision making and self reliance is more than just a matter of changing economic signals and providing more accessible information.

Varying styles of extension work existed in the 1960s and 1970s. While some work styles could clearly be described as belonging within a simple 'transfer of technology' model, other styles were clearly adapted to dealing with the stress and complexity of decision making rather than the transfer of information alone. The development of helping relationships, where extension officers assist a limited number of clients to work through major decisions, has been documented by Phillips and others (Phillips 1985; Anderson 1979). Although this form of extension was often more likely to influence behavioural change, in recent times it has not been provided by public agencies due to its labour intensity and perceptions of a publicly-funded service providing private benefit. The changing attitude to provision of this form of extension has been described in accounts of changes to the New Zealand government's provision of private benefit extension (Cary 1998; Heatherington, Cover, Roberts & Burchmore 1997; Kuiper & Hall 1997).

This intensive style of extension work had potential to assist clients work through consequential decisions. It was a forerunner to the now well-established rural financial counselling service. Other forms of extension being used today may be seen as providing similar support. Property Management Planning could be interpreted as facilitating improved family communications and support to share the social risk and isolation inherent in decision making. Landcare provides social support for farm decision makers, but can also be a means of increasing the social risk of failure (Montgomery 1993).

More recently there has been a re-assessment of the value of one-to-one extension relationships. Clients of the Department of Natural Resources and Environment in Victoria have said they see a role for one-to-one extension, particularly in assisting farmers make management changes 'on the ground' (Roberts & Cloona 1997; Woods, Moll, Coutts, Clark & Ivin 1993). This has suggested the need for a reconsideration of group activity as the main form of extension delivery (Boyd 1997). Campbell (1995) has observed that Landcare has generally been successful in promoting incremental change, but has a limited success in promoting systemic change. Part of the reason may lie in the difficulty of a group process providing support at crucial times during the process of working through and implementing major decisions about resource management. In any major decision there are key points where both social support

and critical information are needed. These needs may not coincide with what can be delivered through group extension processes.

In the Alcoa Woody Yallock project in southern Victoria, one-to-one extension was provided as part of an incentive program to assist in learning the skills of pasture establishment. An incentive payment was used to share the financial risk of learning new skills. Acceptance of the incentives was linked to use of extension visits at key points in the process of pasture establishment. Extension and financial support were only available for the establishment of pasture in two paddocks, considered sufficient to provide time to learn the basics of the technology. This novel approach targeted the incentive towards the risk of experimentation rather than an amorphous public good. Consultancy support provided by the project was limited to the process of learning the technology (Nicholson 1995).

Changing Culture

Stewardship ethics and community education

A first step in the solution to land degradation is, in part, to promote changed attitudes. Changed community attitudes were set as an objective of the National Decade of Landcare program (Standing Committee on Agriculture and Resource Management 1995). There is good evidence to suggest that public investment in community awareness of land degradation issues has been successful in building awareness and professed concern for land degradation (Standing Committee on Agriculture and Resource Management 1995; Barr & Brown 1994).

One must be careful of the expectations of how attitude change might modify the behaviour of land managers. The expectation that changing attitudes of land managers will directly lead to changed behaviour is simplistic. This is most evident in beliefs about the value of promoting a 'stewardship ethic' as a means of changing management practices. Stewardship involves the belief that one has a responsibility or obligation to maintain the land for future generations. Policies to change behaviour via changing the stewardship ethic are likely to achieve relatively little in the absence of other enabling conditions. In situations involving common property resources or externalities there will be a conflict between individual self-interest and the expectation that farmers will undertake activity for the common or future good for little, or negative, financial return (Cary & Webb 2000).

There is a significant body of research that demonstrates that links between environmental beliefs and environmental behaviour are tenuous. This is not just the case in the field of land degradation. Environmental attitudes are far more weakly linked to measures of adoption of farm conservation practices than beliefs about the profitability and risk associated with those practices (Cary & Wilkinson 1997). A study of Ohio conservation cropping studies concluded that farmers were aware of erosion, aware of erosion control techniques, aware of off-site damages, yet most personal characteristics of land owners, including attitudes, were poor predictors of the use of farm conservation practices (Napier & Johnson 1998a, 1998b; Carboni & Napier 1993). Research in Australia provides similar evidence (Cary 1994, 1993a, 1992; Gorrard 1993; Vanclay 1992). Vanclay (1988) found a negative relationship between stewardship and the use of conservation cropping technologies.

A stewardship ethic cannot be relied upon as a sufficient condition to motivate change in farming practices. Policies designed to promote a stewardship ethic may at best indirectly, rather than directly, influence the adoption of improved resource management practices. Bradsen provides an example of the secondary impact of the stewardship ethic:

A land conservation ethic existed 50 years ago and exists now. It is important but cannot ensure land conservation. Rather than use the law to establish an ethic, the ethic should be used to establish effective law. (Bradsen 1989)

The stewardship ethic is most effectively used as a tool to provide public support for measures which internalise the costs of degradation to the source of the degradation. The most recent examples of this use of a public stewardship ethic are the implementation of a cap on the extraction of water from the Murray-Darling system, catchment levies and tree clearing controls. Widely held values of stewardship also produce support for other forms of government intervention based upon voluntary models of conservation behaviour. This is the major outcome of heightened community awareness concerning land degradation. Community awareness programs create effective impacts through a two-stage process where awareness generates a favorable climate for the use of other policy instruments which, more directly, influence behaviour change. Programs designed on the assumption single stage model will generally be ineffective unless they are targeted at inconsequential behaviour.

Promoting hazard appraisal

Another means of promoting changed community attitudes to land degradation has been through the sensitising people to the potential future damage which may arise from inaction. Humans prevaricate and often seem unable to visualise themselves as suffering loss from a probabilistic disaster. There is a tendency to perceptually downgrade predicted natural hazards (White 1974). In the face of the objective likelihood of damage, humans build in earthquake zones, in fire hazard regions and on flood plains. However once damage or loss is experienced, there is often then a tendency to react with vigour, at least for a short period after the contact with the hazard.

In comparison to hazards of interest to the insurance industry, land degradation hazards are comparatively insidious. They are slow to develop and often difficult to appraise in their early stages. The limited research into perception of land degradation problems in Australia has demonstrated a tendency to underestimate the extent of soil degradation on one's own farm (Barr 1999; Amirtharajah & Kearney 1996; AACM-International 1995; Vanclay 1988; Rickson, Saffigna, Vanclay & McTainsh 1987). This tendency is often manifest in what is now called the 'proximity effect', where landholders will describe the resource problem in their region as serious, in their neighbourhood as a moderate problem, and on their own farm as being no problem (Wilkinson & Cary 1992, 1993; Vanclay & Cary 1989). This work suggests that programs to encourage voluntary land use changes on the basis of warnings of future resource degradation are unlikely to be successful.

Landcare

The benefits of local involvement of landholders in conservation programs such as Landcare are often summarised as being:

- Involvement of local people in conservation program planning makes conservation efforts more relevant to resource problems in specific geographic areas.
- Local people become more committed to conservation efforts when they are involved in planning.
- Local people learn about resource problems and possible solutions as a result of participation in conservation program planning.

Recent research in the United States has questioned the value of local community involvement strategies for solving off-site environmental problems caused by

agriculture. In evaluating an Ohio program based upon the above principles, Napier and Johnson (1998a) concluded:

Numerous studies during the previous two decades have demonstrated the futility of using the approach adopted by Operation Future. Findings of the impacts of this organisation and its programs confirm what we have known for approximately 20 years, which is . . . these types of programs are basically ineffective. (Napier & Johnson 1998a)

This contrasts with Australia where it is generally agreed that community involvement, as implemented within Landcare, has been an outstanding success. It suggests the need for a wider examination of the research literature on the achievements of Landcare.

There is ample evidence that Landcare has brought about considerable changes to social norms about land conservation. In its early years there was significant suspicion of the Landcare movement, both from farmers and their representative bodies (Barr 1994). The growth of the movement is well documented by Curtis (1995, 1996) and Curtis, Tracey and De Lacy (1993). Rural concern over environmental issues has increased over the last decade, and the increased concern has proved more sustainable than concern in urban areas (Barr & Brown 1994). Unlike the United States, there is a body of Australian research which links Landcare involvement with changes in farm management practice (Curtis 1996, 1995; Curtis & De Lacy 1996; Luke, Karunaratne & Barr 1995; Mues, Roper & Ockerby 1994; Wilkinson & Cary 1992, 1994b; Curtis, Tracey & De Lacy 1993; Nelson & Mues 1993a, 1993b), although there is still room for debate about the direction of causality.

The extension profession has supported group extension because of a belief in the value of farmer knowledge and a belief that groups are an effective means of facilitating the transfer of this knowledge (Carr & Wilkinson 1997a; Millar & Curtis 1997). This approach acknowledges that farmers are a source of much of the most up to date technical and management information about current farming systems. In Victoria, where the community Landcare movement had its genesis, groups were seen as a means of building social support for land conservation and Landcare was conceived as a means of changing culture (Edgar & Patterson 1991). Given the limitations of Landcare in bringing about systemic change (as opposed to incremental change) and the structural constraints on Landcare discussed previously, support for Landcare as a policy instrument has clearly contributed to cultural change in rural resource management.

Adapting to structural change

Structural constraints associated with pastoral agriculture and dryland salinity in the Murray Darling Basin have been discussed earlier in this report. The upland broadacre farms in the Murray Darling Basin were generally small, with low farm incomes, and with many families surviving on off-farm income (Barr & Ridges 1998a; Gray & Crockett 1998). Adjustment has not always followed a neo-classical course of farm exits and property amalgamation. Instead, on many farms the main adjustment has been the abandonment of expectations of intergenerational transfer. Coupled with this has been a deferral of farm exit in response to a lack of perceived alternatives available to broad acre farm operators. The result in many areas has been a rapid aging of the farm population and an increased dependence upon off-farm income. This process can be seen as a deferral of adjustment from the inter-generational transfer stage to a later life phase.

These demographic changes can be expected to further slow the already slow rate of implementation of the works recommended in many dryland catchment plans. The limited available research suggests that investment in farm businesses is more likely to occur in farms where there is an anticipation of inter-generational transfer. It is less likely to occur on farms where the operators are older and do not expect to transfer the farm to another family generation (Gray, Phillips & Dunn forthcoming; Barr & Ridges 1998a; Gray & Crockett 1998; Chamala 1987; Barr, Ronan & Volum 1979). Curtis's work suggests that increased commitment to off-farm work is associated with lower Landcare group effectiveness.

In the last decade communities and governments have jointly developed catchment management plans. Many of these catchment plans were based upon a number of crucial assumptions about the nature of the catchment's social structure. Among these assumptions were:

- Large areas of catchments are managed as commercial farms.
- The adoption of Best Management Practices by farm businesses can be self-funded.
- The structures of the catchment agricultural communities are static.

Very few catchment plans assess current and future trends in adjustment within the catchment and the implications of this adjustment for implementing the plan (Watson & Hall 1999). The danger of this is that plans may well set unrealistic implementation goals, as suggested by the discussion above. It is also possible that more

appropriate strategies or new opportunities may not be integrated into plans. The pattern of structural adjustment in broadacre agriculture offers potential for differing strategies to those used in most current dryland catchment plans, particularly related to land use change.

With the median age of farmers in some broadacre areas already over 55 years, and the rate of aging approaching 5 years per ten calendar years, the obvious question is how long can this rate of aging continue. Eventually the rate will decline as exits due to age increase. Then the adjustment pattern of a rural areas may change significantly. The number of properties placed for sale may increase substantially. This could result in significantly increased rates of consolidation, a significant increase in the number of new entrants to agriculture or some combination of the two. At that stage there may be an opportunity for adjustment policy tools to be used to enhance the direction of this adjustment in a manner which increases the chances of catchment plan implementation. This could further expand opportunities for various forms of land retirement in high recharge hill country (assuming funding is available), or for other significant land use change, such as using land for plantation forestry.

Farm and plantation forestry

Currently, the rate of planting in farm forestry is slow even though there appear to be significant market opportunities and sufficient marginal agricultural land with suitable rainfall and access to mill infrastructure (Centre for International Economics 1994; Industry Commission 1993; Resource Assessment Commission 1992). Natural resource managers have encouraged farm forestry as a national strategy to assist the move to more sustainable agriculture, enhance regional development and reduce the current account deficit (Race & Curtis 1996). However, significant socio-economic impediments have limited the adoption of farm forestry (Curtis & Race 1995; Fisher 1995). Less than 1 per cent of farmers are planting trees for commercial reasons (Nicol 1995). Because it is unlikely individual farmers will invest in forestry, promotion may need to be done by cost and risk sharing with large companies increasing the integration of farms into vertically integrated structures. A consequence may be a reduced the bargaining position for landholders (AACM-International, Centre for International Economics & Forest Technical Services 1996). The other consequence is the impact of corporate forestry development upon rural community viability. In Western Australia it has been contended that forestry share farming will reduce the rate

of population decline (Farm Forestry Task Force 1995). Given the increasing age of farmers in many regions, we need to ask to what extent this is delaying adjustment.

The changing demographics of the farming community offer some challenges and opportunities for those promoting farm forestry. Given the aging of the farm population, investment in farm forestry by an individual farmer becomes less likely as the period prior to a return on investment increases in relation to the remaining years of life available. Demographic trends may offer some opportunities for the promotion of investment in forestry rights. One of the barriers to the creation of an industry based upon forestry rights is the difficulty of obtaining a sufficient area of forestry rights in a region to justify future investment in wood processing infrastructure. In Victoria consultants are being employed to develop a methodology to be used to gain a commitment to forestry rights which might be then marketed to forestry corporations. This could be called an attempt to develop something resembling tradable future forestry rights. The aging of the farm population and the potential for a future acceleration of the rate at which properties are placed upon the market may offer an opportunity to foresters to enter the land market and make significant land purchases in a relatively small time. Overseas experience of farmland to forestry conversion programs has shown that these generally meet with significant resistance. They are most successful in regions where there is a high proportion of older farmers entering the retirement phase, and where purchase is targeted at the sale of the farm on the retirement of the owner (Jordan 1994).

The major demographic threat to the establishment of plantation forestry in upland areas may be where the agricultural values of a region have been overtaken by demographic trends which increase the value placed by the local community on landscape amenity. Again, overseas evidence indicates that the loss of population caused by agricultural adjustment is often counter-balanced by in-migration in areas where there is high natural amenity and the opportunity for commuting to large centres with employment opportunities (AACM-International 1995). Such 'suburbanisation' appears to be occurring in north-east Victoria, and in proximity to centres such as Bathurst and Canberra. The value placed upon landscape amenity by the community of these districts may be greater than the value placed upon salinity control.

One must conclude that some of the major issues to be resolved in any promotion of plantation forestry are questions that concern social preference which turn on questions of the desired relationships between plantation corporations and landholders, and appropriate social structures for rural communities in the coming decades.

Industrialisation and vertical integration

Outside the uplands and cropping industries, some different adjustment patterns are emerging. In some industries there has been a trend towards vertical integration of farm businesses into corporate production structures (Lawrence & Vanclay 1994; Vanclay & Lawrence 1993). This has led to challenging questions about assumptions about land management and the extent to which the landholder is the key actor in decisions about land use under contract farming methods (Rickson, Burch & Sanders 1997).

The most commonly studied example of this trend is intensive horticulture in northern Tasmania (Miller 1995; Chilvers & Cotching 1994; Barr & Cary 1992; Ewers 1989; Ewers, Hawkins, Kennelly & Cary 1989). The financial pressures upon the processors to maintain the operation of the processing line, and the lack of incentive to bear the cost of temporary storage, can result in contractual requirements on farm operators to manage horticultural operations to the detriment of soil conservation. Potatoes are sown up and down hills, rather on contours because of the limitations of harvest machinery, increasing erosion risk. Harvesting is carried out in wet weather, leading to soil compaction. It is difficult to generalise from this example. In Australia further case studies are being carried out; and internationally the debate is unresolved as to whether vertical integration is good or bad for soil conservation and resource protection.

In a review of 27 US studies of demographic and social determinants of conservation cropping Tweeton (1995) concluded there was:

No evidence that the expected long term tilt to an industrialised agriculture of larger scale operations, more separation of farm ownership from farm operation and non-family corporate structure will mean less soil and water conservation. Although several studies find no differences in conservation between small and large farms, those studies finding differences mostly report better conservation practices on larger farms. (Tweeton 1995)

There appears to be no universal answer to this question. In some circumstances a move towards greater integration in corporate structures may be associated with increased resource degradation. In other locations and industries the environmental impact may be more benign. What is clear is that the trend towards vertical integration can be expected to continue. It is well-established in intensive industries such as chicken meat production and horticulture (wine grapes, potatoes, tomatoes) and can be expected to extend to other industries. A number of social researchers argue that it is timely to develop alternative policy structures and regulation frameworks to promote sustainable resource for this changing industry structure (Burch, Rickson & Sanders 1998; Boehlje 1993; Burch, Rickson & Annells 1992). The Landcare framework for resource protection may become increasingly inappropriate for industries that progress towards vertical integration. In such situations industry based structures, quality control initiatives and regulation are likely to be more appropriate structures to achieve societal environmental objectives.

Conclusions

This review has considered the social constraints to the implementation of more sustainable agricultural practices. Constraints to change in agricultural systems have been canvassed from the perspectives of the farmer, the technology and the socio-economic structure of catchment communities. A number of lessons can be taken from this review.

NRM practices are difficult to promote. Its very hard to think of an example of an Australian 'Best Management Environmental Practice' which has characteristics that would lead to a rapid adoption within the farm community. Some offer economic advantage, but often at the cost of increased complexity, risk and skill demand. For many other practices the advantages may be intangible, captured by someone else, or occur a long way into the future. Benefits are often difficult to observe. Many practices are difficult to test. One obvious lesson to draw is that we cannot expect change in sustainable farming systems to be speedy. While this conclusion may seem obvious, it bears stating if funding and evaluation cycles are conducted over three to five year time spans. Significant change in some farm management practices may be measured in decades or even generations, mediated by structural change in agriculture.

The limitations of reliance on a stewardship ethic. To simplify a complex subject, it is argued that motivation, financial incentive, financial capacity, skill capacity and appropriate technology are necessary before changes in farm management behaviour can be expected. Policies to change motivation in the absence of the other enabling conditions are likely to achieve little. There is a significant body of research which demonstrates the links between environmental beliefs and environmental behaviour are tenuous (see Cary & Webb 2000). Policies designed to promote stewardship ethics will rarely directly influence the adoption of new farming practices. In the longer run, they may facilitate political, cultural and legal changes which may influence the other enabling factors.

Expect a limited response to messages about future threats of land degradation. In comparison to the hazards studied by the insurance industry, land degradation hazards are comparatively insidious. They are slow to develop and are often difficult to appraise in their early stages. The limited research into perception of land degradation problems in Australia has demonstrated a tendency for individuals to underestimate the extent of soil degradation on their own farm. This tendency is often manifest in what is now called the 'proximity effect', where landholders will describe the resource problem in their region as serious, in their neighbourhood as a moderate problem, and on their own farm as being

no problem. This work suggests that programs to encourage voluntary land use changes on the basis of warnings of future resource degradation are unlikely to be successful.

Landcare is a tool to promote incremental change to existing agricultural systems. Messages about natural resource management will not have universal appeal. In the past, extension systems have had only partial contact with the farming community. Contact was often strongest between farmers and extension workers who shared similar values. This congruence of values meant extension was more likely to be effective (Anderson 1981, 1979). Today the Landcare structure involves a substantial minority of Australian farmers. It is probably unrealistic to expect any voluntary policy tool to achieve any greater degree of penetration of the farming community than has been achieved by Landcare. No policy approach will appeal to all the value sets, ambitions and priorities held by people living and working on Australian farms. There is a body of Australian research which links Landcare involvement with changes in farm management practice. However, some of the most informed observers of Landcare have observed that its achievements in the promotion of farming systems have been evolutionary rather than revolutionary. Landcare is about incremental change.

Structural constraints in broadacre industries are a major barrier to change. Part of the reason for the incremental achievement of Landcare lies in the structural constraints to change in much of the broadacre agriculture of Australia. The vast majority of broadacre farm businesses do not produce sufficient surpluses to allow for reasonable living standards, investments in the farm business and investment in resource protection and the environment. Current adjustment patterns are only slowly creating aggregated business more capable of generating appropriate surpluses. In areas such as the Murray Darling Basin we can no longer pretend that voluntary responses under the current farming structure will make a significant difference to dryland salinity (Barr 2000). There are some stark choices. We can make large resource investments to support re-vegetation, we can accept that salinity is here to stay, or we can attempt to change the structure of rural industries. This raises difficult, and as yet unanswered, social questions about what form rural communities might take in the future.

Reticence to plan for catchment structures of the future. Rural communities and agricultural industries are constantly changing. Adjustment trajectories vary from region to region and industry to industry; but these social

changes are not considered in catchment planning. The modus operandi is to plan for communities as they were one or two decades ago rather than planning for the community structure likely to exist in the next 20 years. Catchment social and economic structures are changing rapidly and these changes have potentially significant implications for natural resource management policy.

Some industries and regions will increasingly be vertically integrated into corporate agribusiness. In these regions, greater emphasis may need to be placed upon tools such as quality assurance systems linked to industry programs. Other regions have large areas of the landscape devoted to production systems which are unlikely to be profitable in the foreseeable future given current industry structures. In these areas 'sustainable agriculture' will be as much about industry restructuring as about agricultural systems and agronomy. This will raise larger questions about the acceptable rate of community change and the desirable form of rural communities that are beyond the scope of this review.

References

- AACM-International. (1995). *Social and economic feasibility of ameliorating soil acidification: a national review*. LWRRDC: Canberra.
- AACM-International, Centre for International Economics, and Forest Technical Services. (1996). *Commercial farm forestry in Australia: Development of a strategic framework*. RIRDC: Canberra.
- Abelson, R.P. and Levi, A. (1985). Decision Making and Decision Theory, in Lindzey, G. and Aronson, E. (Eds.), *The Handbook of Social Psychology* Vol. 1. New York: Random House.
- Agricultural Council of Australia and New Zealand. (1998). *Sustainable Agriculture: Assessing Australia's Recent Performance*. Canberra: CSIRO Publishing.
- Amirtharajah, M.S. and Kearney, M.A. (1996). *Glenelg salinity implementation survey: a survey of landholder attitudes, practices and intentions for salinity control in the Glenelg region*. Department of Natural Resources and Environment: East Melbourne.
- Anderson, A.M. (1979). *How Advisors Advise: Agricultural extension as a social process*. Richmond: Hawkesbury Agricultural College.
- Anderson, A.M. (1981). *Farmers' Expectations and Use of Agricultural Extension Services*. Richmond: Hawkesbury Agricultural College.
- Australia and New Zealand Environment and Conservation Council. (1994). *National Rangeland Management Working Group: Rangelands Issues Paper*. Canberra: Department of Environment Sport and Territories.
- Baird, K. (1993). Farmers' perceptions of phalaris: a qualitative approach to developing a marketing strategy for perennial pastures, 4th year B.Ag.Sci. project, La Trobe University: Bundoora.
- Barker, J. (1992). Lucerne intercropping. Paper presented to the Water efficient farming workshop. Bendigo: Centre for Land Protection Research.
- Barr, N.F. (1988). The Tragowel Plains: A Study of An Agricultural Community. [Unpublished].
- Barr, N.F. (1994). Landcare from inside-out and outside in. *The Australian Farm Manager*, 5, 1: 2–10.
- Barr, N.F. (1996). Conventional and low input pasture improvement—a review of recent market research. *New Zealand Journal of Agricultural Research*, 39, 4: 559–68.
- Barr, N.F. (1999). Salinity control, water reform and structural adjustment: The Tragowel Plains Irrigation District, Unpublished doctoral thesis, Institute of Land and Food Resources: University of Melbourne.
- Barr, N.F. (2000). Structural adjustment, catchment planning and land care. In Beckingsale, D. (Ed.) *Changing Landscapes—Changing Futures*. Proceedings of International Landcare Conference, Melbourne.
- Barr, N.F. and Brown, M. (1994). Landcare: Sustaining public opinion, Unpublished address given to the Australian Landcare Conference.
- Barr, N.F. and Cary, J.W. (1984). *Farmer Perceptions of Soil Salting: Appraisal of an Insidious Hazard*, School of Agriculture and Forestry, University of Melbourne.
- Barr, N.F. and Cary, J.W. (1992). *Greening A Brown Land: The Australian Search for Sustainable Land Use*. Melbourne: Macmillan.
- Barr, N.F., Dyson, C., and McInnes, S. (1997). Evaluation irrigation salinity control achievements in the Tragowel Plains. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 615–25.
- Barr, N.F. and Ridges, S. (1998a). *Structural Adjustment and Catchment Management in the Murray Darling Basin: A Scoping Study*. Bendigo: Department of Natural Resources and Environment.
- Barr, N.F. and Ridges, S. (1998b). *Structural Adjustment and the Implementation of Catchment Management Plans: A Case Study of the North Central Victorian Catchment*. Bendigo: Department of Natural Resources and Environment.
- Barr, N.F., Ronan, G., and Volum, A. (1979). *Farmers in a Changing Agriculture*. Melbourne: Department of Agriculture.
- Bodnaruk, K. and Frank, B. (1997). Factors influencing the acceptance of IPM in the Australian apple industry. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 232–8.
- Boehlje, M. (1993). Environmental regulation and corporate policy. *Agribusiness*, 9, 5: 495–508.
- Boyd, M. (1997). What do they want and how do they want it? In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 55–64.

- Bradsen, J. (1989). A review of soil conservation legislation in Australia. Proceedings of the 5th Australian Soil Conservation Conference. Perth: Western Australian Department of Primary Industries.
- Bryant, L. (1999). The detraditionalisation of occupational identities in farming in South Australia. *Sociologia Ruralis*, 39, 2: 236–61.
- Burch, D., Rickson, R., and Annells, R. (1992). The growth of Agribusiness: Environmental and Social Implications of Contract Farming. In: Lawrence, G., Vanclay, F., Furze, B. (Eds.) *Agriculture, Environment and Society: Contemporary Issues for Australia*. Melbourne: Macmillan, pp. 259–77.
- Burch, D., Rickson, R., and Sanders, R. (1998). Farm Decision-Making and Resource Use: New Structures and Changing Responsibilities—Literature Review. [Unpublished].
- Campbell, A. (1991). *Landcare—Testing Times*. Canberra: National Soil Conservation Program.
- Campbell, A. (1995). Facilitating Landcare: conceptual and practical dilemmas. *Rural Society*, 5, 2/3: 13–9.
- Campbell, A. (1995). Landcare: Participative Australian approaches to inquiry and learning for sustainability. *Journal of Soil and Water Conservation*, 50, 2: 125–31.
- Carboni, S.M. and Napier, T.L. (1993). Factors affecting use of conservation farming practices in East Central Ohio. *Agriculture, Ecosystems and Environment*, 45, 1: 79–94.
- Carr, A. (1995). Innovation of diffusion: Landcare and information exchange. *Rural Society*, 5, 2/3: 56–66.
- Carr, A. and Wilkinson, R. (1997a). Scientists and farmers working together: a convergence of knowledge and roles. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 737–43.
- Carr, A. and Wilkinson, R. (1997b). *Innovation of Diffusion: landholder groups and information exchange*. Canberra: Centre for Resource and Environmental Studies.
- Cary, J.W. (1992). Influencing the management of private land. Proceedings of the Improved Extension Methods Workshop. Australian Soil Conservation Advisory Committee: Canberra. pp. 39–46.
- Cary, J. W. (1993a). The nature of symbolic beliefs and environmental behaviour in a rural setting. *Environment and Behavior*, 25, 5: 555–576.
- Cary, J.W. (1993b). *Modelling of adoption of soil conservation practices*. Canberra: LWRRDC.
- Cary, J.W. (1994). *Modelling beliefs related to environmental behaviour*, University of Melbourne: Parkville.
- Cary, J.W. (1998). Issues in public and private technology transfer: The cases of Australia and New Zealand. In: Wolf, S.A. (Ed.) *Privatization of Information and Agricultural Industrialization*. Boca Raton FL: CRC Press.
- Cary, J.W. and Webb, T. (2000). *The Landcare Movement and the Landcare Model: The Social Dimensions of Landcare*. Unpublished paper. Social Sciences Centre, Bureau of Rural Sciences, Canberra.
- Cary, J.W. and Weston, R.E. (1978). *Social stress in agriculture: The implications of rapid economic change*. University of Melbourne: School of Agriculture and Forestry.
- Cary, J. W. and Wilkinson, R. L. (1997). Perceived profitability and farmers' conservation behaviour. *Journal of Agricultural Economics*. 48 (1): 13–21.
- Cary, J.W., Wilkinson, R.L., and Ewers, C.R. (1989). *Caring for soil on cropping lands*. School of Agriculture and Forestry: University of Melbourne.
- Casey, F., Schmitz, A., Swinton, S. and Zilberman, D. (1999). *Flexible Incentives for the Adoption of Environmental Technologies in Agriculture*. Norwell, Massachusetts: Kluwer Academic Publishers.
- Centre for International Economics. (1994). *Community and social benefits of eucalyptus plantations*. NSW: Pennant Hills.
- Chamala, S. (1987). Adoption processes and extension strategies for conservation farming. In: Cornish, P.S., Pratley, J.E. (Eds.) *Tillage: New Directions in Australian Agriculture*. Melbourne: Inkata, pp. 400–19.
- Chilvers, W.J. and Cotching, W.E. (1994). *Changes in Onion Growers Perceptions of Soil Management Problems in Northern Tasmania*. Devonport: Department of Primary Industry.
- Clancy, B. (1999). 'Elders wool plan'. *The Weekly Times*, Melbourne: Herald and Weekly Times, pp. 1–2.
- Cocks, F. (1993). A study into farmers' perceptions of land degradation and soil conservation, B.Ag.Eco. dissertation, School of Business: University of New England.

- Coffey, M. (1992). Farmers' perceptions of upgrading pasture to realise the potential of their grazing land, 4th year B.Ag.Sci. project, La Trobe University: Bundoora.
- Collier, R.A. (1995). *Barriers to utilising the Department of Conservation and Natural Resources extension and advisory services*. Benalla: Conservation and Natural Resources.
- Condon, G., Coffey, M., Vogel, W., Schroeder, P., Bishop, K., and Barr, N. (1995). Qualitative study of the barriers to increasing rates of pasture re-sowing in Victoria. [Unpublished].
- Coutts, J.A. (1997). Changes in extension—an Australian perspective: The coming of age of extension. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australia Pacific Extension Network. pp. 22–32.
- Cromartie, J.B. (1998). Net migration in the Great Plains increasingly linked to natural amenities and suburbanisation. *Rural Development Perspectives*, 13, 1: 27–34.
- Cumming, B., Erol, C., and Mitsos, V. (1995). Addressing cultural and language remoteness in the Goulburn Valley. *Quarterly Bulletin of the International Association of Agriculture Information Specialists*.
- Cumming, B. and Hogan, E. (1997). Enhancing participation in Landcare: It's more than a question of numbers. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 311–9.
- Curtis, A.L. (1995). *Landcare in Victoria: the state of play*. Albury: Charles Sturt University.
- Curtis, A.L. (1996). *Landcare in Victoria: A Decade of Partnerships*. Albury: Charles Sturt University.
- Curtis, A.L. (1997). Landcare, stewardship and biodiversity conservation. In: Klomp, N.I., Lunt, I. (Eds.) *Frontiers in Ecology: Building the Links*. Oxford: Elsevier Science, pp. 143–53.
- Curtis, A.L., Davidson, P., and De Lacy, T. (1997). Women's participation and experience of Landcare in Australia. *Journal of Sustainable Agriculture*, 10, 2–3: 37–56.
- Curtis, A., Davidson, P., and McGowan, C. (1994). *Womens' participation and experience of landcare in north east Victoria*. Albury: Charles Sturt University.
- Curtis, A.L. and De Lacy, T. (1995). Examining the assumptions underlying Landcare. *Rural Society*, 5, 2/3: 44–55.
- Curtis, A.L. and De Lacy, T. (1996). Landcare in Australia: does it make a difference? *Journal of Environmental Management*, 46, 2: 119–47.
- Curtis, A.L. and Race, D. (1995). *Review of Department of Primary Industry and Energy National Farm Forestry Program*. Charles Sturt University, Albury: The Johnstone Centre.
- Curtis, A.L., Tracey, P., and De Lacy, T. (1993). *Landcare in Victoria: Getting the job done*. Albury: Charles Sturt University.
- Department of Natural Resources and Environment, Victorian Catchment and Land Protection Council, and Environment Protection Authority. (1997). *Know Your Catchments Victoria 1997: An Assessment of Catchment Condition Using Catchment Indicators*. Melbourne: Department of Natural Resources and Environment.
- Donaldson, S. (1995). Farm level perspective of constraints to dealing with Landcare. In proceedings of the Australian Agriculture and Resources Outlook Conference. Canberra: ABARE. pp. 190–7.
- Duncan, R.C. (1969). An Investigation of the Trial Stage in the Adoption Process: Aerial Top Dressing in the Clarence Valley. *Review of Agricultural and Marketing Economics*, 37, 2: 207–16.
- Dunn, R. (1995). Grain industry's perspective on the use and adoption of technical information on catchment management and related practices. In proceedings of the 'Downstream effects of land use' National Conference. Department of Natural Resources: Brisbane. pp. 409–10.
- Dunn, T. (1997). Top down theories of extension: use and limitations. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australia Pacific Extension Network. pp. 154–66.
- Dunn, T., Gray, I., and Phillips, E. (forthcoming). From Personal Barriers to Community Plans: a Farm and Community Planning Approach to the Extension of Sustainable Agriculture. In: Schulman, A.D., Price, R.J. (Eds.) *Case Studies in Increasing the Adoption of Sustainable Resource Management Practices*. Canberra: Land and Water Resources Research and Development Corporation, pp. 17–33.

- Dwyer, M.G. (1974). *Human Values in Agriculture*, School of Psychology: University of Melbourne.
- Edgar, R. and Patterson, D. (1991). The evolution continues—Victorian landcare groups. Paper presented to the 7th International Soil Conservation Organisation Conference, . Sydney: ISCO.
- Ewers, C.R. (1988). *Laser Grading in the Goulburn-Murray District: An Innovation Diffusion Study*. Monash Publications in Geography, No. 35, Clayton: School of Geography, Monash University.
- Ewers, C.R.(1989). Implications of Corporate Involvement in Agriculture, Unpublished address given to the Rural Policy Workshop, Annual Conference of the Australian Institute of Geographers. Adelaide.
- Ewers, C.R., Hawkins, H.S., Kennelly, A.W., and Cary, J. (1989). *Onion Growers' Perceptions of Soil Management Problems in Northern Tasmania*. Parkville: School of Agriculture and Forestry, University of Melbourne.
- Ewing, S. (1995). 'Small is beautiful': The place of the case study in Landcare evaluation. *Rural Society*, 5, 2/3: 38–43.
- Farm Forestry Task Force. (1995). *Farm forestry in Western Australia*. Perth: CALM.
- Fisher, T. (1995). *Fighting salinity on a wool cheque: Dryland salinity in the Murray uplands*. Fitzroy: Australian Conservation Foundation.
- Fliegel, F.C. and van Es, J.C. (1983). The diffusion adoption process in agriculture: Changes in technology and changing paradigms. In Summers, G. (Ed.) *Technology and Social Change in Rural Areas*. Boulder: Westview Press,
- Fontana, D. (1991). *Landholders' attitudes towards salinity control options in the Goulburn Salinity Management Plan*. Benalla: Department of Agriculture.
- Frank, B. (1995). Constraints limiting innovation adoption in the North Queensland beef industry. *Agricultural Systems*, 47, 3: 291–322.
- Glyde, S. and Vanclay, F. (1996). Farming styles and technology transfer: Sociological input in the development of a decision support system for viticulture. In: Lawrence, G., Lyons, K., Momtaz, S. (Eds.) *Social Change in Rural Australia*. Rockhampton: Rural Social and Economic Research Centre, Central Queensland University, pp. 38–54.
- Gorddard, B.J. (1993). *Barriers to the adoption of conservation tillage in Western Australia*. Canberra: LWRRDC.
- Goss, K. (1979). Consequences of diffusion of innovations. *Rural Sociology*, 44, 754–72.
- Gray, I. (1992). Power relations in rural communities: implications for environmental management. In: Lawrence, G., Vanclay, F., Furze, B. (Eds.) *Agriculture, Environment and Society*. Melbourne: Macmillan.
- Gray, I. and Crockett, J. (1998). *Producer Profiles based on survey data from the Middle Murrumbidgee catchment*. Charles Sturt University: Wagga Wagga.
- Gray, I., Phillips, E., and Dunn, T. (forthcoming). Aspects of Rural Culture and the Use of Conservation Farming. In: Schulman, A.D., Price, R.J. (Eds.) *Case Studies in Increasing the Adoption of Sustainable Resource Management Practices*. Canberra: Land and Water Resources Research and Development Corporation, pp. 34–47.
- Griliches, Z. (1957). Hybrid corn: An exploration in the economics of technological change. *Econometrica*, 25, 501–522.
- Griliches, Z. (1960). Hybrid corn and the economics of innovation. *Science*, 132, 275–280.
- Griliches, Z. (1962). Profitability versus interaction: another false dichotomy. *Rural Sociology* 27(3), 327–330.
- Guerin, L.J. and Guerin, T.F. (1994). Constraints to the adoption of innovations in agricultural research and environmental management: a review. *Australian Journal of Experimental Agriculture*, 34, 4: 549–71.
- Hamilton, G. (1997). Emergent roles for information products and services. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 188–94.
- Harrison, R. (1992). *Improving wheat belt pastures in South Australia: Market research report prepared for the South Australian Department of Agriculture*. Adelaide: Harrison Market Research.
- Hartley, R. and Lincoln, D. (1993). Integrated marketing of extension messages lifts adoption. Paper presented to the 7th Australian Agronomy Conference. Adelaide:
- Hartley, R., Lucas, P., and Hartley, D. (1990). Directional change in the publishing paradigm of extension material in NSW Agriculture and Fisheries. *Australian Journal of Adult and Community Education*, 30, 3: 180–9.

- Havens, A.E. and Rogers, E.M. (1961). Adoption of hybrid corn: profitability and the interaction effect. *Rural Sociology* 26, 409–414.
- Hawkins, H.S., Almond, E.F., and Dwyer, M.D. (1974). *Post secondary needs of Australian farmers: A survey of the opinions of farmers and agricultural staff*. University of Melbourne: Agricultural Extension Research Unit.
- Hawkins, H.S. and Watson, A.S. (1972). *Shelford: A preliminary report of a social and economic study of a Victorian soldier settlement area*. University of Melbourne: Agricultural Extension Research Unit.
- Heatherington, N., Cover, S., Roberts, K., and Burchmore, J. (1997). The future role of extension services in the context of ongoing government reform. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 494–505.
- Hickey, T. (1997). Education coupled with financial incentives delivers change in the Sunraysia. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australia Pacific Extension Network. pp. 644–8.
- Howden, P., Vanclay, F., Lemerle, D., and Kent, J. (1997). Understanding farming styles. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australia Pacific Extension Network. pp. 269–76.
- Industry Commission. (1993). *Adding further value to Australia's forest products*. Canberra: Commonwealth of Australia.
- Jamison, D.T. and Lau, L.J. (1982). *Farmer Education and Farm Efficiency*. Baltimore: John Hopkins University.
- Janis, M. and Mann, L. (1977). *Decision Making: A Psychological Analysis of Conflict, Choice and Commitment*. New York: Macmillan.
- Jordan, D.J. (1994). *Factors influencing grazier decisions towards sustainable grazing management*. Department of Primary Industry: Roma.
- Karunaratne, K. and Barr, N.F. (1998a). A baseline of adoption of conservation cropping: Mallee region. DNRE: Bendigo. (<http://www.nre.vic.gov.au/catchmnt/conditn/reports/Bmpcrop.htm>).
- Karunaratne, K. and Barr, N.F. (1998b) A baseline of adoption of conservation cropping: North Central region. DNRE: Bendigo. (<http://www.nre.vic.gov.au/catchmnt/conditn/reports/Bmpcrop.htm>).
- Karunaratne, K. and Barr, N.F. (1998c). A baseline of adoption of conservation cropping: North East region. DNRE: Bendigo. (<http://www.nre.vic.gov.au/catchmnt/conditn/reports/Bmpcrop.htm>).
- Karunaratne, K. and Barr, N.F. (1999a). A baseline of adoption of pasture management practices: Goulburn-Broken region.
- Karunaratne, K. and Barr, N.F. (1999b). A baseline of adoption of pasture management practices: North Central region.
- Karunaratne, K. and Barr, N.F. (1999c). A baseline of adoption of pasture management practices: Glenelg region.
- Karunaratne, K., Barr, N.F., and Wilkinson, R. (1998). A baseline of adoption of conservation cropping: Wimmera region. DNRE: Bendigo. (<http://www.nre.vic.gov.au/catchmnt/conditn/reports/Bmpcrop.htm>).
- Kilpatrick, S. (1995). *Training, Change and Profit on Australian Farms*. Hobart: University of Tasmania.
- Kuiper, D. and Hall, M. (1997). Paradigm lost and regained: Moving from extension to consultancy in New Zealand. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 253–63.
- Lawrence, D.N., Graham, T.W., and Clark, R.A. (1994). Sustainable grazing management: Graziers' perspectives and implications for pasture management in the Maranoa region, south Queensland. *Tropical grasslands*, 28, 1: 24–31.
- Lawrence, G. (1987). *Capitalism and the Countryside*. Sydney: Pluto Press.
- Lawrence, G., Lyons, K., and Momtaz, S. (1996). *Social Change in Rural Australia*. Rockhampton: Central Queensland University.
- Lawrence, G. and Vanclay, F. (1994). Agricultural Change and Environmental Degradation in the Semi-Periphery. In: McMichael, P. (Ed.) *Agro-Food System Restructuring on a World Scale: Towards the Twenty-First Century*. Ithica: Cornell University Press, pp. 76–103.
- Lawrence, N., Graham, T.W., Scheffe, C., and Hall, T.J. (1994). *Maranoa graziers impressions of pasture conditions assessment techniques*. Brisbane: QDPI.

- Lees, J.W. and Reeve, I.J. (1994). *Producer Survey M.414: Report to the Meat Research Corporation*. Armidale: University of New England.
- Less, J.W. and Reeve, I.J. (1991). *Competencies for Farming: A compendium of profiles*. Armidale: University of New England.
- Lindsay, R. and Gleeson, T. (1997). *Changing Structure of Farming*. Canberra: Australian Bureau of Agricultural and Resource Economics.
- Littlejohn, M., Vogel, W., Bishop, K., Schroeder, P., and McIntyre, J. (1997). Farmers attitudes and motivations to perennial pasture improvement. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. p. 224.
- Lodge, G.M., McCormick, L.H., and Dadd, C.P. (1991). *A survey of graziers and pasture management practices on the Northern Slopes of NSW*. Tamworth: NSW Agriculture and Fisheries.
- Luke, R., Karunaratne, K., and Barr, N. (1995). *Salinity Control in North Central Victoria: A Measure of Farmers' Beliefs and Attitudes*. Bendigo: Department of Natural Resources and Environment.
- Macadam, R. (1997). A personal history of rural extension in Australia. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australia Pacific Extension Network. pp. 635–43.
- MacLeod, N. (forthcoming). Effective Strategies for Increasing the Suitability and Adoption of Complex Technologies for Sustainable Land Management. In: Schulman, A.D., Price, R.J. (Eds.) *Case Studies in Increasing the Adoption of Sustainable Resource Management Practices*. Canberra: LWRRDC, pp. 187–265.
- MacLeod, N.D. and Taylor, J.A. (1994). Perceptions of beef cattle producers and scientists relating to sustainable land use issues and their implications for technology transfer. *Rangeland Journal*, 16, 2: 238–53.
- Madden, B. (1992). Study of salinity control adoption in the Goulburn-Broken catchment. [Unpublished].
- Marks, N. and O'Keefe, M. (1996). Pastures and farm management practices: research report prepared for Agriculture Victoria. [Unpublished].
- Marsh, P.M. and Pannell, D.J. (1997). The changing relationship between private and public sector agricultural extension in Australia. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australia Pacific Extension Network. pp. 350–6.
- Martin, P. (1995). The constitution of power in landcare: a post-structuralist perspective with modernist overtones. *Rural Society*, 5, 2/3: 30–7.
- Martin, P. and Woodhill, J. (1995). Landcare in the Balance: Government Roles and Policy Issues in Sustaining Rural Environments. *Australian Journal of Environmental Management*, 2, 173–83.
- Mesiti, L. and Vanclay, F. (1996). Farming styles amongst grape growers of the Sunraysia district. In: Lawrence, G., Lyons, K., Momtaz, S. (Eds.) *Social Change in Rural Australia*. Rockhampton: Rural Social and Economic Research Centre, Central Queensland University, pp. 55–63.
- Millar, J. and Curtis, A. (1997). The role of farmer knowledge in group learning: Observations from Prograze and Landcare case studies. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 506–13.
- Miller, L. (1995). Agribusiness, contract farmers and land-use sustainability. *Australian Geographer*, 26, 2: 104–11.
- Montgomery, A.J. (1993). Adoption, success of and influences on perennial grass establishment in the Mid Goulburn catchment of Victoria: Project report to the National Soil Conservation Program. [Unpublished].
- Mues, C., Roper, H., and Ockerby, J. (1994). *Survey of Landcare and land management practices: 1992–93*. Canberra: ABARE.
- Napier, T.L. and Johnson, E.J. (1998a). Impacts of voluntary conservation initiatives in the Darby Creek Watershed of Ohio. *Journal of Soil and Water Conservation*, 53, 1: 78–84.
- Napier, T.L. and Johnson, E.J. (1998b). Awareness of operation future among landowner-operators in the Darby Creek watershed of Ohio. *Journal of Soil and Water Conservation*, 53, 4: 353–7.
- Nelson, R.A. and Mues, C. (1993a). A survey of landcare in Australia. *Agriculture and Resources Quarterly*, 5, 3: 400–10.
- Nelson, R.A. and Mues, C. (1993b). *Survey of Landcare and drought management practices 1991–92*. Canberra: ABARE.
- Newman, B. (1998). A Report on the Dryland Salinity Hazard Arising from the Salinity and Drainage Review. In proceedings of the 1998 MDBC Dryland Forum. Canberra: Murray Darling Basin Commission. pp. 77–9.

- Nicholson, C. (1995). The Promotion of Perennial Grasses: Two Approaches. In: Curtis, A.L., Millar, J. (Eds.) *Community Grasses Project Workshop*. Albury: Charles Sturt University, pp. 79–82.
- Nicol, C. (1995). Landholder Perceptions of the Impact of Tree Planting on Dryland Salinity. In: Murray Darling Basin Commission Workshop Extended Abstracts. Canberra: Murray Darling Basin Commission, pp. 188–91.
- Nicoll, R. (1994). *Landholders' knowledge and perceptions of dryland salinity control options in the Broadford and Kilmore Shires*. Environmental Management Research Project, Deakin University: Rusden.
- Nowak, P.J. (1983). Obstacles to the adoption of conservation tillage. *Journal of Soil and Water Conservation*, 38, 3: 162–5.
- O'Keefe, M. (1993). *A qualitative project into the adoption of pasture research: A summary report*. Canberra: CSIRO.
- Phillips, E. (forthcoming). Social and Cultural Factors that Influence the Adoption of Sustainable Farm Practices. In: Schulman, A.D., Price, R.J. (Eds.) *Case Studies in Increasing the Adoption of Sustainable Resource Management Practices*. Canberra: Land and Water Resources Research and Development Corporation, pp. 48–57.
- Phillips, T.I. (1985). *The Development of Methodologies for the Determination and Facilitation of Learning for Dairy Farmers*. School of Agriculture and Forestry, University of Melbourne: Melbourne.
- Potter, C. and Lobley, M. (1992). Ageing and Succession on Family Farms: The Impact of Decision Making on Land-Use. *Sociologia Ruralis*, 32, 2/3: 317–34.
- Potter, C. and Lobley, M. (1996). Unbroken threads? Succession and its effects on family farms. *Sociologia Ruralis*, 36, 3: 287–306.
- Presser, H.A. (1969). Measuring innovativeness rather than adoption. *Rural Sociology*, 34, 510–7.
- Presser, H.A. and Cornish, J.B. (1968). *Channels of Information and Farmers' Goals in Relation to the Adoption of Recommended Practices: A Survey in a Dried Fruit Growing District*. School of Agriculture: University of Melbourne.
- Prime Minister's Science Council. (1974). *Principles of Rural Policy in Australia*. Canberra: Australian Government Publishing Service.
- Prime Ministers Science and Engineering, I.C. (1998). *Dryland Salinity and its Impacts on Rural Industries and the Landscape*. Canberra: Australian Government Publishing Service.
- Race, D. and Curtis, A.L. (1996). Farm forestry: how things stand. *Australian Journal of Soil and Water Conservation*, 9, 2: 29–35.
- Ralph, I.G. (1972). *Value ranking by farmers*. School of Agriculture: University of Melbourne.
- Ransom, K. (1992). *Dryland lucerne grazing systems: development, demonstration and computer simulation of grazing systems to utilise mixed pastures of sub clover, annual grasses and dryland lucerne*. Bendigo: Department of Agriculture.
- Ransom, K. and Barr, N. (1993). *The adoption of dryland lucerne in North-Central Victoria*. Bendigo: Department of Agriculture.
- Rathge, R.W. and Highman, P. (1998). Population Change in the Great Plains: A History of Prolonged Decline. *Rural Development Perspectives*, 13, 1: 19–25.
- Reeve, I.J. and Black, A.W. (1993). *Australian Farmers' Attitudes to Rural Environmental Issues*. University of New England: Rural Development Centre.
- Reeve, I.J. and Black, A.W. (1994). Understanding farmers' attitudes to land degradation: some methodological considerations. *Land Degradation and Rehabilitation*, 5, 179–89.
- Reeve, I.J., Lees, J., Price, I., and O'Donnell, L. (1995). Evaluation of the 1992–93 Lucerne Promotional Campaign: Unpublished report to NSW Agriculture. Armidale: University of New England.
- Rendell, R.J., O'Callaghan, P., and Clark, N. (1996). *Families, Farming and the Future: Business performance indicators for farming systems in the Wimmera and Mallee of Victoria*. Bendigo: Agriculture Victoria.
- Resource Assessment Commission. (1992). *Forest and Timber Inquiry: Final Report Volume 1*. Canberra: Australian Government Publishing Service.
- Ribaud, M. and Caswell, M.F. (1999). Environmental Regulation in Agriculture and the Adoption of Environmental Technology. In Casey, F., Schmitz, A., Swinton, S. and Zilberman, D. (Eds.) *Flexible Incentives for the Adoption of Environmental Technologies in Agriculture*. Norwell, Massachusetts: Kluwer Academic Publishers.

- Richards, P. (1995). Achieving sustainable land management on small rural properties in the port Phillip Region: unpublished report. Woori Yallock: Department of Conservation and Natural Resources.
- Rickson, R., Burch, D., and Sanders, R. (1997) New and Emerging Structures in Agriculture: Challenges and Opportunities for Natural Resource Management, Unpublished address given to the 2nd Annual Workshop on Integrated Catchment Management, Advancing Integrated Resource Management: Processes and Policies. Australian National University.
- Rickson, R., Saffigna, P., Vanclay, F., and McTainsh, G. (1987). Social bases of farmers' responses to land degradation. In: Chisholm, A., Dumsday, R. (Eds.) *Land Degradation: Problems and Policies*. Cambridge: Cambridge University Press,
- Ridge, P. and Cox, P. (forthcoming). Market Research for Decision Support in Dryland Crop Production. In: Schulman, A.D., Price, R.J. (Eds.) *Case Studies in Increasing the Adoption of Sustainable Resource Management Practices*. Canberra: Land and Water Resources Research and Development Corporation, pp. 127–86.
- Roberts, G. and Cloona, D. (1997). Questioning adoption as the sole criteria of extension success. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 176–81.
- Rogers, E.M. (1962). *Diffusion of innovations*. New York: The Free Press of Glencoe.
- Rogers, E.M. (1983). *Diffusion of innovations* (3rd edn.). New York: The Free Press-Collier Macmillan.
- Rogers, E.M. and Shoemaker, F.F. (1971). *The communication of innovations: a cross cultural approach*. New York: Collier-Macmillan.
- Rowley, T.D. (1998). Sustaining the Great Plains. *Rural Development Perspectives*, 13, 1: 2–6.
- Rutel, T.K. (1998). Is there a forest transition? Deforestation, reforestation and development. *Rural Sociology*, 63, 4: 533–52.
- Salmon, P. (1981). *Personal Psychology of Change in Management*. University of Melbourne: School of Agriculture and Forestry.
- Shaw, H. (1994). *A survey of pastures in the Lake Eppalock Catchment*. Technical Report Series, No. 217, Department of Agriculture: Bendigo.
- Shrapnel, M., Davie, J., and Frank, B. (1997). Influence of psychological factors on policies and options for ecologically sustainable land management. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 236–44.
- Shulman, A.D. and Penman, R. (forthcoming). Emerging Models for Improving Sustainable Resource Management Communication Practices. In: Schulman, A.D., Price, R.J. (Eds.) *Case Studies in Increasing the Adoption of Sustainable Resource Management Practices*. Canberra: Land and Water Resources Research and Development Corporation, pp. 266–73.
- Sinden, J.A. and King, D.A. (1990). Adoption of soil conservation measures in Manilla Shire, New South Wales. *Review of Marketing and Agricultural Economics*, 58, 179–92.
- Standing Committee on Agriculture and Resource Management. (1995). *Evaluation Report on the Decade of Landcare Plan: National Overview*. Canberra: Australian Government Publishing Service.
- Standing Committee on Agriculture and Resource Management. (1998). *Sustainable Agriculture: Assessing Australia's Recent Performance*. Canberra: CSIRO.
- Steain, G. (1997). Low levels of English literacy amongst growers of predominantly Italian background will require a different approach for NSW agriculture. In proceedings of the 2nd Australasia Pacific Extension Conference. Albury: Australasia Pacific Extension Network. pp. 300–10.
- Stephens, R. (1992). *The development of the FarmBiz Package*. Bendigo: Department of Agriculture and Rural Affairs.
- Stoyles, M. (1992). *Cultural Barriers to extension: Results of a survey of the non English speaking background farmers in east Shepparton*. Melbourne: Ethnic Communications.
- Tromph, J. (1995). The effect of the grasslands productivity program on the adoption of productive pasture technology, 4th year B.Ag.Sci. project, La Trobe University: Melbourne.
- Tromph, J. and Sale, P. (1997). The Grasslands Productivity Program: Has it been successful? In proceedings of the Annual Conference of the Grasslands Society of Victoria. Mornington: Grasslands Society of Victoria. pp. 137–40.

- Tversky, A. and Kahneman, D. (1974). Judgement under uncertainty: heuristics and biases. *Science*, 185, 1124–31.
- Tweeton, L. (1995). The structure of agriculture: Implications for soil and water conservation. *Journal of Soil and Water Conservation*, 50, 4: 347–51.
- van den Ban, A.W. and Hawkins, H.S. (1988). *Agricultural Extension*. Harlow: Longman.
- Vanclay, F. (1988). *Socio-Economic Characteristics of Adoption of Soil Conservation*, Griffith University: Queensland.
- Vanclay, F. (1992). The social context of farmers' adoption of environmentally sound farming practices. In: Lawrence, G., Vanclay, F., Furze, B. (Eds.) *Agriculture, Environment and Society*. Melbourne: Macmillan, pp. 94–121.
- Vanclay, F. and Cary, J.W. (1989). *Farmers' Perceptions of Dryland Salinity*. University of Melbourne: School of Agriculture and Forestry.
- Vanclay, F. and Lawrence, G. (1993). Environmental and social consequences of economic restructuring in Australian agriculture. *International Journal of Sociology of Agriculture and Food*, 3, 97–113.
- Vanclay, F. and Lawrence, G. (1994). Farmer rationality and the adoption of environmentally sound practices: A critique of the assumptions of traditional agricultural extension. *European Journal of Agricultural Education and Extension*, 1, 1: 50–90.
- Vanclay, F. and Lockie, S. (1993). *Barriers to the adoption of sustainable crop rotations: Final Report*. Wagga Wagga: Centre for Rural Social Research.
- Vere, D.T. and Muri, A.M. (1986). Pasture improvement adoption in NSW. *Review of Marketing and Agricultural Economics*, 54, 19–32.
- Watson, B. and Hall, N. (1999). *Structural adjustment to facilitate implementation of ICM plans in mixed farming areas: Government policies*. Canberra: Murray Darling Basin Commission.
- Western Lands Review. (1998). *Public Consultation Meetings: Scope of Issues*. Sydney: NSW Department of Land and Water Conservation.
- Weston, R.E. and Cary, J.W. (1979). *A Change for the Better: Stress, Attitudes and Decision Making of Dairy Farmers 1976 to 1978*. University of Melbourne: School of Agriculture and Forestry.
- White, G.F. (1974). *Natural Hazards*. New York: Oxford University Press.
- Whittet, J.N. (1929). Lucerne as pasture in the western districts: Recent investigations into establishing and grazing the stands. *Agricultural Gazette*, 40, 1–16.
- Wilkinson, R. L. (1989). Stepwise adoption of a complex agricultural technology. Unpublished Masters Thesis, School of Agriculture and Forestry, University of Melbourne.
- Wilkinson, R. (1996). *Resource Monitoring by Hawke's Bay Farmers*. Canterbury: Manaaki Whenua Press.
- Wilkinson, R.L. and Cary, J.W. (1992). *Monitoring Landcare in Central Victoria*. University of Melbourne: School of Agriculture and Forestry.
- Wilkinson, R.L. and Cary, J.W. (1993). *Monitoring Soilcare in North East Victoria*. University of Melbourne: School of Agriculture and Forestry.
- Williams, J. (1999). Biophysical aspects of natural resource management. In proceedings of the Australian Agriculture and Resources Outlook Conference. Canberra: Australian Bureau of Agricultural and Resource Economics.
- Wilson, S.M. (1995). Linking biophysical and economic models to formulate socially optimal salinity management plans for the Murray-Darling Basin of Australia, Ph.D. La Trobe University: Bundoora.
- Woods, E., Moll, G., Coutts, J., Clark, R., and Ivin, C. (1993). *Information exchange: a report commissioned by Australia's research and development corporations*. Canberra: LWRRDC.