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UNDERSTANDING  
LANDHOLDERS'  
CAPACITY TO CHANGE TO  
SUSTAINABLE PRACTICES



INSIGHTS ABOUT  
PRACTICE ADOPTION  
AND SOCIAL CAPACITY  
FOR CHANGE

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**National Land & Water Resources Audit**  
*A program of the Natural Heritage Trust*



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UNDERSTANDING LANDHOLDERS' CAPACITY  
TO CHANGE TO SUSTAINABLE PRACTICES

*Insights about practice adoption and social capacity for change*

JULY 2002

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## FOREWORD

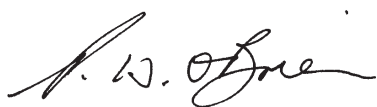
The management of Australia's natural resources is a human activity. As problems such as land salinisation and declining water quality have become of increasing concern the Commonwealth Government has increased its programs aimed at bringing about more sustainable land use. Many of these programs seek to change the management behaviour of landholders. From both a policy-making and a scientific perspective it is important to understand how people conceive of and respond to the need for sustainable land use. If we want to arrest and reverse land and water degradation in rural landscapes we need first to understand what motivates those whose everyday decisions and actions influence land management. We also need to better understand the characteristics of sustainable management practices that most landholders will be willing to adopt.

Most landholders now recognise the existence of significant degradation problems. What is not so well recognised or understood is the capacity of landholders to change to more sustainable land management practices. This publication reports the findings of a large-scale study of the human and social capacity to change to sustainable management practices, undertaken for Theme 6 of the National Land and Water Resources Audit. The findings are augmented by a concurrent project commissioned by Land & Water Australia. Landholders vary in their capacity to change management practices. Additionally there are strong constraints on the capacity of most landholders, as individuals or in groups, to implement many management practices considered to be more sustainable. This report identifies some important realities that confront the desire for significant and speedy landscape change.

Most of the material presented in this publication has been previously presented in three limited circulation reports:

- Social atlas for sustainable management: A social and economic database for the National Land and Water Resources Audit
- Human and social aspects of capacity to change to sustainable management practices
- The adoption of sustainable practices: Some new insights.

This publication synthesises the findings of these reports. It should be essential reading for policy makers, catchment management professionals, extension workers, community groups and those concerned with designing effective land management programs.



Peter O'Brien

EXECUTIVE DIRECTOR  
Bureau of Rural Sciences



## S U M M A R Y

*Human capacity to change to more sustainable practices varies across the catchments and localities of Australia's agricultural and pastoral landscapes. Effective catchment planning needs to take account of these differing social capacities which reflect differing socioeconomic characteristics and locality advantages.*

**Human capacity to change to more sustainable practices is a function of situation and individual circumstances and of the suitability of practices.**

Landholders vary in their capacity to implement many management practices considered to be more sustainable. The suitability and characteristics of specific sustainable practices, and the characteristics of locality (which often determine the suitability of practices) are significant in determining capacity to change to more sustainable practices.

**The use of sustainable practices will depend on how landholders assess the value of recommended practices.**

The use of sustainable practices will depend on how landholders assess the value of recommended practices and their own and others' experience of them. It is often difficult for landholders to see the connection between recommended sustainable practices and sustainability. As a result, they are often lukewarm about sustainable practices.

**Landholders seek to reduce the risk of adopting a new practice.**

Landholders seek to reduce the risk of adopting a new practice. Sustainable practices which are observable, trialable and less complex are generally more quickly adopted than practices which are unobservable, untrialable, and complex.

There are advantages in being able to promote sustainable practices with more universal or global applicability. However, given Australia's diverse environment, there are few sustainable practices that meet the test of global applicability. Universally applicable practices are often less likely to have large impacts on reducing local land degradation problems.

**Socioeconomic factors which can influence adoption of sustainable practices include farm income, age, training, having a farm plan, perception of financial security and community landcare membership.**

Landholder characteristics that potentially influence capacity to change are: level of farm income, age, participation in training, having a documented farm plan and membership of community landcare. There are often interactions between these characteristics; and the relationships with adoption behaviour are often weak. Personal financial capacity is an important component in determining the capacity of landholders to adopt new practices. Landholders' perceptions of their future financial situation were found to be more often associated with practice adoption than were objectively measured indicators of current financial position. Landholders who feel secure in their financial future are more likely to invest resources in adopting new resource management practices.

**Pro-environmental stewardship values and attitudes have a relatively minor influence on the adoption of sustainable practices.**

Pro-environmental or 'green' values and attitudes have a relatively minor influence on the adoption of sustainable practices. The effect of positive attitudes towards the environment is constrained by the influence of prevailing incentives or disincentives to adopt a sustainable practice. Positive attitudes towards the environment act in combination with external incentives or disincentives (including uncertainty of outcome) to determine adoption behaviour.

The effect of strongly positive environmental attitudes on sustainable practice adoption tends to be influential when there are no strong external incentives or disincentives for undertaking the practice. Positive environmental attitudes have little effect on behaviour when external incentives are strongly positive or negative. Promoting sustainable practices with characteristics that encourage more rapid adoption will be more effective than depending on pro-environmental values of landholders.

**Future structural and social changes in agriculture will influence the capacity of landholders to change to more sustainable land use practices.**

The impacts of recent and likely future structural and social changes in agriculture will have a significant effect on the capacity of landholders to improve the sustainability of land use. For a large number of uneconomic small farming enterprises, concentrated close to the seaboard, in the hill country and surrounding major provincial centres, increasing productivity through increasing scale is not an available option. Accordingly the adoption of sustainable practices is likely to be constrained in these regions.

In regions dominated by small farms the consolidation path to productivity increase is often blocked by high amenity-based land values. Changes in agricultural structure, if continued, will lead to some regions remaining clearly agricultural in their character and others moving towards emphasis on amenity agriculture where productivity does not determine land use decision making.

**Increased R&D effort needs to identify and develop locally applicable sustainable practices.**

Increased effort is needed to identify and develop locally applicable sustainable practices and to resist the temptation to promote them beyond localities where their advantage has been established.

Research and development of on-farm sustainable practices must identify practices which have characteristics that are attractive for adoption and have relatively immediate positive consequences rather than less immediate, diffused, or short-term negative consequences. Practices that have outcomes that are 'soon' and 'certain' will have the most powerful drivers for rapid adoption.

# 1 | INTRODUCTION

The idea that there is a key to the adoption of sustainable practices is somewhat simplistic and unidimensional. It is implied in assertions such as 'We just need to convince landholders to change their management practices'. The assumption is, if sustainable outcomes are to be achieved and appropriate sustainable practices are available, an understanding of human motivation will provide the touchstone to unlock human capacity to change. In fact, land managers differ significantly in different localities in Australia and, for many localities, there are few appropriate sustainable practices that meet criteria that would lead to ready adoption.

Many of the desired outcomes of sustainable natural resource management (NRM) programs do not come about autonomously. NRM programs present a policy challenge because of the range of constraints that discourage individual uptake of NRM practices. Constraints to change in NRM systems can be assessed from the perspectives of individual landholders, the characteristics of desirable management practices, the socioeconomic structure of catchment communities and the broader institutional settings.

A significant issue is that economic costs to a landholder of at least some NRM practices (particularly those which provide benefits desired by the wider community) may exceed the on-farm benefits on a short or long-term basis. The lack of immediate financial incentive in a dynamic farm economy may result in many landholders not adopting these practices.

Identification of the social and economic factors that constrain the participation of individual land managers recognises that the significant decisions about land and farm management are made by 'individual farmers, not by catchment groups or regional river management bodies' (Pannell 2001a). Understanding some, if not all, of the factors that determine individual landholder decisions will ensure more realistic and more effective catchment and regional plans.

Concern about land degradation problems amongst the Australian public and amongst rural landholders is now well established. Most landholders now recognise the existence of significant degradation problems. In most areas of Australia some form of 'landcare' related work (including the control of animal pests and weeds, fencing for environmental protection, tree and shrub establishment, and setting aside conservation areas) is undertaken on more than a third of farms (Cary, Barr, Aslin, Webb & Kelson 2001). However policies to improve the management of degrading land will require significant land use change and very significant change to more sustainable management practices within given land uses. Understanding landholders' capacity to change to sustainable practices, recognising barriers to such change and identifying policies which will encourage such change are the focus of this report.

## B A C K G R O U N D

In 2000 the Bureau of Rural Sciences (BRS) completed a review of factors influential in determining individual NRM decisions (Barr & Cary 2000). That review established a number of important findings:

- Encouraging the adoption of more sustainable practices by appealing to farmers' stewardship ethic or altruism will have only limited impact. Factors like the relative financial benefit or cost of the NRM practice, farm financial capacity, farmer skills and motivation are the necessary determinants of whether sustainable management practices are likely to be adopted.
- Policies aimed at changing motivation in the absence of meeting the other enabling conditions will achieve little.
- Landholders' responses to messages about future threats of land degradation are likely to be limited.
- Australian research regarding how landholders perceive their environment and the threat of land degradation shows landholders generally underestimate the land degradation problems on their own farm.

In 2001 the BRS developed a Social Atlas for the National Land and Water Resources Audit which provided an integrated social and economic database system for sustainable management. Two reports were produced from this work: *The social atlas for sustainable management* (Cary, Kelson & Aslin 2001) and *Human and social aspects of capacity to change to sustainable management practices* (Cary, Barr, Aslin, Webb & Kelson 2001). These and other commissioned reports have been integrated by the National Land and Water Resources Audit to produce *The Australian Natural Resources Atlas* ([www.environment.gov.au/atlas](http://www.environment.gov.au/atlas)) and *The Australian Natural Resources Data Library* ([adl.brs.gov.au](http://adl.brs.gov.au)).

In a separate consultancy commissioned by Land & Water Australia, some further ideas on the adoption of sustainable management practices were developed and published in the report *The adoption of sustainable practices: Some new insights* (Cary, Webb & Barr 2001). This present publication distils and consolidates the findings of these studies.

## 2 | S U S T A I N A B L E P R A C T I C E S

Sustainable land management practices are defined here as those which ameliorate unsustainable land use by rectifying biophysical constraints to agricultural production and which conserve the resource base (SCARM 1998). The following list of sustainable management practices has been developed from SCARM (1998), Hamblin (1999), SCA (1991), management practice indicators for State of the Environment Reporting (Saunders, Margules & Hill 1998) and other sources. It should be recognised that this is an incomplete list of sustainable management practices. Many of these practices were identified in the National Collaborative Project on Indicators for Sustainable Agriculture based on then available ABS and ABARE statistics.

### **ALL AGRICULTURAL AND PASTORAL PROPERTIES**

- maintenance of soil cover
- establishing and monitoring ground cover targets—monitoring of pasture and vegetation condition
- nutrient balance accounting (soil and plant sampling)
- soil and plant tissue tests to determine fertiliser needs
- regular soil testing
- fertilising of pastures
- agricultural lands treated with gypsum
- agricultural lands treated with lime
- regularly monitor water tables
- use of deep-rooted perennial pastures
- non-commercial tree and shrub planting
- commercial tree and shrub planting (farm forestry)
- preserve or enhance areas of conservation value
- retention of vegetation along drainage lines
- protection of land from stock by fencing—exclude stock from degraded areas
- protection of waterways from stock by fencing
- animal pest or weed control to control land degradation
- pest and disease control in pastures
- use of integrated pest management (reducing pesticide use)
- slashing and burning of pastures

#### **CROPPING FARMS**

- use of reduced or zero tillage—minimum tillage
- stubble or pasture retention in ploughing—direct drilling
- use of crop or pasture legumes in rotations
- use of contour banks in cropland
- strip cropping
- adjusting crop sequences in response to seasonal conditions

#### **IRRIGATION FARMS**

- irrigation scheduling
- laser graded layout
- storage and reuse of drainage water
- automated irrigation

#### **RANGELANDS**

- control grazing pressure by excluding access to water
- control of water flow from bores
- piped water supplies for stock
- pastoral land stocked at recommended rates
- degraded pastoral land converted to less damaging use
- pastoral land destocked in low feed conditions

#### **DAIRY FARMS**

- use of effluent disposal systems—collection of dairy effluent (ponds or drainage sump)
- pump dairy shed effluent onto pasture

Many of these farming practices are specific to particular environments or to particular farming systems.

Not all the NRM practices listed above will, in isolation, lead to sustainable resource management (for example, fertilising of pastures). What might be sustainable on a farm might be unsustainable for rivers, etc. Hence, the practices which effectively contribute to sustainability will depend on the context and the locality of their use. If one farmer adopts a 'sustainable' practice, it could be totally ineffective if neighbouring landholders do not adopt complementary practices.

## SUSTAINABLE RESOURCE MANAGEMENT OUTCOMES

The use of the sustainable practices listed above are contended to lead to more sustainable resource management. The association is often constrained—it is likely to vary for different localities. Moreover, it may be a long time before a practice achieves a more sustainable outcome. Broader conceptions of sustainable management embrace the need for strategies for sustaining both food security and the need to conserve natural resources.

Definitions of sustainable resource management in agriculture are generally concerned with the need for agricultural practices to be economically viable, to meet human needs for food, to be environmentally benign or positive, and to be concerned with quality of life. Since these objectives can be achieved in a number of different ways, sustainable resource management is unlikely to be linked to any particular management practice. Rather, sustainable agriculture is thought of in terms of its adaptability and flexibility over time to respond to the demands for food and fibre, its demands on natural resources for production, and its ability to protect the soil, water and other natural resources. This goal requires an efficient use of technology in a manner conducive to sustainability (Wilson & Tyrchniewicz 1995). Because agriculture is affected by changes in markets and resource decisions in other sectors and regions, such changes often provide additional pressures leading to depletion of local agricultural resource bases.

Assessments of the sustainability of a production system involve looking forward to a future that is often not universally agreed. It is often easier to look backward, and assess the progress of production systems as they evolve from unsustainable states. The process is further complicated because a sustainable state of resource management is not a fixed or ideal steady state, but rather an evolutionary process of attempting to improve the management of systems, through improved understanding and knowledge. The process is not deterministic as the end point is not known in advance (Wilkinson & Cary forthcoming).

Sustainable resource management is often an abstract state—which occurs in the future and may be hard to identify or measure. Sustainable practices (which are contended to lead to sustainable states or outcomes) are used as ‘indicators’ or proxies for sustainable management.

## OPTIONS FOR RESPONDING TO ENVIRONMENTAL PROBLEMS

Individuals, communities and governments have four options for responding to environmental problems (Edwards & Byron 2001).

- *Do nothing.* This may be a logical approach to a lack of current information about how to solve a problem or a lack of viable options for a solution. This option is also likely to be a rational approach if, given existing knowledge and technologies, the costs of taking action now are likely to be greater than the expected social benefits (Pannell 2001b).
- *Tackle the problem.* Here there should be an assumption of a net benefit to society as a consequence of any action taken. For many land degradation problems the action may simply slow an unfavourable trend. Reversing the trends of many land degradation problems is likely to take in excess of 50 years.
- *Adapt to the problem.* This can involve a range of approaches including growing more tolerant species, and withdrawing land and other resources from agricultural production (Edwards & Byron 2001).
- *Add to knowledge.* This option may be achieved by research which contributes to reducing the problem, adapting to the problem, or both. Knowledge may be gained by both formal research and by ‘local’ research through the observation and creativeness of land managers.

The four options are not mutually exclusive. At the one time, for different land degradations and for different localities, different mixes of the options will be appropriate.

It is important to remember that 'the cost of land degradation' is not the ultimate determinant of management and policy decisions. The more relevant issue is the assessment of the net social benefit of any resource protection. 'The costs of salinity are (often) radically different from the net benefits of salinity management because salinity treatments are (a) only partly effective, (b) slow to take effect and (c) expensive' (Pannell 2001c, p.40).

There is a great diversity in the resource management situations existing in Australia. A useful way of characterising resource management practices is to assess them in terms of their environmental sustainability and their economic viability (Figure 1).

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 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 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 and because of changing commodity prices.

This discussion highlights the costs to a landholder of many conservation or resource management practices that 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, may become more important in influencing the use of conservation practices (Cary & Wilkinson 1997).

**FIGURE 1** | A sustainability matrix for resource management regimes confronting individuals

	ECONOMICALLY SUSTAINABLE	ECONOMICALLY UNSUSTAINABLE
ENVIRONMENTALLY SUSTAINABLE	<p><b>A</b></p> <p>Examples: planting small shelter belts; conservation cropping.</p>	<p><b>C</b></p> <p>Examples: pastoral properties producing medium and coarser wool in 1990s.</p>
ENVIRONMENTALLY UNSUSTAINABLE	<p><b>B</b></p> <p>Examples: high chemical use close to waterways; enterprises with effluent run-off to waterways or aquifers.</p>	<p><b>D</b></p> <p>Examples: some practices in the rangelands, irrigation practices in some salinised areas.</p>

### 3 | UNDERSTANDING HUMAN DECISIONS ABOUT ADOPTION OF SUSTAINABLE PRACTICES

It is useful to first identify and understand the different theoretical perspectives that underlie behavioural scientists' understanding of the adoption of sustainable practices. Here we consider three approaches to understanding, or to seeking to influence, human decisions about adoption behaviour.<sup>1</sup>

- diffusion and adoption theory
- adult education
- environment-based extension.

#### D I F F U S I O N   A N D   A D O P T I O N   A P P R O A C H E S

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 has not 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 in 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) adoption 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 publication. The different

<sup>1</sup> This discussion is drawn from Barr and Cary (2000).

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 them. This paradigm gave rise to two major research trends. One was the study of 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 use 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 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 (see Dunn 1997). Philosophical objections to the assumptions of universalism and a single rational course of action 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 in 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 EXTENSION AND 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 (typically 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 and Lawrence (1994) have 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.*

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. Fisher (1995) raises the question of how compatible farmer goals are with those of the perceived national environmental interest.

The potential for goal conflict in environmental extension should be 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 higher than concerns over resource issues (Barr & Cary 1984; Ralph 1972). It is probably inevitable that, at times, a conflict of interest will arise when 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. In such situations environmental extension will reflect the technology-transfer paradigm rather than the adult education or 'helping profession' paradigm.

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.

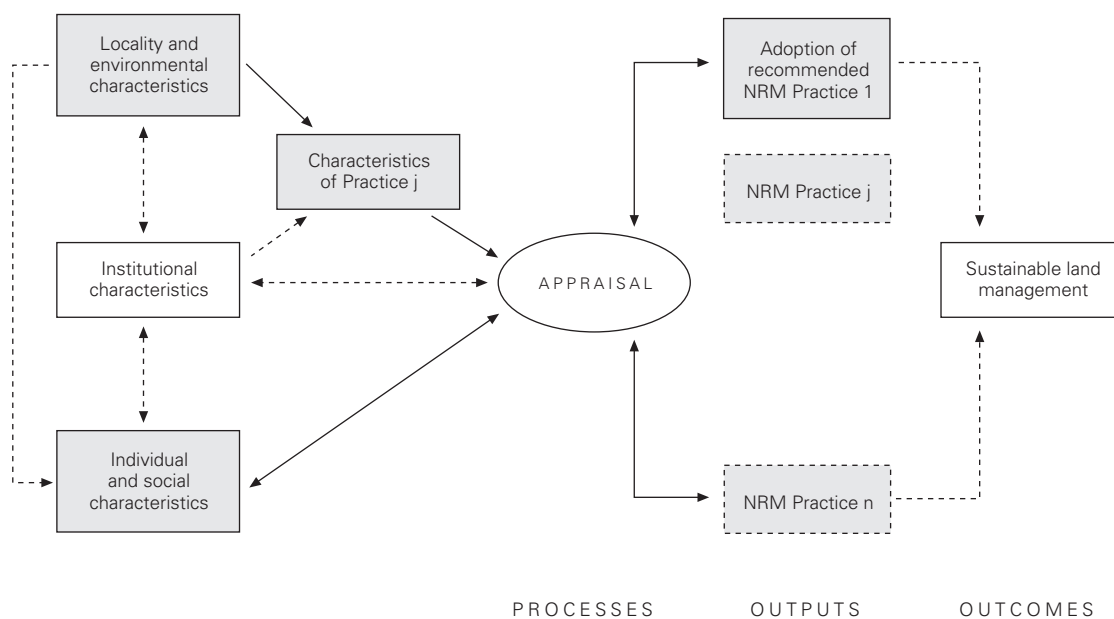
## THE APPRAISAL OF SUSTAINABLE MANAGEMENT PRACTICES

In this section we seek to identify the important groups of factors which might influence a landholder's assessment of practices that are asserted to be sustainable. The relationships between these groups of factors provides a conceptual model that helps to understand the influence of these factors on landholder behaviour and to understand landholders' response (or lack of response) to land degradation.

Figure 2 shows groups of factors that may be important in influencing a landholder’s appraisal of sustainable land management and of potential sustainable practices. Figure 2 is developed from a model by Fenton, Macgregor and Cary (2000). Central to the model presented in Figure 2 is the appraisal process undertaken by an individual landholder. The appraisal process itself is a summation of many underlying psychological processes relating to environmental perception, perceived self-interest, and the complexities of human decision making. Appraisal often involves a complicated psychological calculus by an individual to arrive at a decision. Appraisal has the elements of a ‘black box’—it may be objectively difficult to know the relative influence of the factors that may determine an adoption or non-adoption decision. Social factors, such as land manager attitudes and beliefs about specific NRM practices and about broader natural resource management, will influence adoption of specific practices. Appraisal will also be influenced by land manager attitudes towards those organisations and institutions that may be promoting sustainable land management practices.

The characteristics of locality and environment, and the characteristics of specific practices, which are both extremely significant in landholder appraisal of NRM practices, are specifically identified and will be considered in later discussion. Institutional characteristics incorporate the more formal structures that determine the ‘social’ environment in which landholders decide or anticipate decisions regarding adoption of sustainable practices. Institutional characteristics incorporate the regulatory environment, government agency support structures, and government policy reflected in incentive schemes and taxation arrangements. Individual and social characteristics include many factors such as age and education and cognitive factors that are largely instilled and maintained through social processes. Individual and social characteristics include the personal, family and demographic characteristics and the economic and farm circumstances of a landholder. Some of the key individual and social characteristics influencing capacity to change sustainable practices (and appraisal) will be presented in a subsequent section.

**FIGURE 2** | Model of appraisal of sustainable land management and of potential sustainable practices



The model emphasises that adoption of sustainable NRM practices is not unidimensional, but consists of a potentially wide range of practices that are dependent upon appraisals by landholders. These appraisals are mediated by environmental, institutional, individual and social factors prior to any implementation. Differences in appraisal are determined by a range of individual, institutional and contextual variables and by complex interactions amongst these variables. To date there is limited understanding or research on the appraisal component and the assessment of, or adoption of, sustainable land management practices.

#### **HUMAN APPRAISAL AS AN ADAPTIVE SYSTEM**

The appraisal process also involves the assessment of (or conjectures regarding) the outcome of sustainable land management. In turn appraisal involves judgments as to whether various currently recommended NRM practices will contribute to sustainable management (Figure 2). Conjecture is likely to be involved because there is uncertainty as to whether a recommended practice will, in the longer term, produce a sustainable outcome.

Adaptation is the process by which an organism fits itself to its environment. Complex adaptive systems are systems comprised of interacting agents who change their 'rules of behaviour' as their experience accumulates (Holland 1995). In a complex adaptive system a major part of the environment of any given adaptive agent (in this case landholders) consists not only of the biophysical environment but also of other adaptive agents including institutions. The focus of an adaptive system is on responding to the unpredictable and upon improvement rather than optimisation.

Figure 2 is an example of an adaptive behavioural system which has been kept as simple as possible. Solid lines indicate more certain associations; broken lines indicate associations about which less is likely to be known, or where the association may be problematic or intermittent. Single arrows indicate a likely one-way or recursive relationship; double arrows indicate a likely interacting relationship involving learning or adaptation.

There are important feedback loops between appraisal and the adoption of given sustainable practices. Landholders assess such practices for potential adoption and any adoption of a practice either by the landholder or by others whose experience can be observed by the landholder will influence how the appraising landholder subsequently views (appraises) the adoption of that practice and related practices. More importantly, there are few feedback loops between ultimate states of sustainable land management and NRM practices because there are usually long time lags from the implementation of an NRM practice to the outcome of a 'sustainable state'. Thus landholders cannot be readily assured by reasonable feedback from their own observations that a practice produces a desired ultimate outcome.

Understanding some, if not all, of the factors that influence individual landholder appraisals will ensure more realistic and more effective resource management planning. In the next section we consider the characteristics of sustainable management practices which influence their adoption by landholders.

## 4 | UNDERSTANDING THE NATURE OF SUSTAINABLE PRACTICES

*Sustainable practices have not been tried and found wanting, rather many have been found difficult and not tried. (apologies to G.K. Chesterton)*

A key component in understanding the capacity of landholders to change to more sustainable management practices is to understand how the characteristics of such practices influence their appraisal by landholders.

### THE ATTRIBUTES OF SUSTAINABLE AGRICULTURAL PRACTICES

Rogers has summarised the results of the many adoption and diffusion studies conducted in the 1950s, 60s and 70s (Rogers 1962; Rogers & Shoemaker 1971; Rogers 1983). The general conclusions 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 was highlighted in a major review of innovation adoption in Australian agriculture by Guerin and Guerin (1994). Important attributes influencing the rate of adoption of NRM practices are the relative advantage, the complexity, the compatibility, the trialability and the observability of a given practice (see Barr & Cary 2000). These attributes together with two other attributes—locality differentials in relative advantage and risk characteristics of a practice—are considered below.

#### RELATIVE ADVANTAGE

Relative advantage is normally interpreted in terms of financial advantage to the farm business or the adopter. The perceived financial advantages of environmental innovations (where they exist) have consistently been shown to be one of the best indicators of their subsequent adoption. There is little evidence to suggest that sustainable practices are any different from other agricultural practices in this respect. The nature of limited interaction of pro-environmental attitudes or stewardship values overriding, or compensating for, deficiencies in relative financial advantage of an NRM practice will be developed later.

In a review of the history of environmental innovations on Australian farms, Barr and Cary (1992) concluded that the clear lesson was that environmental innovations that were believed to be profitable were usually readily adopted. Innovations with a net financial cost were rarely adopted. The most studied adoption of an environmental innovation is the progress of conservation cropping on the US corn belt. In a review of Ohio research Carboni and Napier (1993) concluded economic factors were the greatest predictors of adoption.

### **LOCALITY DIFFERENTIALS IN RELATIVE ADVANTAGE**

Frequently it is assumed 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 commonsense assumption, the early work of Griliches (1957, 1960) on the diffusion of the productive innovation of hybrid corn is clearly indicative. 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).

It is dangerous to assume that a practice with advantages in one location will yield the same advantages elsewhere. Given Australia's diverse environment few sustainable practices have universal applicability. The important conclusion for the adoption of NRM practices is that the appropriateness and relative advantage of given NRM practices will vary in geographic space to a very large extent.

### **RISK**

The motivation of human behaviour is more complex than being simply profit driven. While there is much research demonstrating relationships between beliefs about profitability and adoption behaviour this is mediated by a great variation in attitudes towards business profit and a consideration of the risks that characterise much Australian agriculture. 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). Different attitudes to income needs, risk perception, dynastic expectations and cultural expectations of farming mean there are quite distinct groups of farmers. Many farms trade off profit maximisation for risk reduction (Howden et al. 1997; Marks & O'Keefe 1996; Reeve & Black 1993). For many farm operators relative advantage may be strongly moderated by minimisation of complexity and minimisation of risk. As a consequence the differing risk implications of different sustainable practices will be an important consideration in their adoption.

### **COMPLEXITY**

Sometimes innovations which appear simple 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 that is constrained by the management complexity of its practice. Farmers often explain non-adoption of integrated pest management 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.

### **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. There are usually two 'systems' against which the compatibility of a practice will be judged—the current system of farming on a given property and the social system



embracing a farming community or broader 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 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 subterranean 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 often been incompatible with the values of this cultural group.

For many broadacre farmers beliefs about 'good farming' tend to encompass matters such as tidiness, having fences and gates well maintained and having good looking crops or stock (Nassauer 1995). Profitability and sustainable farming practices are less commonly seen as being indicative of good farming (Dunn, Gray & Phillips 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**

Innovations which can be trialled on a small scale prior to full implementation are more likely to be adopted. Trialling 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 trialling without significant investment in machinery. In contrast, dryland salinity control is clearly not amenable to trialling. 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**

NRM practices whose advantages are observable are more likely to be adopted. Traditionally, a new variety or crop is often quite visible to passing observers and this visibility has been used to advantage. Irrigation watertable control is not normally an observable achievement. The development of well flags (to indicate water levels) as part of watertable watch was an innovative method of making watertable levels visible to the passing observer. Many Landcare programs have attempted to locate demonstrations along major roads to enhance visibility.

## CATEGORISING SUSTAINABLE AGRICULTURAL PRACTICES

An inventory of recommended NRM practices is presented below (Table 1). The management practices in this inventory are categorised in terms of attributes that have been found to be important in determining whether management practices are readily adopted or not. Such an approach provides a method for assessing likely adoptability in given farm situations and provides a conceptualisation and categorisation of relevant NRM practices. The appropriateness and relative advantage of given NRM practices will vary in geographic space to a very large extent.

In Table 1 the sustainable practices listed are scored on their level of possession of the following attributes:

- Geographic applicability—refers to relative appropriateness of a practice, in terms of whether it is effective or adapted to only specific localities or, more universally, across many localities.
- Relative Advantage—the financial advantage or other convenience or personal advantage to the farm business or the adopter.
- Risk—refers to uncertainty about likely benefits or costs associated with a sustainable practice, the effectiveness of the practice, when the benefits might be realised and the social acceptability of the practice.
- Complexity—implies that a practice comprises more than one or two simple elements and that its elements interact with each other and, in sometimes complicated ways, with elements of the farming system into which it is to be incorporated.
- Compatibility—the extent to which a practice fits in with existing farm practices, or with existing knowledge or existing social practice.
- Trialability—where practices can be implemented on a small or pilot scale decisions can be more easily made about the value of a new practice without the risks associated with full implementation.
- Observability—practices whose impact or advantage is easily observable or whose outcome is quickly realised are more likely to be adopted.

**TABLE 1** Characteristics of sustainable practices

Sustainable practice <i>(Ideal rating)</i>	Geographic applicability <i>(Hi)</i>	Relative advantage <i>(Hi)</i>	Risk <i>(Lo)</i>	Complexity <i>(Lo)</i>	Compatibility <i>(Hi)</i>	Trialability <i>(Hi)</i>	Observability <i>(Hi)</i>
<b>ALL AGRICULTURAL AND PASTORAL PROPERTIES</b>							
Maintenance of soil cover	Hi	Hi (temporal)	Lo	M-Hi (locality)	M	M	M-Lo
Establishing and monitoring ground cover targets (monitoring of pasture and vegetation condition) <sup>a</sup>	Hi	M	Lo	M-Hi	M	M	M-Lo
Nutrient balance accounting (soil and plant sampling)	Lo	Lo	Lo	Hi	M	Lo	Lo
Soil and plant tissue tests to determine fertiliser needs <sup>a</sup>	Lo	Lo	Lo	Hi	M	Lo	Lo
Regular soil testing	M	M	Lo	Lo	M	Lo	Lo
Fertilising of pastures	M	Hi-M (locality)	M	Lo	Hi	Hi	Hi-M
Agricultural lands treated with gypsum	M	Lo	M-Hi	Lo	Hi	M	M
Agricultural lands treated with lime	M	Lo	M-Hi	Lo	Hi	M	M
Regularly monitor watertables <sup>a</sup>	M	M (locality)	Lo	Lo	Lo	Hi	M
Use of deep-rooted perennial pastures <sup>a</sup>	Hi	M	M-Hi	M-Hi	M (locality)	M	Lo
Non-commercial tree and shrub planting <sup>a</sup>	M-Hi	Lo	Lo	Lo	M-Hi	Hi	Hi
Commercial tree and shrub planting (farm forestry) <sup>a</sup>	Lo	Lo (locality)	Hi	M	Lo	Lo	Hi
Preserve, enhance areas of conservation value <sup>a</sup>	M	Lo	Lo	M	Lo	M	M-Hi
Retention of vegetation along drainage lines <sup>a</sup>	M	Lo	Lo	M	M-Lo	M	M-Hi
Protection of land from stock by fencing (exclude stock from degraded areas) <sup>a</sup>	Lo	Lo	Lo	M	M	Hi	Hi
Protection of waterways from stock by fencing <sup>a</sup>	Lo	Lo	M-Hi	Lo	M	Hi	Hi
Animal pest or weed control to control land degradation <sup>a</sup>	Hi	M	M	M	M-Hi	M	M
Pest and disease control in pastures	M	M-Hi (locality)	M	M	M-Hi	M-Lo	M
Use of integrated pest management (reducing pesticide use)	Lo	M-Lo	M-Hi	Hi	M	M-Lo	M-Lo
Slashing and burning of pastures	Lo	M-Lo	M	Lo	M	Hi-M	Hi
<b>CROPPING FARMS</b>							
Use of reduced or zero tillage (minimum tillage) <sup>a</sup>	Hi	M	M	M	M-Hi	Hi	M
Stubble or pasture retention in ploughing (direct drilling) <sup>a</sup>	M	M	M-Hi	M-Hi	M	Hi-M	M
Use of crop or pasture legumes in rotations <sup>a</sup>	Hi	M-Hi	M-Lo	M-Lo	M-Hi	M	M-Lo
Use of contour banks in cropland <sup>a</sup>	M	M-Lo	M-Lo	M-Hi	M-Lo	M-Lo	M-Hi
Strip cropping <sup>a</sup>	M						
Adjusting crop sequences in response to seasonal conditions	Hi	M-Hi	M	M	M-Lo	M-Lo	Lo
<b>IRRIGATION FARMS</b>							
Irrigation scheduling <sup>a</sup>	M	M	Lo	M-Hi	M-Lo	M-Lo	Lo
Laser graded layout <sup>a</sup>	Hi	M-Hi	Lo-M	M	M-Lo	M	Hi
Storage and reuse of drainage water <sup>a</sup>	M	M-Hi	M	M	M	M-Lo	M
Automated irrigation <sup>a</sup>	M	M-Lo	M-Hi	Hi	M-Lo	Lo	Hi
<b>RANGELANDS</b>							
Control grazing pressure by excluding access to water <sup>a</sup>	M	M	Lo	M-Hi	M	M-Lo	M-Hi
Control of water flow from bores <sup>a</sup>	Hi	M-Lo	Lo	Lo	Hi	Hi	Hi
Piped water supplies for stock <sup>a</sup>	Hi	M-Lo	M	Lo	Hi	M	Hi
Pastoral land stocked at recommended rates	Hi	M	M	M	Hi	M-Lo	M-Hi
Degraded pastoral land converted to less damaging use	M	Lo	Lo	M	M	M-Lo	M
Pastoral land destocked in low feed conditions	Hi	M-Hi	M-Hi	Hi-M	Hi	M-Lo	M
<b>DAIRY FARMS</b>							
Use of effluent disposal systems (collection of effluent; ponds or drainage sump) <sup>a</sup>	Hi	M-Lo	M	M	M	M	Hi
Pump dairy shed effluent onto pasture <sup>a</sup>	M	M-Lo	Lo	Lo	M	Hi	Hi

<sup>a</sup> Some measure of the level of landholder adoption of the practice available from the ABARE Australian Resource Management Supplementary survey.

(Comments in brackets refer to locality or temporal constraints on expression of attribute.)

Hi = High M = Medium Lo = Low

### **OBSERVATIONS ON THE CHARACTERISTICS OF SUSTAINABLE PRACTICES**

The following features and conclusions regarding sustainable practices and their attributes can be identified:

- There is no one sustainable practice which optimally comprises all the attributes by being widely applicable, having high relative advantage to the landholder, low complexity, high compatibility, high trialability and observability, and low risk.
- Very few sustainable practices have widespread or universal geographic applicability. As a consequence, the identification, development and promotion of relevant sustainable practices needs to be locality or catchment specific.
- The sustainable practices with wider geographic applicability (such as deep-rooted perennials) often provide only moderate relative advantage to the landholder. The relative advantage will be different in different localities.
- The level of relative advantage is rarely independent of commodity prices. The relative advantage of many sustainable practices (such as deep-rooted perennials) will be temporally dependent on the value of rural commodities produced as a result of using the practice. Low commodity prices in the broadacre industries have reduced the relative advantage of many sustainable practices.
- The relative advantage and risk attributes are the least mutable in terms of feasible policy interventions. Where relative advantage is low and risk is high, attempts to achieve wide-scale adoption will require large levels of external subsidy or insurance intervention. It will be more feasible to promote those sustainable practices which have higher relative advantage (and preferably lower risk) and to use policy interventions (such as extension and education programs) to overcome or ameliorate complexity and low compatibility and observability.

The two most significant features of the appraisal of sustainable practices are the often low profitability of such practices and the lack of information and associated uncertainty in assessing the worth of such practices in a particular locality. Local information and knowledge needed for tackling land and water degradation is often deficient. It is often abstract and catchment-based rather than based on concrete local empirical information at the farm level. End of catchment discharge indicators of soil and river salinisation may be known but local impacts within catchment recharge and discharge areas are generally inadequately identified. In situations where externalities exist and individuals are unlikely to capture sufficient benefits to act optimally, the externalities are likely to be complex with the knowledge of external benefits and private costs rudimentary. Even for the apparently straightforward task of evaluating the use of perennial plants to control groundwater levels in regions at risk of dryland salinisation, Mara, Pannell and Abadi Ghadim (2001) identified a wide range of 'information' difficulties facing landholders. They identified that observability of treatment impacts on groundwater levels is low and observations are costly; there are long time lags between treatment and effect; and, in a common property groundwater problem, the effectiveness of a local trial by an individual farmer may be compromised by non-trialling neighbours.

## 5 INDIVIDUAL, SOCIAL AND RESOURCE CHARACTERISTICS AND CAPACITY FOR CHANGE

Landholders vary in their capacity to change management practices. Many socioeconomic factors have been discussed by different authors as being relevant to landholders' and farm families' ability and willingness to change to more sustainable land management practices. There have been a number of major reviews and studies that have explored the social and other aspects of adoption of more sustainable management practices in Australian agriculture (e.g. Barr & Cary 2000; Fenton, MacGregor & Cary 2000; Guerin & Guerin 1994; Reeve & Black 1993). Two of the most recent studies—in the Goulburn Broken catchment of Victoria (Curtis et al. 2000) and a national benchmarking study (Solutions Marketing and Research 1999)—were reviewed in some detail in Cary, Webb and Barr (2001).

In the review, *Human and social aspects of capacity to change to sustainable management practices* (Cary, Barr, Aslin, Webb & Kelson 2001), undertaken as part of the National Land and Water Resources Audit, nine groups of socioeconomic factors most commonly suggested to influence the adoption of sustainable management practices were evaluated. The findings from that research indicated there were few, if any, indicators that uniformly and reliably predicted which landholders were more likely or less likely to change land management practices. The factors or characteristics most commonly found to influence the adoption of sustainable management practices, and thus the potentially useful indicators of capacity to change to sustainable management practices, were:

- age
- occupational training or education
- level of farm income and farm business characteristics
- participation in landcare and property management planning
- farm size.

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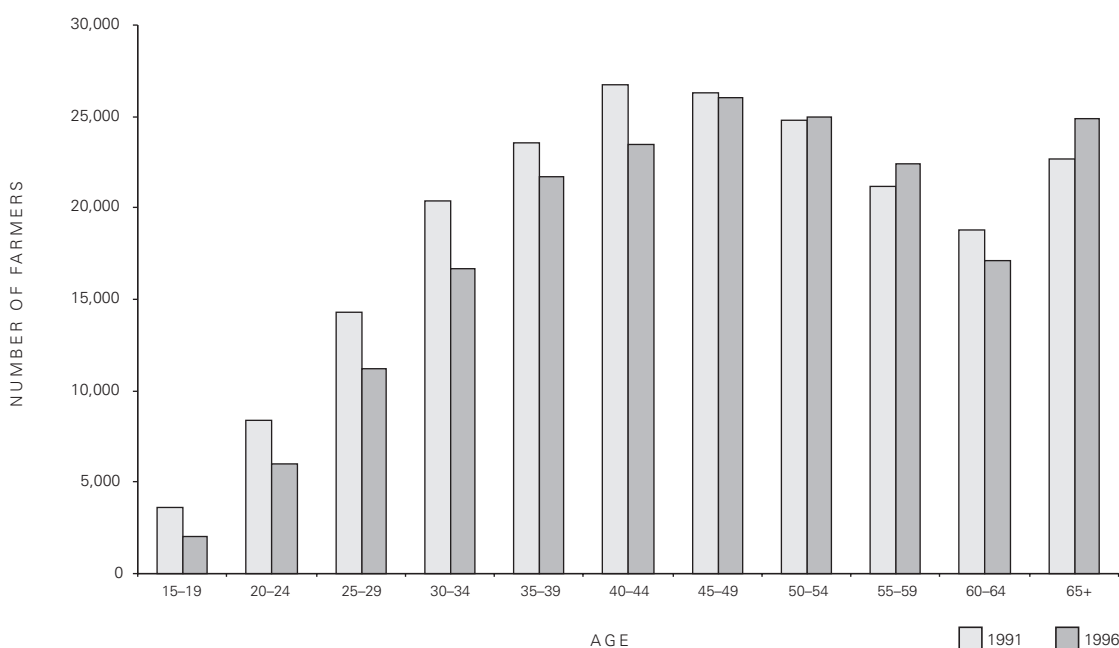
Age is an important social characteristic because it is an indicator of the structure of the agricultural workforce that is changing in Australia, and changing differentially in different localities. Relationships between age and the adoption of sustainable practices are unlikely to be linear, and may be confounded by other factors. At the community level, in localities with an increasingly aged farmer population implementation of sustainable practices is likely to be low. An ageing rural population, linked with increasing out-migration from rural areas (Haberhorn et al. 1999), suggests a reduction in family farm succession, which in turn is likely to lead to a reduced willingness to make significant investments in sustainable practices (Curtis et al. 2000).

There is mixed evidence concerning the impact of age on adoption of sustainable practices at individual landholder level. Younger farmers tend to be more aware of land degradation on their farms. However, there appears to be no clear correlation between age and sustainable management practice adoption. Curtis et al. (2000) found no significant relationship between adoption and age. However, they found younger farmers were more likely to have prepared farm management plans and budgets. Solutions (1999) found no significant relationship between landholder age cohorts and scores on a composite NRM behaviour indicator. However, there were significant age effects for both tree planting and for action taken to treat erosion. For tree planting there was an increase in adoption as age increased to a maximum adoption rate in the 45–55 age group, and then a decrease for age cohorts beyond this. There was a similar pattern for action to treat erosion, with peak of adoption occurring in a younger cohort, the 35–44 age group, and declining as age increased.

Farmers' average or median ages have been increasing more rapidly than those of some other occupational groups, and slightly more rapidly than the metropolitan population. On the basis of census data, between 1991 and 1996 the median age of farmers increased from 46 to 48 years, whereas the median age of Australia's metropolitan population increased by one year (Haberkorn et al. 1999). Garnaut and Helali (1999) concluded that the average age of principal decision makers in broadacre agriculture rose from 49 to 52 years over the period 1981–82 to 1997–98.

The changing proportions of farmers of different ages in 1991 and 1996 can be seen in Figure 3. There has been a proportionally large decline in the 15–19 to 40–44 age groups and an increase in the older 55–59 to 65+ groups. This suggests a declining number of new entrants into farming or increased exits out farming by younger farmers. These changes are related to an Australian population drift towards the coast (ABARE 2000; Haberkorn et al. 1999), that is particularly pronounced among 15–24 year olds.

**FIGURE 3** | Number of farmers by age group in 1991 and 1996 (SOURCE: ABS)



There is considerable variation from area to area in the median age of farmers (Map 1). Based on ABS 1996 census data, the oldest farmers tend to be located towards the coastal regions, particularly in the south-east of the continent, but generally from central Queensland to the South Australia border. In these areas the median age of farmers was between 47 and 51 years and, in significant pockets in some higher rainfall grazing areas, greater than 52 years (Barr et al. 2000). With some exceptions in the pastoral zone, median age has tended to fall as one moves westward towards the South Australian and Northern Territory borders.

#### KEY POINTS

- The more intensively farmed regions of Australia contain the older farming population.
- There is mixed evidence about the impact of age on adoption of sustainable practices; any relationship between age and the adoption of sustainable practices is unlikely to be linear, and will often be confounded by other factors.

## EDUCATION AND OCCUPATIONAL TRAINING

Traditionally, Australia's farmers have tended to have lower levels of formal education than the Australian average. For example, in 1995, 32% of Australia's farmers had post-school qualifications whereas 49% of the Australian labour force as a whole had these qualifications (Synapse Consulting 1998). ABARE survey data from broadacre and dairy industry farmers show that, in 1994–95, 50% of farm owner-managers had completed 1–4 years of secondary school and 23% had completed 5–6 years (Garnaut & Lim-Applegate 1998). Observations about relatively low levels of formal education apply more to farming men than to their spouses or to farming women. The ABARE study found that an estimated 10% of owner-managers had completed a tertiary qualification in 1994–95 compared with 19% of their spouses, and that 42% of female owner-managers had completed a tertiary qualification (Garnaut & Lim-Applegate 1998). However, female owner-managers comprised only 3% of all owner-managers contacted in this ABARE study.

Educational levels are likely to be related to age, with younger farmers often having higher educational attainments than older ones. For example, the ABARE study found that almost two-thirds of owner-managers aged less than 40 years had completed at least five or six years of secondary schooling, but this percentage declined significantly in older age groups (Garnaut & Lim-Applegate 1998). Younger farmers were more likely to have participated in training activities (Mues, Chapman & Van Hilst 1998).

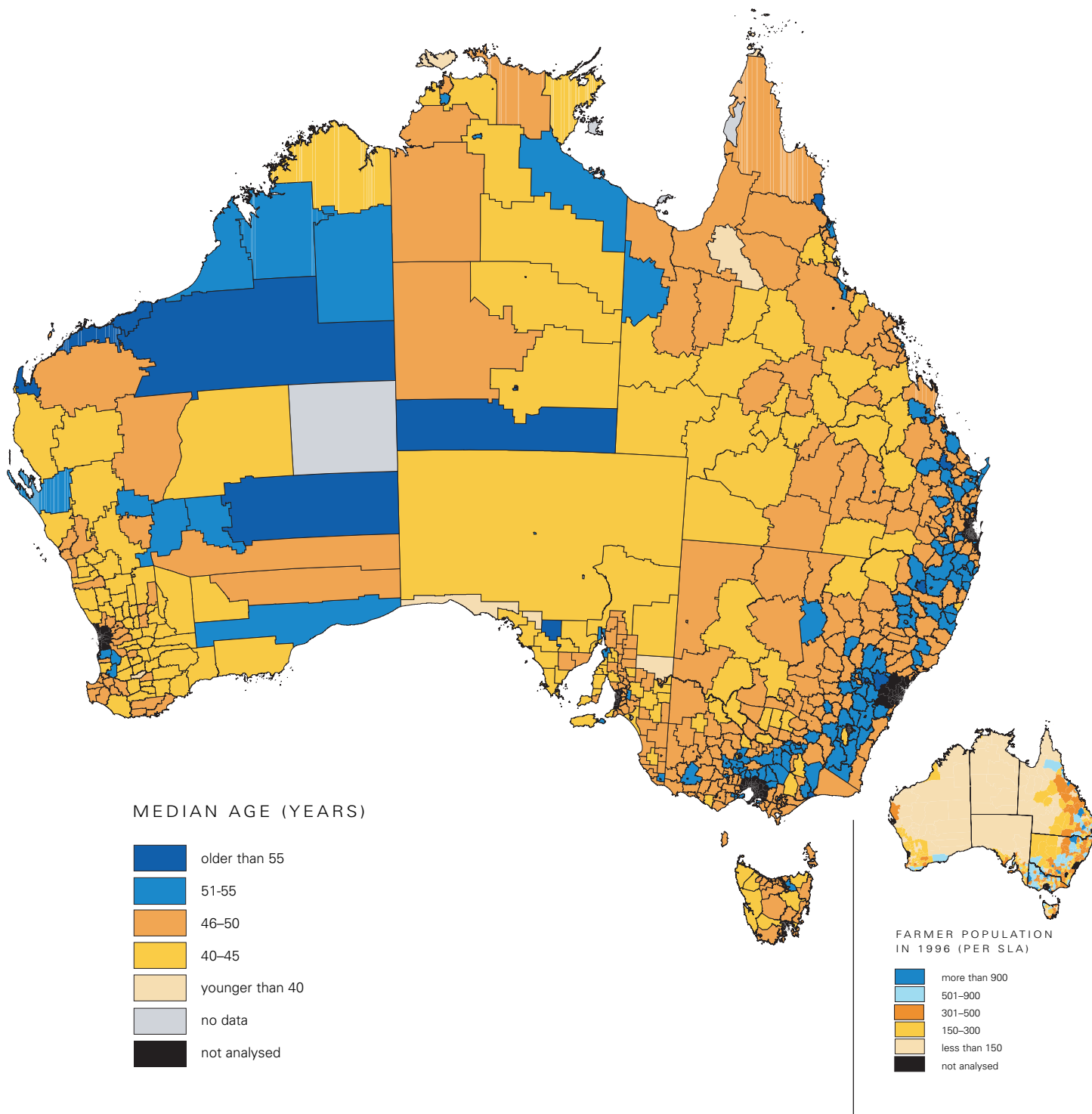
Educational levels are of particular interest because of an expected relationship between higher educational attainments and greater willingness to adopt new practices, or to seek further education or training as needed.

There is mixed evidence regarding the relationship between farmers' educational levels and their adoption of sustainable land management practices. In many Australian studies there are no direct relationships between adoption of best practices and the level of formal education.

Higher levels of formal education may be important in enabling members of farm families to obtain off-farm income to supplement farming returns, and hence enhance their financial capacity to adopt more sustainable practices. Garnaut et al. (1999), using data from ABARE 1996–97 farm surveys, found that farming women and men without post-school education were less likely than other farmers to have off-farm employment.

Using data from the ABS agricultural finance survey, Kilpatrick (1996) demonstrated that farm incomes tended to be higher in farm families where farmers reported greater participation in training activities. She also found that farm incomes were correlated with owner-managers'

**MAP 1** | Median age of farmers and farm managers, 1996

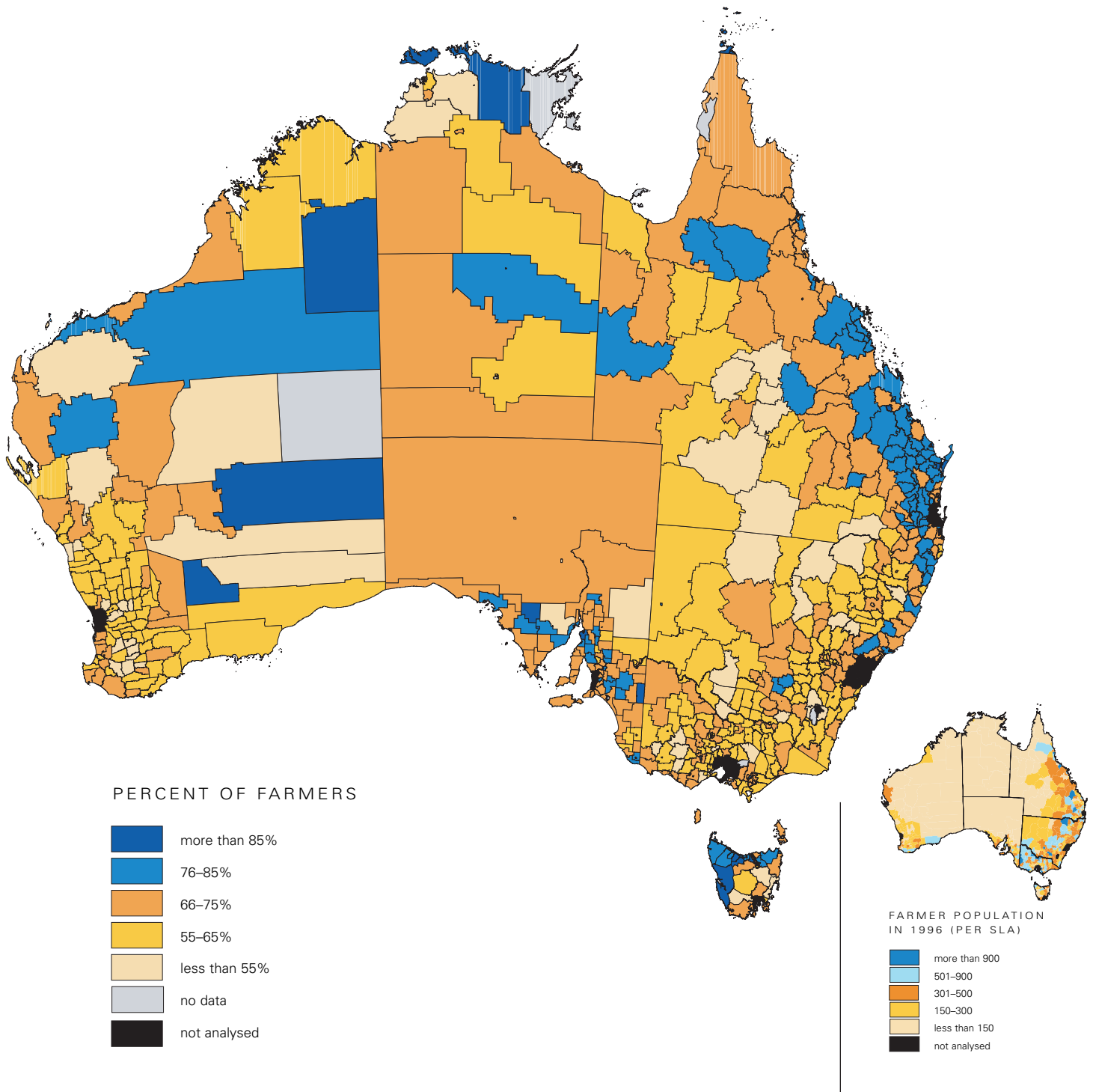


**DATA SOURCE:** Australian Bureau of Statistics. Population and Housing Census (1996)  
**SPATIAL UNITS:** Statistical Local Areas  
**PROJECTION:** Albers Equal-Area Conic  
**DATUM:** WGS84

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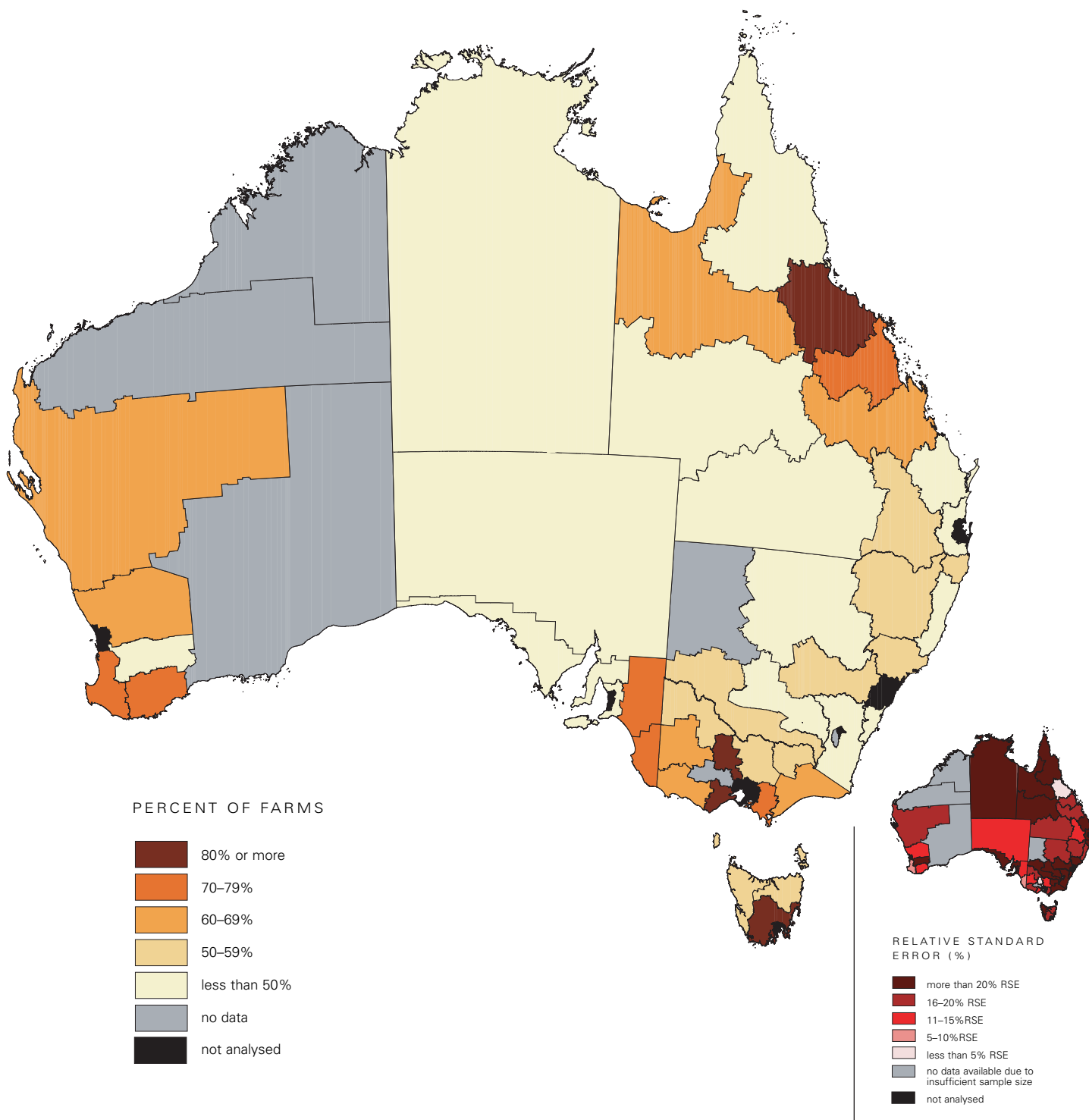
**MAP 2** | Farmers aged 14–16 years of age when they completed schooling



**DATA SOURCE:** Australian Bureau of Statistics. Population and Housing Census (1996)  
**SPATIAL UNITS:** Statistical Local Areas  
**PROJECTION:** Albers Equal-Area Conic  
**DATUM:** WGS84

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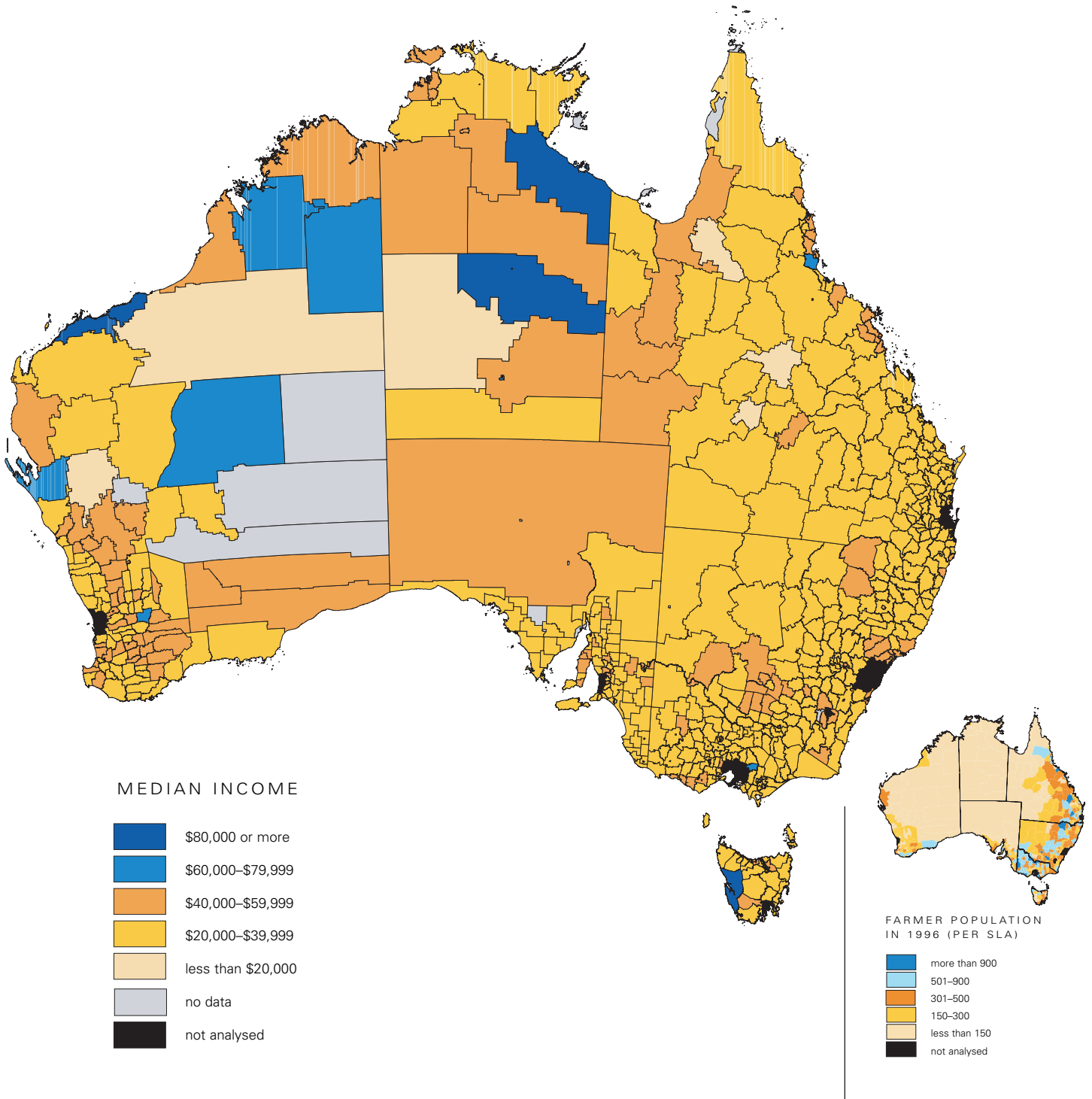
**MAP 3** | Participation in any course or training activity 1996–97 to 1998–99  
(three-year average)



**DATA SOURCE:** Australian Bureau of Agriculture and Resource Economics (ABARE) Farm survey data, 1996–97 to 1998–99.  
**SPATIAL UNITS:** Statistical Divisions  
**PROJECTION:** Albers Equal-Area Conic  
**DATUM:** WGS84

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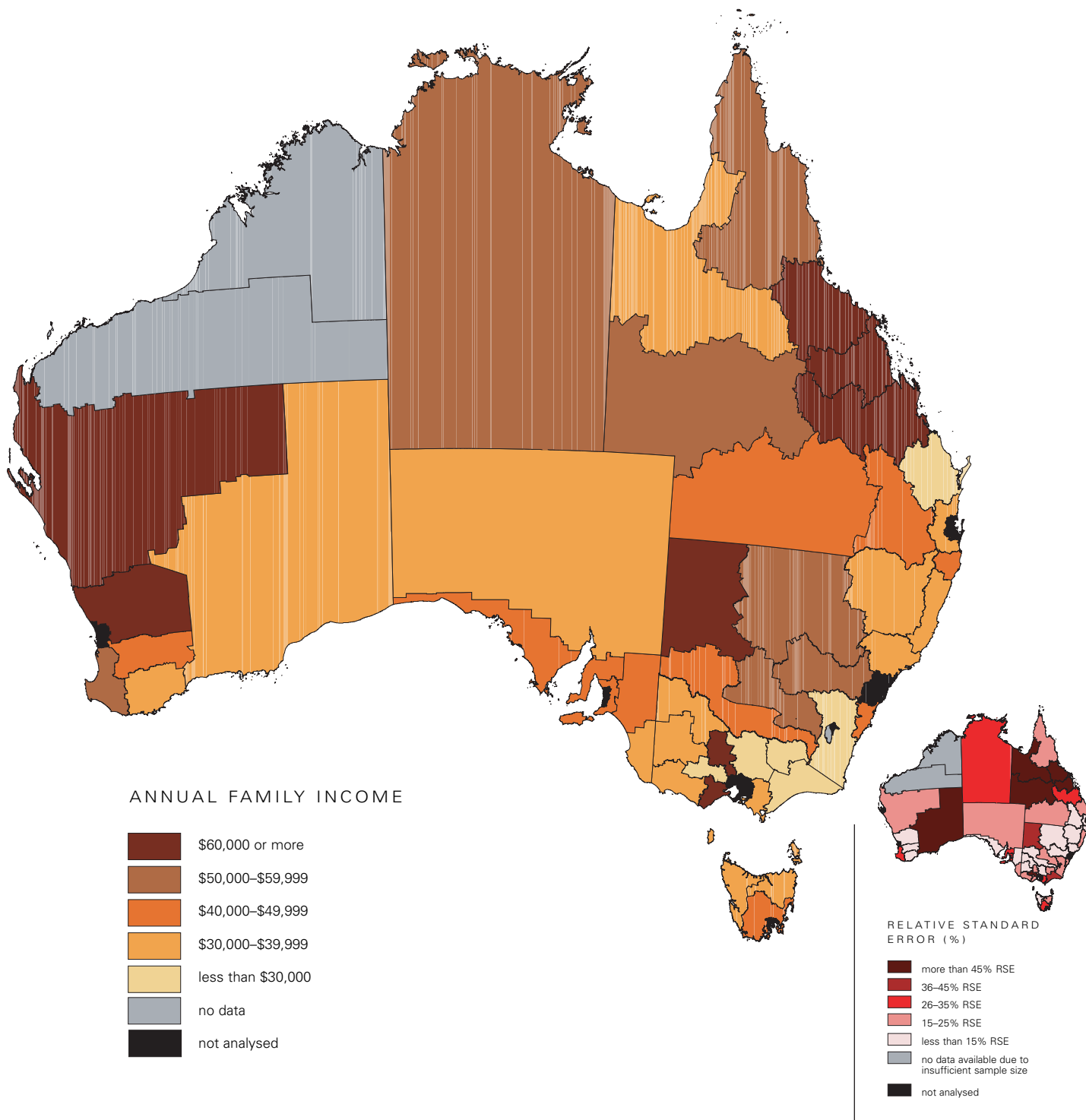
MAP 4 | Median farm family income, 1996



**DATA SOURCE:** Australian Bureau of Statistics. Population and Housing Census (1996)  
**SPATIAL UNITS:** Statistical Local Areas  
**PROJECTION:** Albers Equal-Area Conic  
**DATUM:** WGS84

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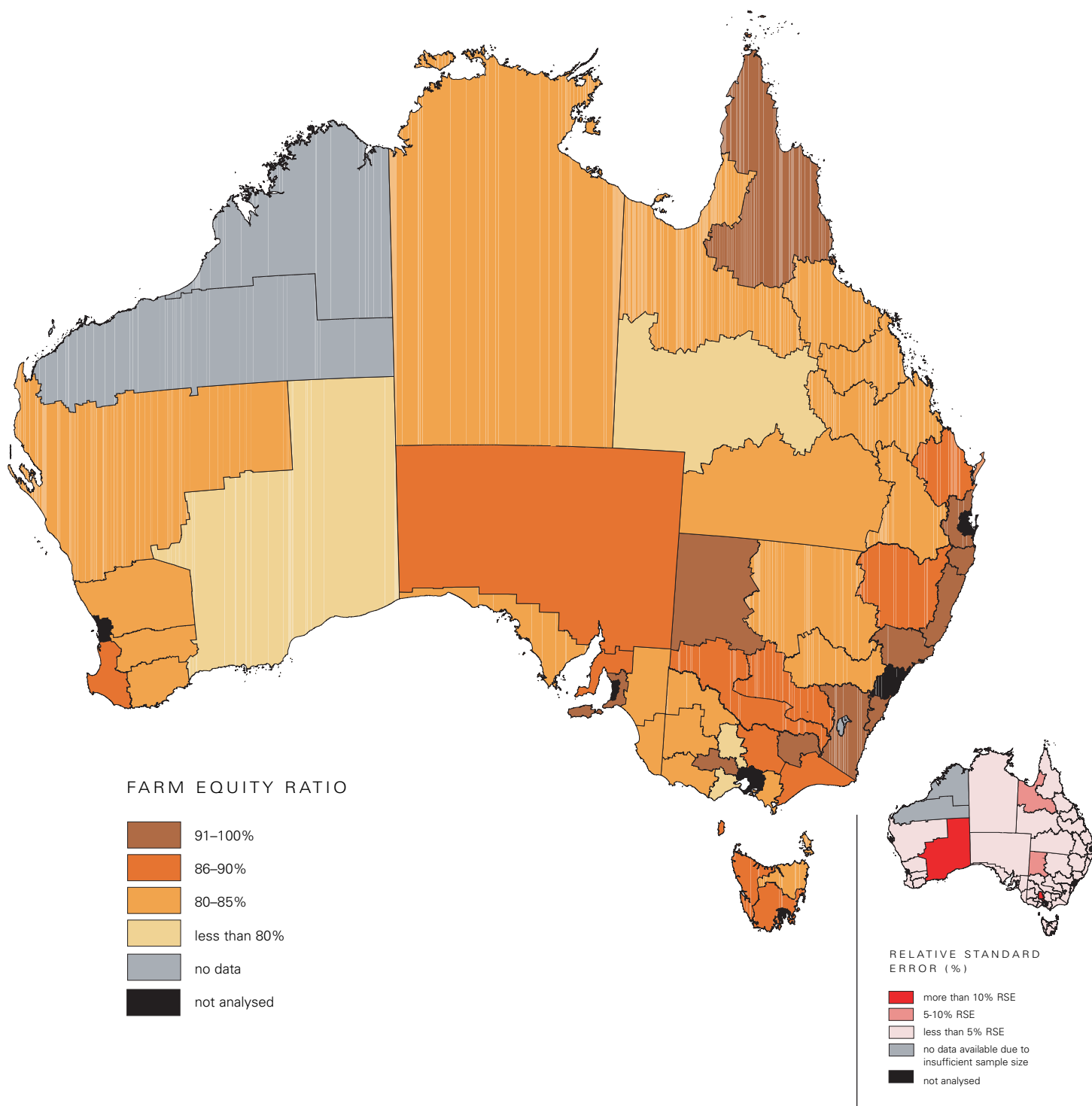
**MAP 5** | Annual family income, 1996–97 to 1998–99 (three-year average)



**DATA SOURCE:** Australian Bureau of Agriculture and Resource Economics (ABARE) Farm survey data, 1996–97 to 1998–99.  
**SPATIAL UNITS:** Statistical Divisions  
**PROJECTION:** Albers Equal-Area Conic  
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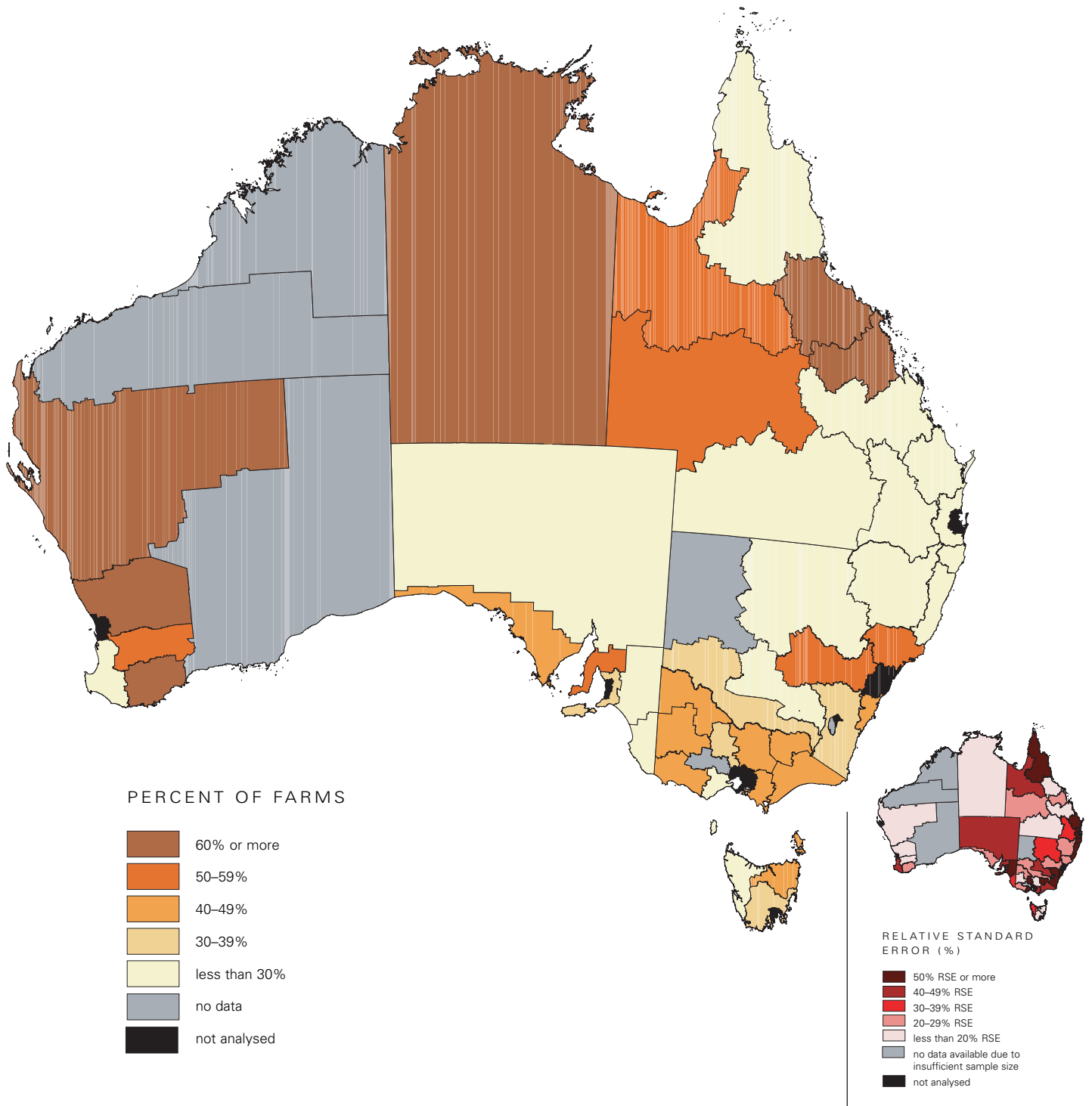
MAP 6 | Farm equity ratio, 1996–97 to 1998–99 (three-year average)



**DATA SOURCE:** Australian Bureau of Agriculture and Resource Economics (ABARE) Farm survey data, 1996–97 to 1998–99.  
**SPATIAL UNITS:** Statistical Divisions  
**PROJECTION:** Albers Equal-Area Conic  
**DATUM:** WGS84

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**MAP 7** | Membership of community landcare in 1998–99



**DATA SOURCE:** Australian Bureau of Agriculture and Resource Economics (ABARE) Resource Management Supplementary, 1998–99

**SPATIAL UNITS:** Statistical Divisions

**PROJECTION:** Albers Equal-Area Conic

**DATUM:** WGS84

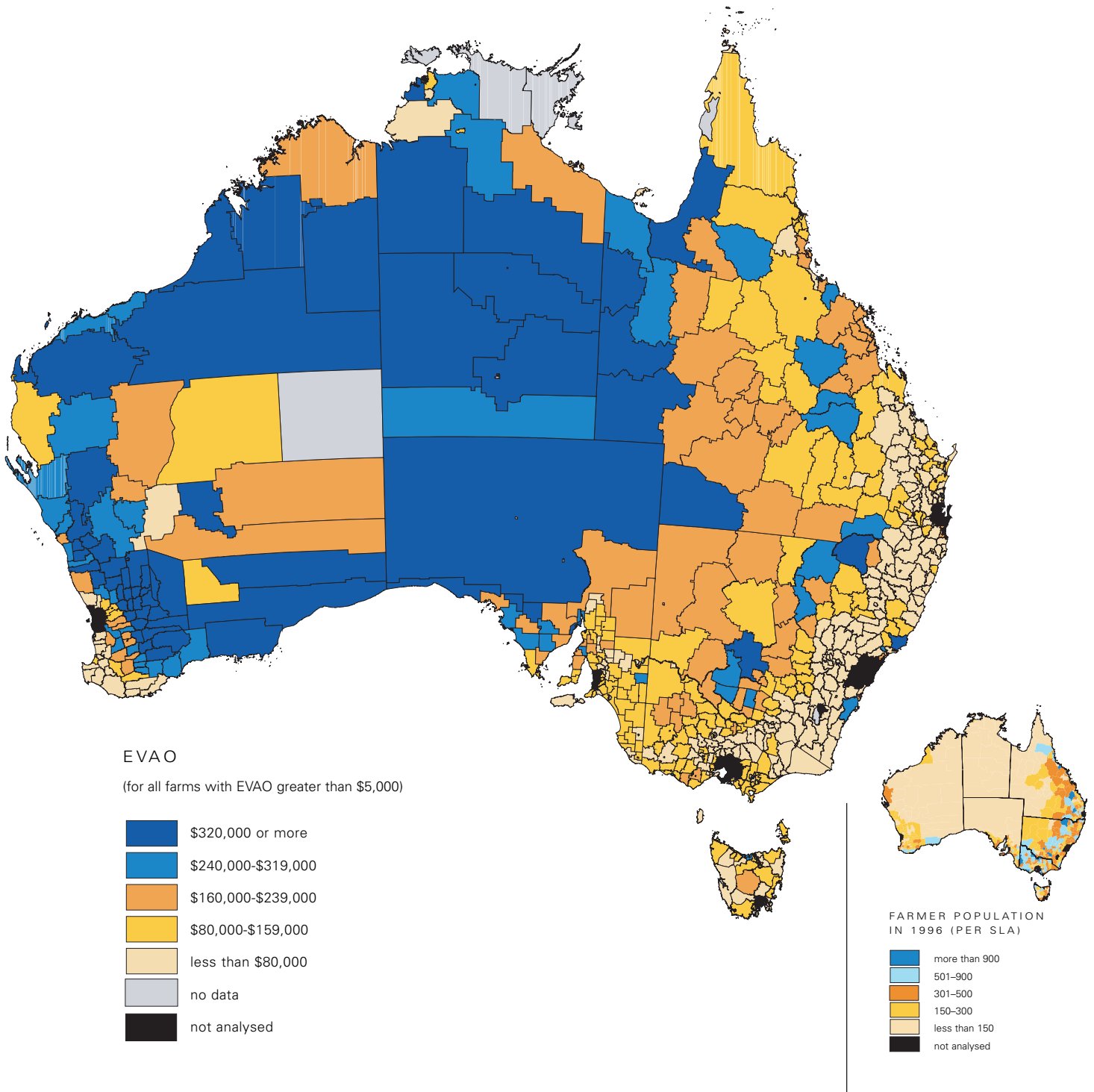
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MAP 8 | Median estimated value of agricultural operations (EVAO)



**DATA SOURCE:** Australian Bureau of Statistics. Agricultural Census (1996-97)  
**SPATIAL UNITS:** Statistical Local Areas  
**PROJECTION:** Albers Equal-Area Conic  
**DATUM:** WGS84

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levels of formal education, and in particular that farm businesses run by people with agricultural qualifications returned higher average incomes (excluding interest payments) than those run by people without these qualifications. Relationships between formal education and farm business assets were much smaller than those between formal education and income. Data from recent ABARE farm surveys (Garnaut & Lim-Applegate 1998) showed that farm businesses in which the owner-manager or spouse had a university or other tertiary qualification tended to be larger in size (as averaged over 1992–93 to 1994–95) than those run by people with less formal education. However, in this 1998 study, no consistent relationship was found between farm performance and educational levels of owner-managers or spouses. Reeve and Black's (1993) national survey found that better educated farmers had more favourable attitudes towards using outside expertise to assist with on-farm conservation practices. In a more specific study, Curtis et al.'s (2000) investigation of landholder willingness and capacity to manage dryland salinity in Victoria's Goulburn Broken catchment found no significant relationship between higher education levels and adoption of best practices.

A survey conducted by Solutions Marketing and Research (1999) to monitor the performance of the Commonwealth Government's Agriculture—Advancing Australia (AAA) program package included five national indicators related to AAA goals, one of which was an NRM behaviour indicator. Based on a sample of 2,043 agricultural producers, Solutions found no significant relationship between formal educational attainments and their NRM indicator.

In the analysis of the ABARE Resource Management Supplementary survey of Australian broadacre and dairy farmers, presented later in this report, more frequent participation in training was commonly associated with the adoption of sustainable practices.

Map 2 relating to educational attainments among Australian farmers depicts data from people who identified their primary occupation as 'farmer' or 'farm manager' in the 1996 ABS Population and Housing Census. Leaving school at age 14–16 generally indicates attendance of between 2 and 4 years of secondary schooling. Map 3 showing participation in any courses or training activities over the period from July 1996 to June 1999 is based on data from ABARE farm surveys.

#### KEY POINTS

- A relatively high percentage of Australia's farmers have no post-secondary education.
- Relationships between formal educational attainments and adoption of sustainable NRM practices are unclear or weak.
- Participation by farmers in courses or training activities is associated with adoption of sustainable practices.
- Both the pattern of educational attainments among farmers and their participation in courses and training activities appear to be influenced by farm distance from educational institutions and farmers' average ages, with older farmers and those in more remote regions being less likely to participate.

## FARM INCOME AND FARM BUSINESS CHARACTERISTICS

Poor or low financial viability is likely to be a major constraint on the adoption of more sustainable management practices. Reviews of economic pressures affecting the depletion of natural resources on farms in Australia have indicated that since the 1950s declining terms of trade have reduced primary producers' per unit production margins significantly. Consequently, producers have looked to improvements in efficiency to make their enterprise more profitable and to maintain a minimum net income and standard of living.



In overseas research studies (mainly in the United States), it has been found that the greater the level of gross farm income, the greater is the likelihood that conservation and land management practices will be implemented (Carboni & Napier 1993; Saltiel et al. 1994; Witter et al. 1996). In the analysis presented in chapter 7, for 15 sustainable practices in the 1998–99 ABARE Resource Management Supplementary survey annual farm cash income and profit at full equity were each only associated with increased adoption of one practice of those considered. Higher farm equity ratio was associated positively with one practice and negatively associated with three practices.

Map 4 shows median farm family income in 1996. The data was provided by the ABS and is aggregated at the Statistical Local Area (SLA) level and by predetermined income categories (which change between censuses). ABS estimates are likely to be less accurately estimated at the individual level, but represent estimates from all relevant population members.

Map 5 shows annual family income which reflects both on- and off-farm income from all sources. The data was provided by ABARE and is aggregated at the Statistical Division (SD) level. There are two levels of variability of on-farm income which need to be considered. Firstly, there is the variation for given properties between years. In some areas of Australia and for some farm enterprises this variation can be very large. Secondly, there is the variability of the estimate of the income for the SD of interest, measured by the Relative Standard Error (RSE). As well, there can be scale and heterogeneity issues that introduce variation. SDs can be very large areas and what may be true at one scale may not be true at another. For example, the farm income of pastoral properties on the Barkly Tableland in the Northern Territory is likely to be very much higher than in the southern, less-productive areas of the same SD.

Median farm family income patterns for 1996 (Map 4) tend to suggest that pastoral families, particularly in parts of Western Australia and the Northern Territory, were earning good incomes, but that incomes were relatively low (below \$40,000) throughout most of the wheat-sheep and intensive agriculture areas of eastern Australia. In some parts of remote Australia, higher family incomes appear to be associated with nearby mining operations, suggesting that mining-related activities are providing alternative employment opportunities for some farm family members.

Annual family income has been examined as a three-year average for the period 1996–97 to 1998–99 by SD (Map 5). Using a three-year average tends to smooth out some variations due to seasonal conditions and may be a better indication of the base levels of family income. Map 5 indicates that annual family incomes tend to be related to property sizes, with returns from large pastoral properties generally higher than from small farming operations. The income of pastoral families is also more likely to be obtained solely from on-farm activities than is income in the more intensive agriculture areas where more opportunities are likely to exist for earning off-farm income.

Map 6 shows farm equity ratio which is a measure of the farm's owned capital relative to total capital, reflecting level of debt. High equity ratios may reflect farm families' financial capacity to make further investments in their properties; but lower equity may reflect recent purchase of a farm property or of additional land. Farm equity is affected by changing land values as increasing land values lead to increases in the value of owned capital, counter-balancing debt. This is a significant factor, particularly in the more intensively farmed areas of coastal Australia. Mues, Chapman and Van Hilst (1998) found that higher equity ratios were associated with the adoption of regular soil testing by cropping specialists; however, they were unable to establish an association between equity ratio and other sustainable practices. In chapter 7 we report a number of associations between equity ratio and more sustainable practice adoption. Specifically, higher equity ratios were positively associated with use of controlled bores and negatively associated with monitoring of pasture and vegetation condition in the pastoral zone. Higher equity ratios were negatively associated with use of deep-rooted perennial pasture and monitoring watertables in the wheat-sheep and high rainfall zone.

#### KEY POINTS

- In Australia there have been few definitive studies which link objectively measured financial indicators to adoption of sustainable practices; however, 'financial constraints' self reported by landholders are frequently cited in research studies as being an important barrier to the adoption of otherwise attractive innovations or management practices.
- Commonsense, and conventional understanding of human motivation, suggest that low incomes and high debt discourage adoption of sustainable practices which have low returns and long delays in achieving any benefits.
- Variability of many farm financial measures often will be as great within a geographical locality as the variability between different areas; this suggests attention to scale issues when using aggregated financial data as geographically based indicators.
- Low incomes resulting from farm industry and institutional structural change will frequently be geographically concentrated in specific localities.
- Low incomes as a consequence of extended low commodity prices or extended drought conditions will also be geographically concentrated in specific localities.

#### PARTICIPATION IN LANDCARE AND PROPERTY MANAGEMENT PLANNING

Farmers' and farm families' exposure to the social and cultural norms of peer groups are likely to be key factors influencing their willingness to change to more sustainable practices. Participation in social groups and movements, particularly when continued over long periods, is likely to have significant influences on members' attitudes—members become socialised to group norms and values, and may go on to exert similar influences on other people within their social networks (Stern et al. 1999). For this reason, participation in groups like community landcare indicates shifting individual values and community norms towards a more sustainable land management ethic (Cary & Webb 2000; Fenton, Macgregor & Cary 2000). It does not necessarily lead to adoption of more sustainable practices. This also requires motivation, financial incentives and appropriate skills and resources, as well as favourable attitudes and problem awareness (Barr & Cary 1992, 2000; Guerin & Guerin 1994; Vanclay & Lawrence 1994).

Estimates suggest there are more than 4,000 community landcare groups operating in Australia, and in 1998–99 approximately 37% of broadacre and dairy farms had a property representative who was a community landcare member (Cary & Webb 2000; Kemp & Alexander 2000). Mues, Chapman and Van Hilst (1998) found that membership was highest in the wheat-sheep and pastoral zones. They showed that community landcare members tended to come from larger and less intensively cropped farms and on average had more livestock, higher levels of farm cash income, and higher rates of return on farm business capital than farmers who were not members. Mues, Chapman and Van Hilst's survey also indicated that community landcare members were more likely to report land degradation problems on their properties, show best practice land management, and participate in training activities, possibly suggesting significant social influences from contact with landcare group members and landcare information networks. However, links between community landcare participation and adoption of best practices were not supported in Curtis et al.'s (2000) survey of the Goulburn Broken Catchment in Victoria.

Map 7 provides the percentage of farms in each SD where a family member is a member of community landcare, and shows high membership in Western Australia, Victoria and Northern Territory. Community landcare membership appears to be highest in pastoral and wheat-sheep areas of Australia. In part, this may be related to lower population densities in these areas than in more intensive agriculture areas, and hence the increased significance of social contacts provided by community landcare membership. The reliability of the estimates of membership is lower in pastoral regions because of smaller sample sizes.

#### KEY POINTS

- 37 per cent of farms in Australia have a family member who is a member of community landcare; median length of membership was more than four years for all regions where data were available.
- In the majority of SDs for which data were available, on more than 50% of farms where a family member was in community landcare landholders reported that their involvement influenced farm decisions.

#### FARM SIZE

There is evidence that the larger the farm in terms of its physical size, the more likely the farm manager is to adopt new and more sustainable farm management practices. The explanation for this is associated with economies of scale, i.e. the larger the property, the easier it is to manage profitably and the more resources available for improving land management. Increased property size, if linked to increased financial viability, removes a major constraint to adoption. There is also the possibility that smaller property sizes when coupled with the demands to create higher farm incomes can lead to overuse and depletion of resources. Sub-economic farm size has been identified as the main cause of overgrazing in the Western Division in New South Wales and the Mulga region in Queensland (CIE 2001).

The influence of size on sustainable practice adoption is often complicated by the 'bifurcation' of Australian agriculture with an increasing tail of less profitable and often smaller-sized farm businesses and by the increasing presence of part-time and recreational farmers who generally farm smaller-sized properties. The former situation may discourage adoption of sustainable practices while landholders in the latter situation are often predisposed to implementing certain types of sustainable practice.

Property size was a major influence on the adoption of sustainable practice in the Broken Goulburn catchment in Victoria (Curtis et al. 2000). In this study there was a significant positive relationship between the adoption of more sustainable management practices (absolute area sown to introduced perennial pastures) and property size. When the proportion of a property under a sustainable practice was used there was a significant negative relationship between the adoption of best practice and property size. Curtis et al. (2000) explained that smaller properties were adopting some practices at levels representing higher proportions of their total property, while larger property owners had implemented most best practices over a larger area. Thus while property size influences adoption of sustainable practices, there is adoption among both large and small property owners (Curtis et al. 2000). Cary (1992) reported a similar inverse relationship between proportion of property planted to trees and property size, though no relationship with absolute number of trees and property size. Cary suggested that farmers plant a symbolic number of trees, thus those with smaller properties plant a greater proportion of their property to trees.

The estimated value of agricultural operations (EVAO) is a measure of gross farm income. However, EVAO is not an indication of enterprise profitability and so, in itself, does not indicate financial capacity to adopt sustainable practices. EVAO is correlated with farm (enterprise) size and is a useful indicator of farm size as it is often a better measure of the scale of the farm business than is farm area.

Map 8 indicates the median EVAO for 1996–97 highlighting very large differences in farm property size in different geographical areas of Australia. A generalised geographical pattern of increasing farm size moving to the centre and to the north of Australia predominantly reflects decreasing rainfall and increasing unreliability of rainfall, as well as the difference between pastoral land uses and other types of farming. However, due to the range of farm sizes Australia-wide depictions of EVAOs do not adequately discriminate differences within the more climatically favoured east, south-east coastal, and south-west Western Australia areas.

## 6 | ATTITUDES AND VALUES AND LIKELIHOOD OF CHANGE TO SUSTAINABLE PRACTICES

As a consequence of the often tenuous nature of the link between attitudes and values and behaviour it has always been difficult to predict individual behaviour as arising from an individual holding a particular value or having a particular attitude. Pro-environmental values have been important in fostering awareness of land degradation, but they have a relatively minor influence on the adoption of sustainable practices. For the most part, stewardship and landcare values have more significant indirect than direct effects on resource management behaviour. They provide a consensus for community action (and for the imposition of informal or formal social constraints) but they have a much weaker direct influence on individual action.

### ATTITUDES, BELIEFS AND VALUES

In many studies it has been observed that attitudes and behaviours are related to an extent that ranges from a small to a moderate degree. There is a general tendency for individuals, in the absence of constraints, to seek consistency between attitudes and behaviours. Another way for individuals to achieve psychological consistency is to publicly espouse 'symbolic beliefs' reflecting the relevant social norms but engage only in token behaviour, sufficient to provide apparent consistency (Cary 1991, 1993). Instrumental beliefs, related to self-interest, are likely to be more powerful than (moderately held) symbolic beliefs in influencing substantive environmental behaviour. The attitude-behaviour relation is further complicated by the fact that causation is not one-way: behaviour can also determine attitudes.

The link between attitudes and behaviour is complex because the relationship between them is commonly many-to-one i.e. many different attitudes of potentially differing strength and direction and includes attitudes towards complying with social norms regarding the behaviour. These may be associated with a particular desirable behaviour. Thus an individual may have some attitudes that are 'positive' towards a particular NRM behaviour (e.g. it is good for the environment) and other attitudes that are 'negative' towards the particular behaviour (e.g. it costs me money). An attitude exists within a personal knowledge structure comprised of beliefs linked in associative networks. If all 'attitudes' in an individual's belief system with respect to the behaviour are not taken into account it is unlikely behaviour can be successfully inferred.

Beliefs are the knowledge base upon which attitudes are formed. The traditional, all-embracing tripartite conception of an attitude asserted that an attitude comprised emotional, cognitive and behavioural components. The cognitive component is better thought of as the relevant beliefs that underpin individuals' attitudes. Beliefs can be thought of as assertions about the degree of association between objects which exist within, and comprise, a domain

of cognition. An assertion that planting trees will reduce groundwater accessions is a belief. More complex beliefs might embrace assertions about the length of time between planting trees and subsequent reduction in groundwater accessions.

Belief systems have much in common with broader social knowledge systems; but they are not identical. Belief systems belong to an individual and are idiosyncratic. Belief systems often include representations of 'alternative' worlds, typified as ideological beliefs (Abelson 1979). Belief systems are likely to include a substantial amount of episodic material from personal experience. And, beliefs can be held with varying degrees of certainty.

Values are more generalised aggregations of attitudes and beliefs; values allow more generalised responses to a wider range of entities. Values tend to be more strongly held and to be more stable than attitudes and hence they are changed less easily and less quickly. Changes in values and subsequent associated changes in behaviour are thus harder to observe. While there is mixed research evidence in the literature, there is a body of evidence indicating positive relationships between environmental values and environmentally protective actions. Ross (1999, p. 29) has provided an assessment of the implications:

- Values are closely related to people's priorities.
- They provide guidance—however loose—to people's likely behaviour, including their adoption of new 'technologies'.
- They offer approaches for assessing what policy options people will accept, or perhaps reject.

In considering the adoption of more sustainable resource management practices the landcare ethic provides a useful characterisation of environmental values. The landcare ethic embraces a broad continuum of values. At one end—the 'deeper green' end—is a concern for the health of the land as an end in itself. At the other end is a more utilitarian or instrumental focus of protecting the land to ensure its continued productivity and thus economic benefit to the farmer (Cary & Webb 2000).

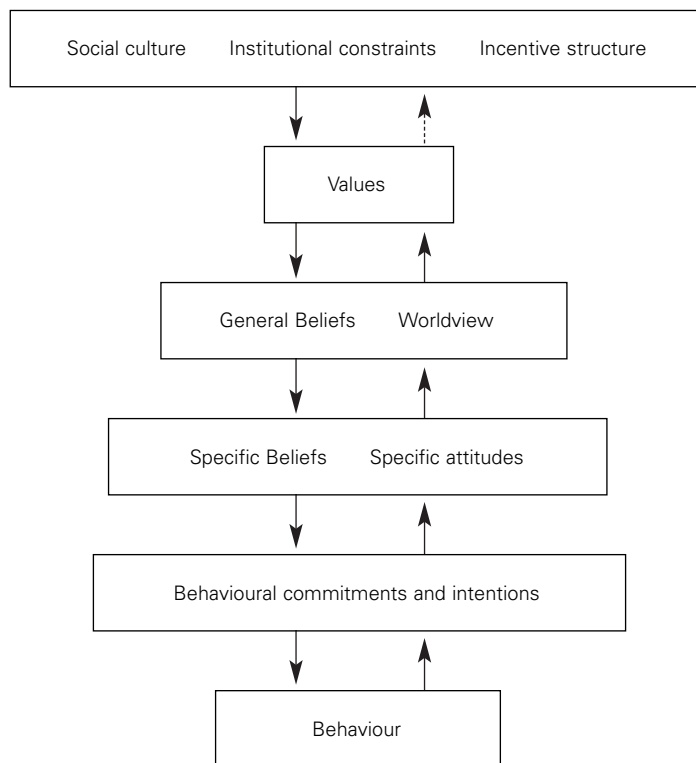
Over the longer term aggregate changes in personal value systems and more strongly held attitudes become community norms. The resultant formation, or reinforcement, of norms—such as the norms embracing a landcare ethic—can lead to the strengthening of social movements and reinforce feedback loops for socially desirable personal (pro-environmental) behaviour and for supporting social or legal regulation that prescribes or proscribes such behaviour.

#### A FRAMEWORK OF ENVIRONMENTAL CONCERN

It is useful to develop a simple framework to depict how values and beliefs influence an individual's appraisal process and potentially influence individual behaviour. The adaptive responses are complex and are mediated by wider social assessments that are changing over time and are multidimensional in nature. Values and beliefs which reflect environmental concern and, potentially, adaptive behaviour can be derived from Stern et al.'s (1995) socio-psychological framework (Figure 4). The framework we adapted here is one developed from work by Stern (1992), Stern et al. (1993), Stern and Dietz (1994) and Stern et al. (1995).

The broad outline presented in Figure 4 shows interactions which occur between the various elements. While the interactions are often two-way, causation generally flows from top to bottom. The factors identified at the top of the framework are considered to be less mutable by the individual or through the life course than those at the bottom.

**FIGURE 4** | A framework of environmental concern (AFTER STERN ET AL. 1995).



The framework highlights that individuals are located within a social 'culture' which influences the development of values, beliefs, attitudes and, ultimately, behaviours. Social culture factors play a large role in the shaping of an individual's early life (and later life) experiences and general beliefs about the world.

Many values are formed through early family socialisation processes, and these values are thought to be relatively stable in adults (Oppenheim 1992; Stern & Dietz 1994). Such existing pre-formed values are likely to be resistant to change; however, 'new' (as opposed to earlier formed) values can be more easily embraced.

At the next level Stern et al. (1995) place an individual's general beliefs and worldview. These encompass an individual's broad understanding of how the world operates. In the context of environmental issues this level of the framework comprises an individual's understanding of the biophysical environment and its function, and also how the environment is affected by human actions. Stern et al. (1995) consider worldview to be causally antecedent to values. They argue that, in contrast to values that are formed during early family life, worldviews are more likely to be the result of broader experiences within the social and political world. Furthermore, while values tend to be largely immutable in adults, worldviews, being comprised of beliefs, are vulnerable to empirical challenge and may change. Notably worldviews and general beliefs at this level of the framework are distinguished from more specific or localised beliefs, such as those associated with a particular location.

A key feature of Stern's framework is the role that values and worldview play in the assimilation of new information by individuals. Values and worldview may operate as 'social amplifiers' in that a particularly strong value orientation may lead an individual to selectively seek information or attend selectively to information about the consequences of some action for the objects they value (Stern & Dietz 1994). Likewise values and worldview may act as 'filters' for information where individuals may more readily accept information that is congruent with their values and worldview. This function, particularly of value orientations, may work to attenuate the potential impact that any empirical challenge, through information provision, has upon beliefs.

Specific beliefs and specific attitudes are located towards the bottom of the framework in Figure 4. These psychological variables are placed most proximate to behavioural intent and actual behaviour, and are considered to have greatest impact upon them. In the framework this is the position where attitudes towards a particular practice and beliefs about the impacts and consequences of those practices would be located. Stern and Dietz (1994) stress that the processes of construction of an individual's attitudes towards specific environmental issues are important as these issues are often, at least initially, unfamiliar to those who form attitudes about them. They argue that individuals tend to ignore details and issue-specific information, but rather classify a topic and then make reference to their more general beliefs and values in forming their specific attitudes and beliefs about that issue (Stern et al. 1995). When asked to express an attitude about a particular environmental issue, an individual will review their beliefs about the issue and assess the likely impact upon the things they value.

The final two components of Stern's framework relate to behavioural intent and finally to actual behaviour. These are of particular interest to policy makers attempting to encourage more sustainable farming practices by farmers. Behavioural intent has typically been operationalised by Stern and colleagues through the use of responses to scales about likelihood to take political action and willingness to pay extra tax to ameliorate negative environmental consequences (Stern et al. 1993; Stern & Dietz 1994). The linking of actual behaviour to other components of the framework, rather than self-reported intentions, is arguably the least developed aspect of Stern's framework. The framework highlights the important role that social culture, values and beliefs play in the formation of specific attitudes and specific beliefs regarding a particular environmental issue.

## ATTITUDES AND VALUES AND SUSTAINABLE MANAGEMENT PRACTICES

Earlier a distinction was made between environmental or deeper green values and those which were more utilitarian or instrumental (see section on Values above). Typically for most people, apart from the most environmentally committed, utilitarian and instrumental values tend to predominate over environmental and non-instrumental values, in determining behaviour related to environment and the use of more sustainable practices. We will now explore the conditions under which different values come into play.

Guagnano et al. (1995) have enunciated the conditions under which positive environmental values and attitudes are most likely to influence, or be associated with, significant behaviour change. The effect of positive environment values is constrained by the influence of prevailing incentives or disincentives to adopt a sustainable practice. Positive environment values interact with external incentives or disincentives (such as costs, benefits, convenience, or uncertainty of outcome of a given practice) to determine adoption behaviour regarding sustainable practices. The effect of strongly positive environmental attitudes on sustainable practice adoption tends to be influential when there are no strong external

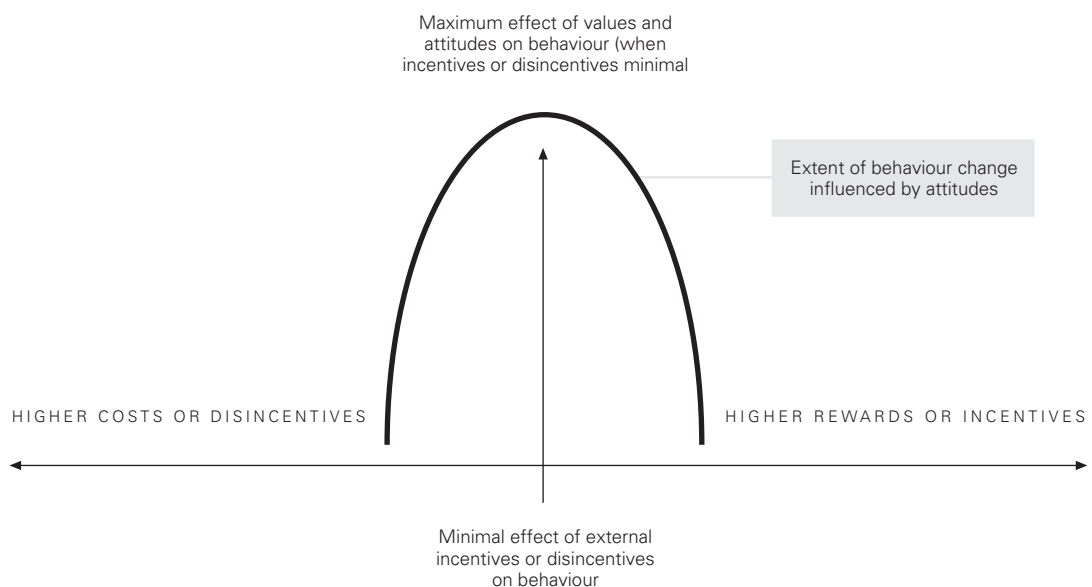
incentives or disincentives for undertaking the practice. (An urban example is kerbside recycling of domestic waste.) Positive environmental attitudes have much less effect on behaviour when external incentives or external disincentives are strong (for example forgoing the convenience of the private automobile in favour of public transport). In the latter case it is the external factors which usually compel or prohibit the behaviour in question.

We depict a schematic diagram of the conditions for maximum influence of environmental values or attitudes on the individual's decision to adopt sustainable practices in Figure 5.

The strength of the external conditions determines the bounds of influence of positive environmental attitudes and values (Cary, Webb & Barr 2001). In situations where the private benefits are negative, or in open access common property situations, the expectation that farmers will make significant investments in public good activity for little or negative financial return is usually doubtful. Guagnano et al.'s (1995) proposition implies that for personal behaviours that are not strongly favoured by being required or tangibly rewarded, the more difficult, time-consuming or costly the behaviour, the weaker is the dependence on attitudinal or environmental value factors.

Values and attitudes have both direct and indirect effects on individual behaviour. The analysis above applies to the influence of personal attitudes and values on personal behaviour, and this can be considered a direct effect. The impact of many individuals' values when expressed in social aggregates—as social norms—becomes more complex and their influence is potentially more powerful. This influence can be considered an indirect effect. Over the longer term aggregate changes in personal value systems and more strongly held attitudes become community norms. The reinforcement of norms—such as the norms embracing a landcare ethic—can lead to the strengthening of social movements (such as the landcare movement) and reinforce feedback loops for socially desirable environmental behaviour (Stern et al. 1999).

**FIGURE 5** | Conditions for maximum influence of environmental values or attitudes on individual's decision to adopt sustainable practices





## 7 | RECENT RESEARCH FINDINGS: MODELLING ADOPTION BEHAVIOUR

### INTRODUCTION

As highlighted in the previous chapter relationships between the adoption of sustainable farming practices and the available range of farm family, farm property and farm business characteristics are complex and sometimes tenuous. While some relationships have been found in empirical studies, (e.g. Cary & Wilkinson 1997; CIE 2001; Curtis et al. 2000; Drake, Bergstrom & Svedsater 1999; Mues, Chapman & Van Hilst 1998), there is no widely accepted theoretical model of human adoption behaviour that can guide and direct empirical studies. Consequently research tends to be atheoretical and exploratory in nature.

This chapter provides an overview of an analysis of data from ABARE's Resource Management Supplementary (RMS) survey for the 1998–99 financial year. The complete analysis is detailed in Cary et al. (2001). The general approach in the analysis was to model the association between a range of farm family, farm business and farm property characteristics and the reported adoption of various resource management practices. The testing of *a priori* hypotheses was not the intention of the analysis; rather we have inductively explored the associations between practice adoption and the range of characteristics where previous research has suggested relationships.

Data covering a range of landholder characteristics and the reported adoption of sustainable land management practices were selected from the 1998–99 ABARE Australian Agriculture and Grazing Industries Survey and the Australian Dairy Industry Survey (see ABARE (2000) for survey description). The surveys incorporated the RMS, which collected data regarding resource management practices and land management, including the:

- presence, extent and costs of degradation
- participation in training
- landcare membership and involvement in landcare activities
- content and use of farm plans
- cost of landcare capital works
- adoption of best practices in farm management
- area of crops sown with different tillage practices
- recent changes to tillage practices
- attitudes to degradation and conservation
- farm forestry and functions of trees on farms.

Based upon their utility in understanding farmer adoption behaviour 16 landholder characteristics were selected for analysis. These characteristics and their definitions are listed in Table 2.

The potential range of sustainable resource management practices that could be adopted will be determined by the nature of the farming enterprise and its location (see Table 1). Some practices will only be relevant to particular types of industries or to particular locations. Table 3 details the practices for which adoption was explored. Logistic regression was used to model the adoption of the practices investigated. Details of individual models are provided in Appendix B of Cary et al. (2001).

**TABLE 2** | Variables explored in analysis of Resource Management Supplementary survey

Variable	Definition
state of residence	variable with between five and seven levels as appropriate
farm cash income	difference between total cash receipts and total cash costs
profit at full equity	farm business profit, plus rent, interest and finance lease payments less depreciation on leased items. It is the return produced by all the resources used in the farm business
closing equity ratio	calculated as farm business equity (value of owned capital, less farm business debt at 30 June) as a percentage of owned capital at 30 June
financial concern attitude	variable with 5 levels (strongly disagree, disagree, neither agree nor disagree, agree and strongly agree) indicating response to the statement 'I don't have the financial resources available to adequately address land and water degradation on my property'.
financial outlook attitude	variable with 5 levels (strongly disagree, disagree, neither agree nor disagree, agree and strongly agree) indicating response to the statement 'I feel the profitability of my farm is likely to fall from current levels over the next 5 to 10 years'
landcare membership	variable indicating the membership of landcare in the year 1998–99
length of landcare membership	measured in years
recent training	number of courses or training activities undertaken in the last three years
PMP participation	variable indicating involvement in a Property Management Planning (PMP) program
farm size	size of the farm measured in '000 hectares
land use intensity	intensity of land use measured in sheep equivalents per hectare
age	owner/operator's age in years
farm plan	presence of a farm plan or property management plan
technical concern attitude	variable with 5 levels (strongly disagree, disagree, neither agree nor disagree, agree and strongly agree) indicating response to the statement 'I don't have the technical resources available to adequately address land and water degradation on my property'
environmental concern attitude	variable with 5 levels (strongly disagree, disagree, neither agree nor disagree, agree and strongly agree) indicating response to the statement 'Land and water degradation is a critical concern to me in farm planning'

**TABLE 3** | Resource management practices investigated

Resource management practice	Pastoral	Wheat Sheep	High Rainfall	Dairy Farms	Irrigated Farms
controlled flow bores	x				
controlling grazing pressure by excluding access to water	x				
monitoring of pasture and vegetation condition	x				
deep rooted perennial pasture		x	x		
tree and shrub establishment		x	x	x	
regularly monitor watertables		x	x	x	
soil/plant tissue test to determine fertiliser needs		x	x	x	
collection of dairy effluent (ponds or drainage sump)				x	
pump dairy shed effluent onto pasture				x	
laser graded layout					x
use irrigation scheduling tools					x
monitoring of pasture and vegetation condition	x	x	x	x	x
preserve/enhance areas of conservation value	x	x	x	x	x
exclude stock from degraded areas	x	x	x	x	x
percentage conservation tillage	x	x	x	x	x

## FINDINGS

The significant findings from the analysis are summarised in Tables 4 and 5. Table 4 presents the frequencies with which family, farm property and farm business characteristics were associated with adoption of the investigated management practices. In the majority of cases the direction of the relationship between practice adoption and characteristic as suggested by past studies and theoretical propositions was correctly predicted.

Table 5 summarises the relationship between characteristics and individual practices. Symbols in a box indicate a significant association between the relevant characteristic and practice adoption. An addition (+) symbol indicates a positive relationship; as the characteristic increases so too does the likelihood of practice adoption. A minus (-) symbol indicates the converse. In the case of the state of residence an asterisk (\*) indicates a significant association, though there is no inherent direction in the variable. Where the direction of a significant relationship is confirmed the cell is shaded.

**TABLE 4** | Characteristics significantly associated with practice adoption

Characteristic	Frequency of significant associations		Characteristic	Frequency of significant associations	
	<i>predicted</i>	<i>not predicted</i>		<i>predicted</i>	<i>not predicted</i>
state of residence	9		landcare membership (1998–99)	3	0
financial outlook attitude	7	1	length of landcare membership	1	1
farm plan	6	0	financial concern attitude	1	1
recent training	6	0	PMP participation in last 3 years	2	0
environmental concern attitude	6	0	age	2	0
land use intensity	4	2	farm cash income	1	0
technical concern attitude	4	1	farm size	0	1
closing equity ratio	1	3	profit at full equity	1	0

**TABLE 5** Factors which are associated with the adoption of sustainable management practices

FARM FAMILY, FARM PROPERTY AND FARM BUSINESS CHARACTERISTICS	PASTORAL ZONE			WHEAT-SHEEP AND HIGH RAINFALL ZONES			
	<i>controlled flow bores</i>	<i>controlling grazing pressure by excluding access to water</i>	<i>monitoring of pasture and vegetation condition</i>	<i>deep-rooted perennial pasture<sup>1</sup></i>	<i>soil/plant tissue tests to determine fertiliser needs<sup>1</sup></i>	<i>tree and shrub establishment<sup>2</sup></i>	<i>regularly monitor water tables<sup>2</sup></i>
age							
environmental concern attitude			+		+	+	
technical concern attitude			-	-		+	
financial concern attitude				+			
financial outlook attitude	-		+	-		-	
landcare membership (1998–99)	+					+	
length of landcare membership					+		
recent training					+		
farm cash income					+		
closing equity ratio	+		-	-			-
profit at full equity			+				
farm plan			+		+	+	+
farm size				-			
state			*	*	*	*	
land use intensity					+	+	+
PMP participation in last 3 years				+			

shaded cells indicate association relationships in predicted direction  
 + significant positive association at the 95% confidence level or higher  
 - significant negative association at the 95% confidence level or higher  
 \* see individual models for nature of relationship  
 1 broadacre farms only  
 2 including dairy farms

**STATE OF RESIDENCE**

State of residence was commonly a significant explanatory variable in adoption behaviour. Farmers based in Queensland were typically less likely to adopt the practices explored than the Australian average. This may be due to structural and institutional arrangements that are unique to Queensland farmers; alternatively it may be a consequence of Queensland farming systems and the applicability of the practices explored. The finding certainly suggests the need for more detailed exploration of the Queensland situation, particularly as much previous research has focused on the south-eastern states.

**AGE**

Age was significant for the adoption of two practices, with younger farmers more likely to adopt than older farmers. This is consistent with findings that suggest that younger farmers tend to be more aware of land degradation and recognise the need for the adoption of conservation practices (Fenton, Macgregor & Cary 2000).

DAIRY FARMS		IRRIGATION FARMS		ALL FARMS			
<i>collection of dairy effluent</i>	<i>pump dairy shed effluent onto pasture</i>	<i>laser graded layout</i>	<i>use irrigation scheduling tools</i>	<i>monitoring of pasture and vegetation condition</i>	<i>preserve/enhance areas of conservation value</i>	<i>exclude stock from degraded areas</i>	<i>percentage conservation tillage</i>
						-	-
		+			+	+	
-					-		-
	-			-	-	-	
	+						
	-						
+			+	+	+		+
		+		+			
	*	*			*	*	*
				+	-		-
			+				

**FARM FINANCIAL CHARACTERISTICS**

The financial outlook attitude variable reflects owner-manager’s perceptions about the future profitability of their farms. With the exception of one practice, the direction of the significant association was as expected. Those individuals who thought their future profitability would fall in the next five to 10 years were less likely to adopt the practice. To a much lesser extent, owner-managers who felt more able to afford to address land and water degradation were more likely to adopt practices. The findings confirm that financial capacity is an important component in determining the capacity of individuals to adopt new practices. Farmers who feel secure in their financial future are more likely to invest resources in adopting new resource management practices. Absolute measures of financial capacity (farm cash income and profit at full equity) were each positively related to adoption of only one practice. Those owner-managers who had higher equity and thus greater financial flexibility to operate their farm businesses were less likely to adopt particular practices. However, in the case of controlling flowing bores the converse relationship was found. Overall, the relationship between equity and adoption was not as might be predicted. This suggests the possibility of

other confounding effects associated with high equity and the need for more careful analysis of the adoption habits of those farming enterprises with high equity. It is possible that landholders with high equity in their properties are more risk averse and thus less inclined to adopt risky resource management technologies.

#### **E D U C A T I O N   A N D   T R A I N I N G**

Recent involvement in training courses was consistently significantly associated with adoption in a positive direction. Those landholders who had attended more training courses were more likely to adopt practices than those who had attended less. Training is clearly an important contributor to an individual's capacity to change. Training was the characteristic most frequently linked to practice adoption in Mues, Chapman and Van Hilst's (1998) study, though of less importance in CIE's (2001) study. In addition to the number of recent training courses attended, the more specific involvement in a Property Management Planning course or program was positively associated with the adoption of two practices.

Training and participation in PMP may alleviate technical concerns that owner-managers have about resource management practices. While this direct relationship was not explored, those owner-managers who felt they did not have the technical resources to adequately address land and water degradation on their property were less likely to adopt resource management practices. This concern and the impact that training has on adoption behaviour suggest that training and overcoming any fears that owner-managers may have about resource management practices are an important aspect of an individual's capacity to adopt. Technical concerns about the resources required to adequately address land and water degradation are likely to reflect the fact that many sustainable management practices are complex to integrate into farming systems and are often not adapted or appropriate for use in many localities.

It should be noted that a generic education level variable was not incorporated in the models estimated due to difficulties in developing a meaningful measure and, more importantly, due to likely confounding effects with age. Furthermore the specific measures, just discussed, are likely to be a more accurate reflection of relevant training.

#### **F A R M   S T R U C T U R E   A N D   F A R M   P L A N**

Land use intensity measured in sheep equivalents per hectare was associated with adoption for six practices. For four of these practices as the intensity of land use increased so too did the adoption of practices, while in the case of preserving or enhancing areas of conservation value and conservation tillage the association was negative. Mues, Chapman and Van Hilst (1998) also found a significant positive association with two practices they investigated. In general it may be argued that those owner-managers who farm most intensively would need to adopt resource management practices in order to maintain the productive capacity of their property. Those who did not may find the resource base is unable to withstand increased intensity of production.

While Curtis et al. (2000) highlighted the importance of farm size in their work on practice adoption, this analysis found that farm size was only significantly associated with adoption of deep-rooted perennial pasture in the wheat-sheep and high rainfall zones.

The existence of a farm plan was significantly positively associated with the adoption of six practices. The importance of a farm plan was not demonstrated in either Mues, Chapman and Van Hilst's (1998) or Curtis' et al. (2000) studies; however, it was the most frequently associated characteristic in the CIE (2001) study of the rangelands. The presence of a farm plan would suggest a more proactive and prepared owner-manager who may take greater advantage of new farming techniques and approaches.

## LANDCARE AND ENVIRONMENTAL ATTITUDE

Community landcare membership has been associated with greater adoption of resource management practices (e.g. Cary & Webb 2000; Curtis & DeLacy 1996; Mues, Chapman & Van Hilst 1998) and these findings, at least in some cases, also support that association. However, the length of landcare membership was anomalous, with both a positive and negative association found. Landcare membership and the length of that membership are sometimes used as a surrogate for commitment to a stewardship ethic or pro-environmental value position (e.g. Curtis et al. 2000). In this study an environmental concern attitude was able to tap this stewardship dimension, and the expected relationship was commonly found. Those owner-managers who considered land and water degradation as critical concerns in farm planning were also more likely to have adopted resource management practices.

## S U M M A R Y

Personal financial capacity was an important component in determining the capacity of landholders to adopt new practices. Farmers who felt secure in their financial future were more likely to invest resources in adopting new resource management practices.

Landholders' perceptions of their financial situation were more often associated with practice adoption than were objectively measured indicators of financial position. An individual's subjective assessment of their financial situation may be a better predictor of adoption than objective measures. This highlights the importance of perceived reality in adoption behaviour; similar associations between financial perceptions and business behaviour can be observed in the wider economy.

More frequent landholder involvement in training courses and having a farm plan were commonly associated with adoption of resource management practices. Participation in training courses related to management and skills is an important contributor to an individual's capacity to adopt sustainable practices.

Landholders who considered they did not have the technical resources to adequately address land and water degradation on their property were less likely to adopt resource management practices. Training may reduce this concern and increase human capacity to implement resource management practices. Technical concern about the resources required to adequately address land and water degradation is also likely to reflect the fact that many sustainable management practices are complex to integrate into farming systems and are often not adapted or appropriate for use in many localities.

The analysis produced some statistically significant findings which compare favourably with other studies. The differences between studies and some anomalous findings suggest more consideration needs to be given to the types of characteristics that will usefully explain the adoption of sustainable practices. Furthermore, analysis such as this that tends to be based on a large zonal or whole of Australia approach will frequently be confounded by the large variability that exists in Australian agriculture and the often locality-specific nature of many sustainable management practices. Understanding of farmer adoption behaviour could be advanced through more specific studies focusing on particular localities and industries.

## 8 | FUTURE SOCIAL AND DEMOGRAPHIC DIMENSIONS OF RURAL LANDSCAPES

### THE CHANGING STRUCTURE OF AUSTRALIAN AGRICULTURE

Australia has a large number of financially small farms. These farms are not evenly spread across the rural landscape. They tend to be concentrated close to the seaboard, in the hill country and surrounding major provincial centres. Smaller farms tend to be grazing properties. Financially larger farms are more often found in the flatter, drier, more remote regions of rural Australia. One could argue that larger farms are more likely to be found in landscapes with lower amenity value as perceived by the average Australian. They are also likely to be found in regions with less access to off-farm employment. While financially larger farms control a large proportion of the rural landscape, there are some regions in which they control very little of the landscape.

The capture of productivity improvements is crucial for industries to remain ahead of the compression of their terms of trade. Farm businesses must generally be large enough to generate a surplus that can be used to fund expansion. In the past decade a number of research studies have shown that productivity improvements are more likely to be captured by larger farms (Australasian Agribusiness Services 1997; Ha & Chapman 2000; Knopke, Strappazon & Mullen 1995). The path to increased productivity within the existing farming system varies depending on industry. Historical analysis shows that cropping industries have consistently achieved productivity improvements. Grazing industries, often dominated by smaller farms, have been far less successful at capturing economies of scale.

Off-farm income is crucial to the continued farming future of families on many small farms. Off-farm income is not a new phenomenon in Australian agriculture (Barr & Almond 1981; Core 1974; Paul 1982). Each of these reports showed off-farm income was important in some sections of the agricultural community. More recent studies published by ABARE have shown how off-farm income has become crucial to the living standards of many farm families (Garnaut & Lim-Applegate 1998; Rasheed, Rodriguez & Garnaut 1998). Off-farm income has risen consistently in broadacre agriculture over the past 20 years from \$6,000 to \$20,000 per annum. During 1994–95 farm income comprised only 37 per cent of farm family income on broadacre farms. Almost 40 per cent of broadacre farm families earned off-farm salaries and wages, and these wages contributed 50 per cent of family income in these households (Agricultural Council of Australia and New Zealand 1998). The decision to seek off-farm employment is generally driven by low farm incomes. Families with off-farm income tend to be operating smaller farms with lower farm incomes.



Families on mid-sized farms often experience the greatest pressure to adjust out of agriculture. The dependence of many families on small farms to supplement income means that there is little correlation between farm family income and farm size. The smallest farms are often nearest the larger population centres, and the families on these farms often have relatively high household incomes. Families on larger farms have generally maintained income through capturing productivity increases. Income pressures have often fallen disproportionately upon families operating mid-sized farms. There is evidence that the highest rates of exit from farming have been from these farms (Barr 2001). This exit has not been consistent across the rural landscape. Although these farms are mid-sized from a national perspective, they will often be the smaller farms in broadacre agricultural regions dominated by larger farms. In these regions agricultural businesses are more able to compete against amenity land purchase and to fund the purchase of land.

Farm consolidation occurs during buoyant seasons. The pattern of adjustment in these areas is very much influenced by prevailing commodity prices. During periods of low commodity prices there are far fewer businesses with the capacity or confidence to embark upon land purchase. Potential sellers are unable to get their price on the market and are less likely to sell. Those sales that do occur are more likely to be to new entrants, whose enthusiasm to purchase is less affected by poor farm business performance. The aggregate result of this is that during hard times the rate of exit from farming decreases, while the rate of entry remains relatively unchanged. This is often accompanied by an increasing ageing of the farm population. Structural change leading to consolidation is more likely during periods of high commodity prices.

In regions dominated by small farms the path to productivity increase is blocked by amenity-based land values. In small farm regions there are many barriers to the amalgamation of properties. Few existing farm businesses can create a surplus that is available to fund business expansion. Dependence upon off-farm income reduces the pressure to follow an expansionary strategy. Those businesses that do wish to expand will often be unable to justify expansion because of high land values. High land values are a reflection of amenity value, the value of proximity to sources of off-farm employment and capital in housing stock. Capitalisation in housing gives a competitive advantage to new entrants over existing landholders. There has been little farm consolidation in these areas in the past decade, and there is unlikely to be any in the foreseeable future.

Major adjustment decisions occur between farming generations. Many of the major decisions about leaving agriculture occur when farm families are considering whether the next generation will remain on the farm. There is strong evidence that fewer and fewer young persons are choosing to continue in the family farming business. This trend seems unrelated to commodity price fluctuations. It may reflect a deeper social trend in the lifestyle preferences of younger generations and the attraction of alternative career paths opened by improving educational levels. This is the major factor contributing to the increasing average age of the farming community. Deferral of farm exit contributes to a far lesser extent. Another impact is the emergence of mid-life inter-generational transfer where the decision to take over the family farm occurs when the older generation is forced out of farming by age or ill health (and transfers the farm to a son or daughter in mid-life).

These changes in agricultural structure, if continued, will lead to a sharp division in the agricultural futures of rural regions. Some regions will remain agricultural in their character. Others are on a path towards an amenity agricultural future where productivity does not drive land use decision making. There are many intermediate areas where the future is far from clear. These differing futures raise some very important questions about catchment planning and the nature of the future landscape.

## LONGER-TERM SOCIAL ASPECTS OF FUTURE LANDSCAPES

Most non-engineering attempts to control insidious land degradation, like dryland salinity, will need to be implemented over a number of generations; and most of the benefits of interventions will not be captured for several generations. During this period there will be significant changes in the structure of rural communities and economies, and community values may change significantly. Planning to control salinity to produce sustainable land use should take account of these changes where possible. While predicting the future is difficult, it is necessary to attempt to understand the current pressures for change in rural Australia and use this understanding to plan catchment strategies.

The control of dryland salinity should focus our attention on the future structure of rural landscapes. Dryland salinity poses serious challenges for natural resource policy. In many parts of the landscape, stabilising of watertables requires significant changes to the landscape. Major changes in catchment landscape will always be redistributive, having significant social impacts. There may be major social costs. Policies to implement these changes need to be gradual in their application. Even if such landscape changes are able to be achieved, there will be a lag of between fifty and several hundred years between implementation and observable outcomes. We face a similar challenge in developing a policy response to the human-induced global greenhouse effect. Many of the benefits of any investment in the abatement of greenhouse gas production will be captured in future generations.

Some important implications can be drawn from these characteristics of the salinity and greenhouse policy challenge. By following a path of landscape change, we are seeking outcomes not for the current generation, but for future generations. Therefore it is useful to ask what aspects of the landscape are future generations most likely to value and what social or environmental costs are likely to be of most concern to them.

Implementing significant changes to the landscape most frequently will only be achieved with policies which generate changes in land management over a long period of time. Policies aimed at changing landholder behaviour will need to be designed not only for landholders of the present, but also the likely landholders of the future. This raises the question of whether future landholders will have the capacity or incentive to respond to the signals or incentives which are relevant to today's landholders. Rural Australia is experiencing significant structural change which is rapidly altering the character of some rural areas and their agricultural industries. The social and economic landscapes will be changed by financial and social forces well before the policies of land use change have a biophysical impact.

Thus it is important to be aware of the contemporary social and economic forces at work in relevant rural landscapes and the implications of observable trends for catchment landscapes. In the following sections some of the factors which may cause significant change in the social structure of rural Australian landscapes over the longer term are reviewed.

### ECONOMIC FORCES

**The declining terms of trade for farm products:** Declining terms of trade have been a long-standing feature of Australian agriculture. The rate of terms of trade decline appears to have slowed in the past decade, leading to some debate as to a fundamental shift in the nature of agricultural markets. Such optimism needs to be tempered by an understanding that declining terms of trade are driven by technological innovation. In agriculture, technology often improves productivity by allowing increases in farming scale and improvements in labour efficiency. New technology will always be adopted by segments of the agricultural and food industries if it offers economic advantage. Minor advances in the technology of managing

existing farming systems bring gradual cost pressures upon those less able or willing to adopt these innovations. The result is a gradual change in the structure of agriculture as farm numbers decline. In recent years there has been an average annual 1.5 per cent decline in the number of farm establishments in Australia. This decline is the price of maintaining competitiveness (Lindsay & Gleeson 1997).

**Consequences of technological innovation:** Major technological shifts often bring major changes in the structure of agricultural communities. A review of the major technological shifts in Western agriculture by the Western Agri-Food Institute (Anon 2000) concluded that major technological shifts in agriculture always create winners and losers, and that the new technology often shifts the frontier of agriculture. The most significant major innovation cited in the Western Agri-Food Institute review is the introduction of the internal combustion engine to agriculture. This assisted in doubling the volume of wheat production in Australia and opening a new frontier in the West Australian wheat belt. The long-term concentration of most of the Australian dairy cattle within Victoria is another example of the redistributive impact of new technologies and management practices.

The question we must consider is whether there are new technologies that promise or threaten a similar shift in the structure of Australian agriculture. Two technological innovations are regularly discussed in contemporary debate: genomics and information technology. The former may create new crops or niches, or change the relativities of advantage between different regions. Unlike the majority of earlier major technological innovations in agriculture, genomic knowledge is strongly protected by intellectual property law. The technology may favour certain types of farms: those which are more closely integrated into the marketing chains of agri-food conglomerates which own the technology. This may facilitate much more tightly integrated production and marketing chains. These potential impacts of genomics are unclear in the current debate over the ethics of genetic manipulation of food.

The impact of information technology is generally expected to be the reduction of the role of 'middle-men' in many supply chains in our marketing systems (disintermediation). The most obvious example in Australian agriculture is the gradual demise and sometimes re-invention of the wholesale fruit and vegetable markets under the influence of expanding contract and direct supply relationships between major supermarket chains and producers. Changes in intermediary relationships are also occurring in other industries as Internet-based marketing tools are adopted by both producers and suppliers.

Putting aside the impacts of major new technologies, one can be reasonably confident of two clear impacts of terms of trade decline. The number of farms will continue to decline, and fewer farms will produce a larger proportion of the agricultural production of the country. These trends are obvious not only in Australia, but also in other developed nations (Anon 2000; Economic Research Service 1997; Freshwater 2000).

## CHANGING SOCIAL VALUES AND STRUCTURES

**The continuing urbanisation of Australia:** Urbanisation is an outcome of the impact of technological innovation upon agriculture. Australia is urbanising rapidly and at an accelerating rate. The State of Victoria provides a clear example. In 1920 there were 20 Victorians for every farm in the state. By 1970 the ratio had risen to over 50. Today the ratio is 175 Victorians for every farm in the state. Modelling of the potential future adjustment of agriculture suggests that this ratio, for Victoria, may be close to 400 by 2021 (Barr 2001). The contribution of agriculture to the national economy can be expected to reflect a similar decline. There are some obvious consequences that flow from this.

The culture of farming will have less and less influence upon the creation of Australian social values. At the most trite level, this means that the political influence of the farming lobby will decline. This is but a continuation of a well-established trend. More importantly, there will probably be increased demand for non-productivity values from agricultural resources. We can see the greatest example of this in the use of the multi-functionality of agriculture in the European position on agricultural trade reform. In the Australian context, multiple functions will include improved quality and quantity of water supply, improved health of riverine habitats, 'clean' food and landscape amenity (Cocks 1999; Ellyard 1998). It is possible these demands will appear more and more onerous when viewed from a traditional farming perspective.

Currently, demand for landscape amenity is a major influence upon the pattern of structural change in Australian agriculture. The influence is manifest in the high price of land in the more amenable and accessible parts of the rural landscape. These higher land prices restrict the capacity of agriculture to adjust to maintain competitiveness and inexorably drive the path of adjustment to a non-commercial agricultural future. The potential for these amenity pressures to increase over the next 20 years is strongly linked to the demographic structure of the nation. Research in the United States has shown the close relationship between rural area development and natural amenity. Over a thirty-year period, regions with the lowest landscape amenity and often the most competitive agricultural businesses experienced the greatest population losses (McGranahan 1999).

**The decline of farming as a lifestyle identity and the growth of market-based identities:**

Increasing demand for multi-functional agricultural services is only one of the changes that will be brought about by changing social attitudes. Over the past thirty years there have been major shifts in social values within agricultural communities in Australia. These changes have been documented by Bryant (1999). Bryant described three shifts in social belief structures which lead to land managers shaping new understandings of their roles as a farmer. These changes will have a significant influence upon the future patterns of structural adjustment in Australian agriculture.

The first major shift has been from a view of oneself as a farmer towards a more urban occupational identity. Farm managers increasingly are likely to see themselves less as a farmer than as a manager with skills that have much in common with other business managers outside agriculture. This is in part an outcome of the shift towards off-farm work and in part a response to the promotion of a more managerial view of farming through industry, education and government organisations. It is not unreasonable to speculate that we may see a decline in the traditional perspective that 'farming isn't a job, but a way of life', and that this may change the pattern of farm exit decisions made by Australian farmers as well as the way farm businesses are managed. Current evidence is that younger farmers are more likely to conduct sophisticated business planning (Tanewski, Romano, & Smyrniotis 2000). The increasing capacity of the agricultural sector to interact with the urban world, and the greater demands for sophisticated business management and production skills will further change the traditional agrarian values of the Australian farm community.

The second social change identified by Bryant is what she has called 'the centrality of the market in constructing the self'. This shift is seen in the trend for increasing numbers of farmers to consider their value in terms of strategic decision making on the farm, rather than their ability to undertake physical labour in an outdoor setting. This reflects trends towards the use of the language of managerialism and entrepreneurship within the wider community. As this trend continues, farm managers will less and less see themselves as farming as a way of life, and more and more construe their farming activity as a search for business profit and market opportunity, or construe their farm as a residence.

**Rural youth and the march of modernity:** A related shift in social values is the lessening attractiveness of agriculture as a career destination for younger rural Australians. This can be seen both in the decreasing entry of younger persons in to agriculture and in the continuing lowering of entry scores for tertiary agricultural courses. This loss of interest is not strongly related to the fluctuations in commodity prices, but reflects the impact of modernity upon the rural youth population (Gabriel 2000). This is the major factor contributing to the increasing average age of Australian farmers and is leading to new forms of later age agricultural entry and inter-generational transfer. These changes have the potential to create patterns of farm gentrification in some closer settled agricultural regions. These changes also have the potential to accelerate the shift towards less traditional farming identities.

**Changing gender relationships:** The third social change identified by Bryant is a shift in gender relationships on the farm. Fewer and fewer farm women identify with the traditional role of 'farmer's wife' and increasingly are likely to identify as a joint farm manager or as having an occupational life separate from the farm business. It has been estimated that women number 40 per cent of farm business partners and 32 per cent of the farm paid workforce. Many women work off the farm to support farm family living standards. This trend is a reflection of social trends beyond agriculture and has been well documented by a number of Australian researchers (Alston 1995; Argent 1999; Gournaut, Rasheed, & Rodriguez 1999; Nelson 1999; Oldrup 1999).

The change in women's roles over the past 30 years has had some profound impacts upon the process of structural change in agriculture. One of the most obvious implications has arisen from the entry of women into the workforce outside farming. This has greatly increased farm family dependence on off-farm income earned by women. It could be argued that this has in some areas reduced the pressure for structural change in agriculture by removing the imperative to increase income through farm business expansion.

The change in women's roles extends beyond the workplace into family and relationship expectations. Detraditionalisation of marriage relationships is a feature of the modern Australian farm family. Just as in urban Australia, expectations of marriage relationships are greater and the alternatives to continuing in an unsatisfactory marriage are more socially acceptable than a generation ago (Wolcott 1999). Marriage as an economic contract has been replaced by marriage as an emotional relationship, recognition of the crucial role healthy relationships play in personal wellbeing (Weston 1999). It may be that far fewer women on farms are today willing to endure what they consider to be an unsatisfactory relationship or family lifestyle. In a study of farm families in the early 90s, farm women's lack of satisfaction with marriage and family relationships was the greatest predictor of farm business failure. This was more important than farm size or profitability (Barr 1999). Thus farm adjustment patterns were, in part, being driven by pressures for relationship adjustment within families. The result in the locality under study was a shift in the pattern of adjustment from consolidation towards churning and fragmentation. The implication of this is that the successful farm business management team today has a greater need to develop the skills of communication and teamwork within the farm business and household.

The development of careers for women over the past generation has increased the difficulty of many male farmers in finding a spouse. The need to consider dual careers in relationship establishment may lead to new patterns of migration as aspiring farmers seek to accommodate the needs of potential spouses who do not wish to adopt the traditional role of farm wife. There is anecdotal evidence of decisions to exit farming or move farm location to improve the chances of finding a partner.

**Detraditionalisation of national cuisines:** Detraditionalisation is not just a phenomena of Australian agriculture. It is a force in urban Australia and in the societies with whom we trade agricultural commodities. Traditional patterns of food consumption and purchase are changing as lifestyles change, affluence increases and food availability improves. In Australia this has contributed to the growth of the market power of supermarkets in the food sector (Piggott, Griffith & Nightingale 2000). The Centre for International Economics modelled the implications of population growth and increasing affluence upon the commodity demands of our major trading partners (LWRRDC 1997). The results suggest a significant shift in the relative demand for various agricultural products. The greatest increases in demand will be for cotton and horticultural products. There will be much smaller increases in demand for cereals and beef. The modelling suggested that there was even the potential for a decline in demand for wool. Cotton and horticulture industries are major users of irrigation water. These demand patterns would increase the value of water to the Australian agricultural economy, increasing the competition for the resource within agriculture and between agriculture and both environmental uses and urban water supply. The result will be accelerated adjustment of the irrigation sector as less efficient water users respond to market signals regarding the value of water.

**The demographic progression of the baby boomer generation:** The first of the 'baby boomer' generation reached the early retirement age of 55 in 2001. The retirement of this generation will peak between 2010 to 2015. It is possible that the increase in the number of retired superannuants will boost the current trends towards the development of amenity farm landscapes. Agriculture has its own baby boomer generation. But farm retirement strategies differ from those of salaried and waged employees. A significant number of farmers continue to farm well beyond the age of 65. Barr (2001) has attempted to model the impact of farmer retirement on the demographic structure of agriculture based upon evidence of farm entry and farm retirement behaviour in the period 1986–96. The modelling suggests that by 2021 it is conceivable there will be a decline in farmer numbers of between 40 and 60 per cent. There is also the potential for the average age of farmers to rise by another three years. Within the next 20 years a large proportion of rural properties will change ownership. The impact this change in property ownership will have on Australian farming is unclear. Given the detraditionalisation of farming, the changing expectations of farm transfer and reducing attractiveness of the farm lifestyle to many young rural people, we can expect that the farm population will be considerably different from today's farm population.

#### **B R O A D E R   E N V I R O N M E N T A L   F A C T O R S**

**Fossil fuel dependency and biomass production:** Some Australian futures researchers believe fossil fuel dependency will be one of the greatest pressures for change in Australian agriculture in twenty years time (Foran 2000). Modelling of Australian energy demand and supply over the next fifty years suggests there may be a rapid turnaround in the balance between supply and demand some time after 2025 (Foran 1998). This would impose major costs upon the current agricultural production and food distribution systems. One outcome may be the growth of a bio-fuel industry to supply feedstocks for ethanol or methanol production (Foran & Mardon 1999). Such a change would radically alter some landscapes and social structures.

**Catchment plan implementation:** Increasingly, catchment communities are working with governments to develop catchment plans. A major focus of catchment plans is changed land use, with an emphasis in many areas upon increasing both tree cover and the area of perennial pastures. Increasing tree cover, if achieved through industrial plantation development, will have major impacts upon the social and economic structure of some rural communities. Evaluation of the social impact of plantation development in south-west Victoria has shown that there will be significant reduction in the demand for labour over the next 20 years (Petheram et al. 2000). Although the sowing of perennial pastures is an innovation more

compatible with existing farming systems, it is not clear that success in this venture will not be without the potential for generating its own social impacts upon the structure of farming.

Much of the land where pasture improvement is promoted for salinity control is dominated by wool production. The wool industry, being the dominant world producer, is in a unique position among the broadacre industries. Because Australian production of wool dominates the world market, future productivity improvements that increase wool production could lower the wool price, resulting in a redistribution of income across the industry, rather than an overall increase in income. Similar risks may exist for smaller industries with limited world markets. These issues are being investigated as part of a current Murray Darling Basin research project (Anon 2001).

## FUTURE SOCIAL LANDSCAPES

We can be confident that the future economic and social structure of rural communities will be different from the structures present today. Analysis of trends in the United States by the Economic Research Service of the US Department of Agriculture shows a strong decline in the dependence of many rural regions on agriculture. It also shows the growth of new economic and social structures based upon secondary industry, amenity and retirement services, public land industries and the services sector (Economic Research Service 2000). Extrapolating upon current trends we can identify some structural changes which are occurring across much of rural Australia. Social landscapes are diverging, with more regions characterised by less dependence upon agricultural production. The social characteristics of agricultural landscapes will potentially move in at least three directions, typified as: traditional agricultural, amenity and small farm-based.

**An agricultural future:** In regions characterised as traditional agricultural, agricultural enterprises will maintain their competitiveness in agriculture through farm aggregation and the continued adoption of farm management innovations and technologies. Farm incomes will remain relatively prosperous, though unstable. The progression of the terms of trade for agriculture and the adoption of productivity innovations will be crucial determinants of farm family wellbeing. Traditional agricultural regions will experience continued population decline and small town decline. The continued expansion of farm size will mean labour availability remains a major limitation on the implementation of environmental works. There will be a continuing decline in the ratio of labour units to farm area. It is probable that these farms will exhibit a mix of traditional inter-generational transfer and mid career inter-generational transfer. The West Australian wheat belt, irrigation dairy farming, cotton farming and the northern rangeland can be identified as areas following this adjustment path.

**Amenity landscapes:** These landscapes exist as the periphery around metropolitan and provincial cities. They are also found along the eastern and south-western seaboard of Australia. Here the link with farming is tenuous, with land values determined by amenities such as sea views, proximity to town and a pleasant climate. With the exception of some intensive industries, there is limited future for agriculture other than as supplementary to other activity. From a business perspective, the use of this land for agricultural purposes normally would not be expected to generate an adequate return to capital. The use of the occupational label of farming within official statistics for such areas will tend to reflect past history rather than current use. There is little likelihood that these regions will revert to any agricultural-based future.

**The small farm future:** In regions characterised as small farm landscapes most farm businesses will be unable to maintain economic competitiveness due to the high cost of land. The value of land will continue to reflect amenity and housing stock value of land rather than

its potential for agricultural production. For most small farm land managers there will be continuing or increasing dependence upon off-farm income. Farm family economic security will increasingly be reliant upon a diversified and strong regional economy. The rural population will be less likely to fall as fast as that in the agricultural areas. Production-based solutions to land degradation will become increasingly less attractive as the farm population identifies less with agriculture and the need for productivity improvements. Many areas may be increasingly valued for their ecosystem services rather than their agricultural production. There will be major questions over inter-generational transfer and land ownership in these regions during the next two decades. It is likely that subsequent generations of users of this land will have different cultural expectations with regard to the land and farming. Changes in the values and aspirations of the land-owning population may open new options for catchment protection. Some districts may move increasingly towards a form of retirement farming with a stable aged population of land managers. This scenario is most characterised by the beef industry in the high rainfall zone and in sections of the wool industry. The uncertain future of regions characterised as small farm landscapes is significant for future natural resource management policy. Substantial areas of the agricultural zone of Australia fall within this structural group, including many areas along the southern sections of the Great Dividing Range.



## 9 | FUTURE DIRECTIONS FOR SUSTAINABLE PRACTICE ADOPTION

Encouragement of landholders to adopt more sustainable management practices is easy where landowners believe that they will be better off or no worse off financially by making the change. If, however, landowners believe that they will be worse off financially there is a serious impediment to adoption. Sustainable practices which provide economic and other advantages will generally be adopted more rapidly. In most cases, any economic advantage will be influenced by commodity prices, which are outside the control of farmers and can fluctuate significantly. Ideally, sustainable practices should provide observable and positive consequences for land managers over a short time frame rather than depending on pro-environmental values of land managers.

Landholders generally seek to reduce the risk of adopting a new practice. Mara, Pannell and Abadi Ghadim (2001) have reviewed the influence of uncertainty and risk on adoption decisions. They emphasise the importance of personal experience, experimentation and learning in the adoption process, reflecting associated uncertainty and the adaptive nature of an adoption decision for the decision maker. Sustainable practices which are observable, able to be experimented with and less complex will be more quickly adopted than practices which are complex or where the outcomes are not able to be observed or have long time lags before being observed.

Very often the economic advantage of a particular sustainable management practice varies with location. It is to be expected therefore that rate of adoption will vary between districts and regions.

It makes no sense to assume that a practice with advantages in one location will yield the same advantages elsewhere. Given Australia's diverse environment few sustainable practices have universal applicability. Sustainable practices with wider geographic applicability, such as deep-rooted perennials (which usually need to be accompanied by other complementary inputs), often provide only moderate advantage to the landholder. Increased effort needs to be applied to identify and develop locally applicable sustainable practices. Effort also needs to be made to resist the temptation to promote these practices beyond localities where their advantage has been established.

### RESOURCE AND SOCIAL CAPACITY

Farmers vary in their capacity to change management practices. The linkages between socioeconomic characteristics of land managers and the use of sustainable practices have been explored in this publication. This research showed that it is difficult to predict which landholders are more likely or less likely to change land management practices. The following

factors are likely to be the most useful as indicators of landowner capacity to change to more sustainable management practices:

- participation in occupation-related training
- level of farm income
- optimism about future farm income
- farms having a documented farm plan
- membership of landcare
- age.

In fact, most of these variables were not found to be particularly strong or reliable predictors (see Cary et al. 2001 for detail).

## INTERVENTIONS TO PROMOTE THE ADOPTION OF SUSTAINABLE PRACTICES

In chapter 6 we highlighted the limited impact that pro-environmental values and attitudes have upon the adoption of more sustainable farming practices. Such values and attitudes have relatively minor impact in bringing about sustainable practice adoption when there are significant costs and considerable uncertainty associated with adoption. For significant behaviour changes the impact of pro-environmental values and attitudes tends to be indirect (and considerably delayed, through social influence) rather than directly influencing individuals' behaviour. This analysis suggests that greater influence on sustainable practice adoption will be achieved by focusing on relevant behaviours and practices rather than personal attitudes and values. Thus it will be more useful to adopt a behaviour analysis approach to encouraging appropriate NRM behaviours.

Geller (2001) identified three behavioural principles that are relevant to encouraging the adoption of sustainable practices. Here we present four principles—including Geller's three—which should inform policy making when seeking to encourage sustainable practices. These principles focus on making any intervention to change behaviour more effective. The behaviour analysis approach is based on the behavioural intervention principles developed by B. F. Skinner (1953, 1974). Skinner's behaviourism has been long established but, more recently, has been unfashionable because of its exceptionally narrow view of human behaviour as being a series of responses to external stimuli. Human behaviour is clearly much more adaptive and internally focused. However, a wider and more complex understanding of human behaviour does not preclude Skinner's behavioural principles being relevant to explaining human behaviour.

### **PRINCIPLE 1: FOCUS INTERVENTIONS ON OBSERVABLE BEHAVIOUR**

If the behaviour cannot be readily seen by the individual (and by others) it will be ineffective to encourage it; it will be difficult to monitor and to be seen as rewarded (or penalised, for its absence). Geller contends that behaviour-based intervention acts people into thinking differently, whereas person-based intervention thinks people into acting differently (Geller 2001). Person-based approaches are impractical for major interventions to change NRM practices because they are not cost-effective in community settings. Person-focused intervention requires extensive one-on-one interaction between a client and a trained intervention specialist (Geller 2001).

There are constraints to applying this principle to the adoption of many recommended sustainable practices. Many practices are not readily observable (see the section on observability in the chapter 4), and the outcomes from the practices are not apparent until a considerable time after the behaviour is initiated (see the discussion of Figure 1). The success of farm tree planting, particularly along roadside fences and in front paddocks, is an example of the effectiveness of this principle. Where a policy choice exists for intervention which involves observable behaviour it will be useful to select such interventions.

**PRINCIPLE 2 :  
LOOK FOR EXTERNAL FACTORS TO IMPROVE PERFORMANCE**

Because specific attitudes, perceptions and beliefs related to a given sustainable practice are difficult to identify and change directly it is likely to be more effective, in the first instance, to look for external factors influencing behaviour independent of individual feelings, preferences and perceptions (Geller 2001). When interventions are implemented which lead to changed individual behaviour indirectly, individuals change their attitude, commitment, and internal motivation reflecting the reciprocity between behaviour and attitude (Bem 1970; Geller 2001). (See reciprocal arrows in Figure 4.)

**PRINCIPLE 3 :  
FOCUS ON POSITIVE CONSEQUENCES TO MOTIVATE DESIRED BEHAVIOUR**

Most human behaviour is undertaken to gain a positive consequence or to escape or avoid a negative consequence. According to Geller (2001) humans learn more from their successes (i.e. are more positively reinforced) than they learn from their mistakes. Geller contends that recognising people's environment-protective behaviour will facilitate more learning and positive motivation than will criticising their environment-damaging behaviour. Ideally, to bring this principle into play for increasing the adoption of sustainable practices we need to identify NRM practices with relatively immediate positive consequences rather than less immediate, diffused, or short-term negative consequences. Practices which have outcomes that are 'soon' and 'certain' will have the most powerful motivating consequences (Geller 2001). This suggests that, given the delay in achieving sustainable environmental outcomes from many sustainable practices, the most effective practices will be those with more immediate productive outcomes and complementary (but more delayed) environmental outcomes.

**PRINCIPLE 4 :  
FOCUS ON BEHAVIOUR RATHER THAN VALUES**

A central tenet of a behaviourist focus is that behaviour is determined by its consequences and, therefore, most people are unlikely to modify their behaviour as the result of information or advice alone, especially when the information pertains to a distant future (Skinner 1987; Geller 2001). This is the conundrum (or potential folly) for promoting sustainable practices, with low or negative immediate benefits, on the basis of appeals to future environmental sustainability.

*Although people will often follow advice when the adviser's (or proponent's) information previously led to reinforcing consequences, this situation requires people to experience the reinforcing consequences of following the adviser's message. This type of learning . . . is especially difficult when the future consequences (reinforcing or punishing) are unclear, uncertain, or remote. (Geller 2001)*

Primary appeals to broad world views or abstract values are unlikely to engender effective behaviour change because such views are considerably removed or often disengaged from everyday behaviour (see linkages in Figure 4). Sustainable practice promotional strategies, promoted primarily on the basis of instrumental and more immediate benefits, can be

reinforced at an important secondary level by promotional information regarding the environmental rationale for adopting the practice. The secondary effect provides a long-term reinforcement (Boyce & Geller, forthcoming). Appeals such as 'think globally, act locally' are not as psychologically powerful as appeals to 'think locally, act locally'.<sup>2</sup>

## IMPLICATIONS FOR R & D

The most effective means for encouraging sustainable practice adoption is to primarily focus on the relevant behaviours and practices that contribute to sustainable outcomes. Interventions to change values and attitudes should be a secondary focus because values and attitudes have indirect influence on behaviour, and their influence is commonly constrained because sustainable practices may often be complex or costly, time-consuming or characterised by delayed rewards. Many practices may not be adapted or elaborated for local conditions.

Human behaviour related to implementing sustainable practices is adaptive, rather than simply reactive, in its nature. Landholders and farmers adapt their behaviour on the basis of their experience. Appraisal and implementation of sustainable practices will depend on assessment of, and experience with, the use of such practices. For landholders, the difficulty of observing linkages between many recommended sustainable practices and desired sustainable outcomes is likely to further reduce positive appraisals of sustainable practices by landholders.

## TYPES OF PRACTICES

It is the inherent characteristics of sustainable practices that usually have the biggest influence on the rate of their adoption by producers. Sustainable practices that provide economic and other advantages will generally be adopted more rapidly. There is a need to develop or identify the practices that will produce desired sustainable outcomes and be inherently attractive to potential adopters.

Landholders generally seek to reduce the risk of adopting a new practice. Sustainable practices which are observable, triable, and less complex are generally more quickly adopted than practices which are unobservable, untriable, and complex. Sustainable practices with environmental benefits are generally less advantageous to the producer, more complex, harder to trial and have benefits which are difficult to observe.

Pannell (2001b) has observed that the farm-level economics of currently available management practices for salinity prevention are adverse in many situations. As a consequence, Pannell recommended both better targeting of government programs, based on more rigorous analyses of proposed public investments, and a greater emphasis on the development of improved technologies, both for salinity prevention and for adaptation to a saline environment.

R&D programs need to develop sustainable practices with relatively immediate positive consequences rather than less immediate, diffused, or short-term negative consequences.

Effective R&D intervention means designing practices to provide external benefits to make environment-sustaining behaviour more likely (Principle 2 in previous chapter). The most motivating consequences are 'soon, certain, and sizable' (Geller 2001). The fall-back (and much more expensive) position is to otherwise change the external conditions in order to make environment-sustaining behaviour more likely (Geller 2001). The latter strategy is only feasible for government or institutional intervention rather than R&D corporations.

<sup>2</sup> And the global will obviously follow.

## **THE ATTRACTIVENESS OF PRACTICES IS NOT INDEPENDENT OF THE ECONOMIC ENVIRONMENT**

The level of relative advantage is rarely independent of commodity prices. The relative advantage of many sustainable practices (such as deep-rooted perennials) will be dependent on the value of rural commodities produced as a result of using the practice. Low commodity prices in the broadacre industries have reduced the relative advantage of many sustainable practices.

## **LOCAL ADAPTATION**

The relative advantage of sustainable practices varies in different locations. It is dangerous to assume that a practice with comparative advantages in one location will yield the same level of advantage elsewhere. Few sustainable practices have universal applicability. (See the variation in geographic applicability for the sustainable practices listed in Table 1.)

There are obvious advantages in being able to promote sustainable practices with more universal or global applicability. Firstly, messages can be simplified; secondly and more important, where a given practice or management behaviour is universally similar social pressure can be more clearly brought to bear to ensure behaviour maintenance. Social norms are easier to establish for practices that are widely used and understood than for locality-specific behaviour.

The advantage of generically global practices (for example, small-scale tree planting in higher rainfall areas) for promoting and reinforcing sustainable practice adoption is seductively attractive. However, given Australia's diverse environment, there are few sustainable practices which meet the test of global applicability. And universally applicable practices are often less likely to have large impacts on reducing local land degradation problems. The sustainable practices with wider geographic applicability, such as currently available deep-rooted perennials, often provide only moderate relative advantage to the landholder. The relative advantage will be different in different localities.

As a consequence, every advantage should be taken of sustainable practices that have widespread application. But, more importantly, increased effort needs to be applied to identify and develop locally applicable sustainable practices and effort made to resist the temptation to promote them beyond localities where their advantage has been established. When, or if, local sustainable practices are developed this approach can be thought of as locality branding of practices in the same way that certain agricultural products (such as wine) are locally branded. This is an example of 'think locally, act locally'.

## **ASSESSING PRACTICES**

To increase the likelihood that improved sustainable practices will be adopted by landholders R&D corporations have two options. First, improved management systems can be developed and adapted in conjunction with landholders in relevant localities. Second, potential improved practices being considered for promotion on farms could be market tested with typical farmers or landholders at any early stage of their development. Such an approach encompasses long established on-farm trials. However, such assessment should evaluate more than the traditional focus on technical feasibility. Potential new sustainable practices should be assessed against each of the desired attributes of geographic applicability, relative advantage, risk, complexity, compatibility, observability and trialability considered in Table 1. Ideally, a recommended sustainable practice should meet all these criteria for adoption in a particular locality. Realistically, a recommended practice should meet as many of these criteria as possible, particularly relative advantage and observability.

After sustainable practices are released and during early promotion individual practices derived from research need to be assessed—in terms of their attributes—as to why the practices are, or are not, adopted.

#### **REINFORCING LEARNING**

Given the outcomes from many sustainable practices are not readily observable (see observability characteristics in Table 1) it is important to provide reinforcing learning experiences in any promotional or extension campaigns.

Learning about and adapting sustainable practices are especially difficult when the future consequences (reinforcing or punishing) are unclear, uncertain or remote. Humans learn more from their successes than they learn from their mistakes and are more positively reinforced by their successes (Principle 3 above). Therefore landholders often need assistance to identify positive consequences of a sustainable practice as early as possible and to short-circuit early short-term failures.

An example of this approach has been the use of small on-farm pilot demonstrations for the development (and local elaboration) of conservation cropping techniques as part of the Soil Care program (Barr & Cary 1992; Wilkinson & Cary 1993). The demonstrations and pilot development are focused on local conditions, managed by a group of local property holders, and the responsibility for success or failure is shared. Once the given practice is seen to be feasible and advantageous to implement, individuals can do so knowing the consequences are likely to be positive. Such approaches help identify any immediate and positive consequences of sustainable practices which may not otherwise be readily apparent.

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