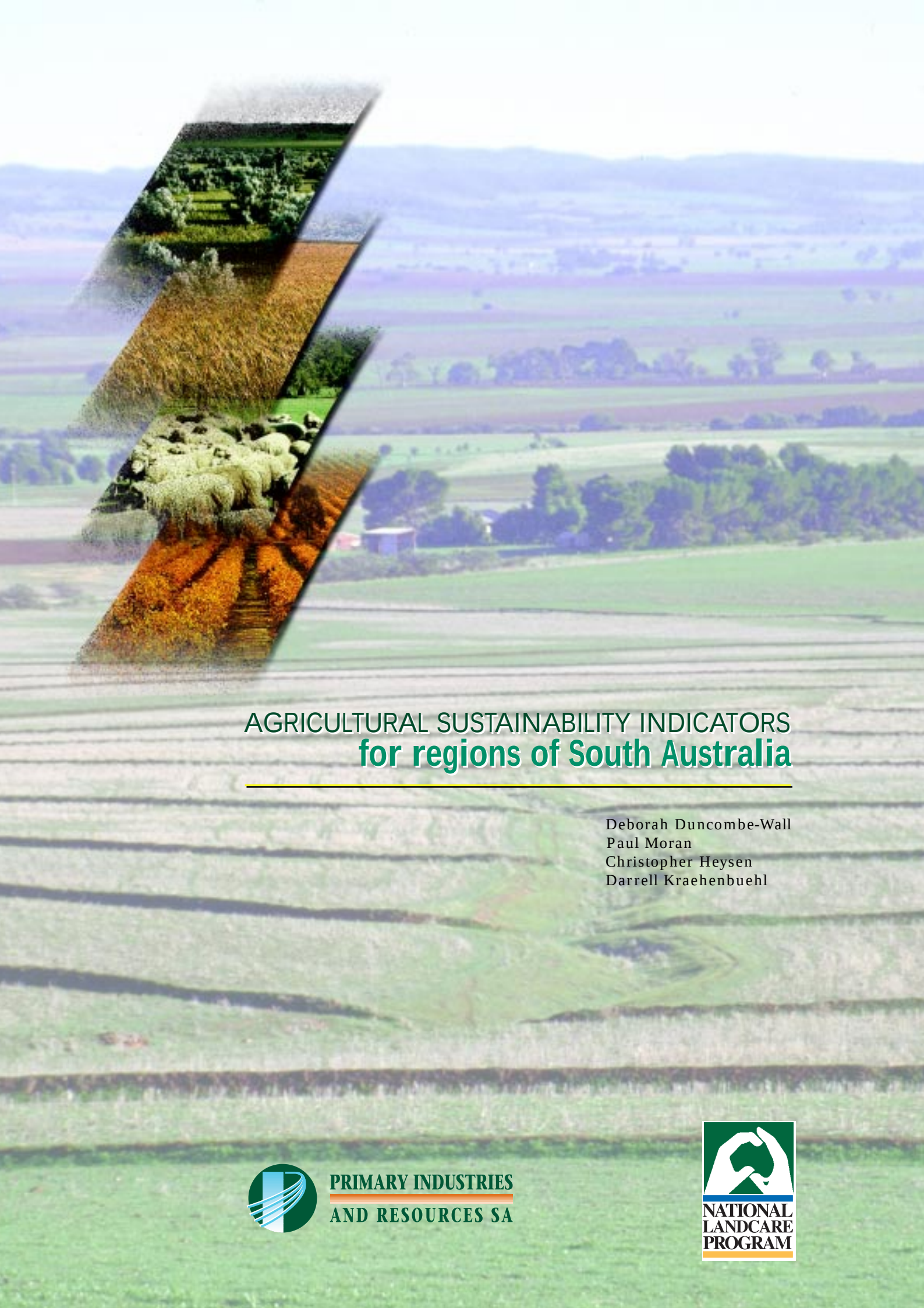

AGRICULTURAL SUSTAINABILITY INDICATORS
for regions of South Australia

Deborah Duncombe-Wall
Paul Moran
Christopher Heysen
Darrell Kraehenbuehl

PRIMARY INDUSTRIES
AND RESOURCES SA

NATIONAL
LANDCARE
PROGRAM

FOREWORD

DURING the 1990's there has been increasing public interest in ecologically sustainable development and the accountability and use of the state's soil, water, flora and fauna.

In late 1995, Primary Industries and Resources SA began the development of sustainability indicators of agriculture for South Australia. This coincided with a program of the Standing Committee on Agriculture and Resources Management, which was developing a national set of indicators to monitor the sustainability of agriculture in Australia.

This report is the first comprehensive picture of how we can measure South Australia's agricultural industry's sustainability in economic, social and environmental terms. The indicators that have been chosen are those that measure the policy framework put in place by government to improve the sustainability of the land.

Overall, there have been significant improvements in the adoption of sustainable land management practices, even against the background of falling commodity prices and higher production costs.

One of the policies of the State and Commonwealth Governments has been to develop the skills of farmers in managing the land. The indicators include an analysis of the ability of landholders to better manage the land and improve financial viability.

Further work will continue on making these indicators more useful and accessible to a wide cross section of land managers. Also there will be ongoing refinement and new indicators developed to supplement the current set of indicators.

The State Government will continue to work with the community to develop programs and policies which will ensure the long term sustainability of our valuable farming land for future generations.

ROB KERIN
Deputy Premier
Minister for Primary Industries,
Natural Resources and Regional Development

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AGRICULTURAL Sustainability Indicators for Regions of South Australia has been published as the first attempt to develop sustainability indicators at a regional and state level within South Australia.

Much of the work under pinning this report has been developmental and while it does highlight some trends in agricultural sustainability within South Australia some caution needs to be taken with the interpretation of the indicators. For example the attribute, adoption of sustainable management practices does not really measure 'best practice', as we know that 'best practice' changes over time and from one region to another. It does however indicate that there is a trend within the farming community to improve their farming enterprise through better management strategies. It also provides trend information on management practices within a region even if they aren't really 'best practice'.

While each attribute and indicator have been reported individually in some places within this report, they were designed as a suite and are complementary to each other. Neither the indicators nor their attributes should be viewed in isolation as this might lead to misinterpretation.

While this report is not a definitive measure of the sustainability of agriculture in South Australia, it is a starting point for discussion and further development of agricultural sustainability indicators, with managers, planners and community groups.

ACKNOWLEDGEMENTS

The Sustainability Indicators project team would like to acknowledge and thank the projects Technical Reference, and Steering Committees for their support and time. We would also like to thank Russell Flavel, Greg Cock, Richard Payne and Bill Davies for their contributions to the direction of sustainability indicators project.

Designed by PIRSA Graphics
Prepress by The Bureau
Printed by Custom Press

ISBN 0 7308 4398 X

CONTENTS

1. INTRODUCTION

The Sustainability of agriculture in South Australia

Agriculture is a key primary industry in South Australia and makes a significant contribution to the wealth and quality of life for urban and rural communities within the state. This is the first report on the indicators of the sustainability of agriculture for South Australia. The indicators have been established to monitor and evaluate the progress of the state's agricultural industries towards achieving the goals of sustainable agriculture. These indicators are for government, industry bodies, community leaders and primary producers to better target their policies, programs and activities to pursue the economic sustainable development of agriculture for generations to come.

Background

In 1993 the Standing Committee for Agriculture and Resource Management (SCARM) proposed a set of indicators to monitor the sustainability of agriculture at a regional and state level. These were to be based on relatively simple data sets, many of which were already available for extensive areas of the country. During 1994 and 1995 a pilot feasibility study on the proposed indicators and their attributes was conducted by scientists from Commonwealth and State agencies.

In July 1995 SCARM established the National Collaborative Project on Indicators for Sustainable Agriculture (NCPISA). This project attempted to finalise the technical development of the agreed indicators and attributes from the pilot study. It also assembled relevant data to provide the first national report on the sustainability of Australian agriculture, including trend analysis within the past decade.

In late 1995 South Australia begun the Agricultural Sustainability Indicators for Regions of South Australia project, which utilised the methodologies that were developed for the NCPISA project. Unlike the NCPISA project, the State project has a regional focus. This project created indicators for the Agri-Ecological Systems for South Australia and in some cases the indicators were able to be developed right down to Statistical Local Areas (similar to Local Government Areas).

Sustainable agriculture

Sustainable agriculture is the use of farming systems and practices, which maintain or enhance:

- the economic viability of agricultural production;
- the natural resource base; and
- other ecosystems which are influenced by agricultural activities.

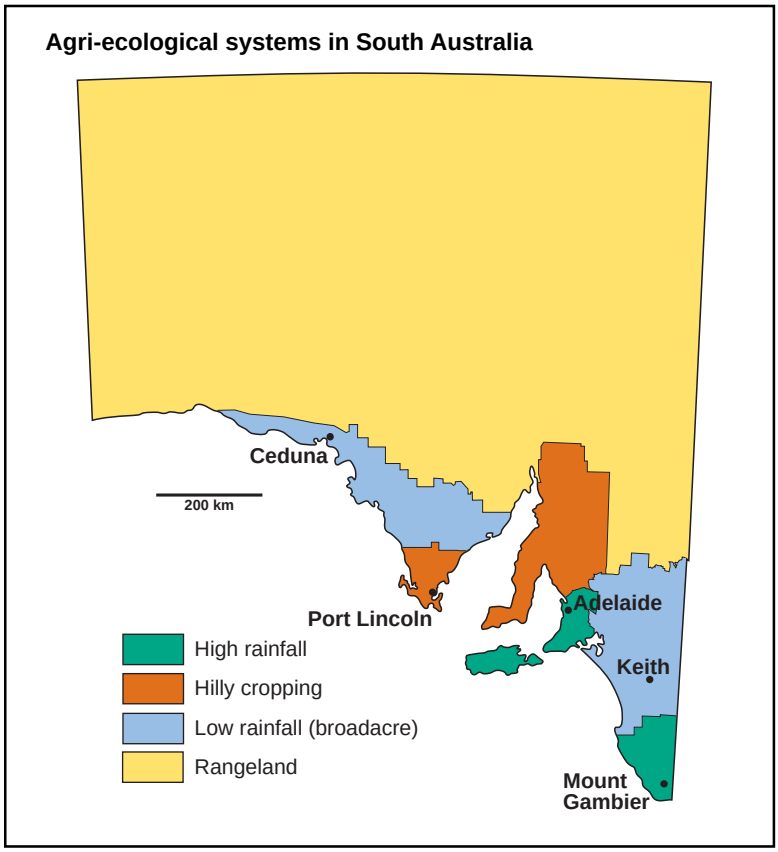
Its basic goals are that:

- farm production is sustained or enhanced over the long term;
- adverse impacts on the natural resource base of agriculture and associated ecosystems are ameliorated, minimised or avoided;
- residues resulting from the use of chemicals in agriculture are minimised;
- the net social benefit (in both $ and non-$ terms) derived from agriculture is maximised; and
- farming systems are sufficiently flexible to manage risks associated with the vagaries of climate and markets.

(Source: Standing Committee of Agriculture 1991. Technical Reports Series No. 36, pp. 4-5.)

Agri-ecological systems of South Australia

To assist in reporting on the sustainability of agriculture at a local level, South Australia has been divided into Agri-Ecological Systems. These are regions where there are similar agricultural production systems and environmental conditions, climate and soils.



High rainfall

This system has a winter growing season and a rainfall exceeding 500-550 mm per annum. Pasture systems are based on legumes and perennial grasses. A wide range of land uses is associated with the opportunity to harvest water, the extent of groundwater available and the long growing season.

Hilly cropping

This system has an undulating to hilly landscape and a rainfall generally in excess of 375 mm per annum. It provides a safe and reliable climate for mixed farming systems, with a growing season generally exceeding six months. The altitude varies from sea level to 700 m above sea level resulting in significant temperature variability and the relatively small average farm size allows for more intensive management of the land.

Low rainfall

This system has a rainfall of 350 mm and below, it is vulnerable to climatic variability and is likely to exhibit adjustments in the scale and nature of farming. The main commodities produced in this system are wool, cereals and dairy.

Rangelands

This system is based on the use of natural pasture and rangeland species for grazing without cropping. The main industries operating in this system are wool, meat and hides from sheep, cattle and kangaroos, and feral animal harvest such as goats, rabbits and horses.

2. SUSTAINABILITY INDICATORS

IN general, agricultural industries in SA have been continually changing to be more productive and competitive on the international market. This has occurred whilst limiting the detrimental effects on the soil, water, flora and fauna it relies upon. Unfortunately it is not realistic or possible to give a single rating of sustainability for agriculture in SA as the indicators and attributes are so diverse. However it is possible to form a general picture on how well the state is performing by considering all the indicators and their attributes collectively.

Indicator definition

Indicators are a composite set of attributes or measures that embody a particular aspect of agriculture.

Indicator criteria

- Utility - meeting the needs of decision-makers at regional and national levels.
- Applicability - at both the national level and capable of differentiation at regional levels.
- Assisting decisions - they help to make to better decisions.
- Validity - satisfy valid sampling, statistical and consistency methodologies.
- Comprehendible - allow for unambiguous interpretation of issues, trends and comparative states.

Attribute definition

Attributes are numerical descriptions of individual parameters or responses.

Attribute criteria

- Validity - the soundness of the attribute to actually represent the physical/socio-economic object that the attribute was designed to measure.
- Utility - the ability to apply the attribute with ease and effectiveness.
- Specificity - the applicability of the attribute to all industries/regions and at a national scale.
- Data availability - the availability of a data source to quantify the attribute, ie. data are collected on a regular basis and at a frequency appropriate for reporting.

3. STATE OVERVIEW

The following provides a summary of the findings in relation to each indicator and its attributes.

Long-term real net farm income

From 1979 to 1995 there has been a decline in net farm income within the broadacre and dairy sectors of agriculture within South Australia, though net farm income is still above the Australian average.

However, the efficiency of broadacre and dairy production has increased considerably from 1978/79 to 1994/95 (above the Australian average), through the steady growth in productivity. During this time, outputs virtually doubled while inputs rose slightly.

There has been a downward trend in the Terms of Trade Index for the state from 1952/53 to 1994/95, which is in line with the general trends of major world economies. In real terms a continuing narrowing of the margin between input and output prices means farmers must improve productivity to maintain net farm incomes and remain profitable.

Overall, the debt servicing capability of the rural sector in South Australia is in a good position and the two rural debt surveys of 1994 and 1996 showed a declining trend in the proportion of farms experiencing debt servicing difficulties.

From 1983 to 1996 there has been little change in the number of farms with an estimated value of agricultural operation in excess of $22,500.

Unfortunately state wide data on net farm income and productivity is only available for broadacre farming and dairying industries and terms of trade data is limited to broadacre farming only. No net farm income data is available for the horticultural industry.

Managerial skills

From 1986 to 1991, the levels of education in the farming community has increased with the number of farmers with higher level qualifications from trade certificates to higher degrees rising significantly. More farmers are now undertaking higher studies that will lead to better resource management and therefore more effective and sustainable prospects for agriculture. However comparisons with other sectors shows that the rural community still lags significantly behind that of the general population in terms of formal education.

There has been a relatively widespread adoption of practices that protect or improve soil condition.

Farmer's participation in informal training varies across the state but significantly fewer farmers in the livestock industries attend informal training or have a farm plan. There needs to be more work done to promote the financial and sustainability benefits of both training and farm planning to these farmers.

Surveys have shown that the sources of resource management information of most value to farmers are friends and relations, the media, technical journals (except for the Rangelands) and field days, reach a large number of farmers.

Land and water quality to sustain production

Due to improved land management practices there has been a significant improvement in the water use efficiency for wheat and barley from 1965 to 1994.

From 1986/87 to 1994/95 potassium and phosphorous fertiliser usage in South Australia has dramatically increased. The soils in S.A. are naturally poor in phosphorous and without annual application of fertiliser the soil would eventually loose its capacity to sustain the productivity of current farming systems.

In 1996/97 perennial vegetation in the South Australian Rangelands was in a reasonable to good condition relative to the previous five years.

Data on soil acidity and sodicity was not available in time for inclusion in this report but will be available in future reports.

Offsite environmental impacts

Improved land use practices such as improved tillage methods and stubble retention from 1986 to 1996 have resulted in a considerable reduction in the level of wind erosion in the past 20 years. Continued improvements in land use practices that retain surface cover are necessary to ensure this trend is maintained.

In 1993 the potential impact of agriculture upon conservation reserves varied across the state in intensity and form. Potential impact was minimal in the Rangelands due to the large size of reserves and low intensity of agriculture. The highest potential impact is in the Hilly Cropping region due to the large area of agriculture compared to conservation reserves and the greater intensity of agriculture in this region.

Data on chemical residues and salinity levels in streams is available at the national level but cannot be reported at state or lower levels.

4. REGIONAL HIGHLIGHTS

Rangelands agri-ecological system

Long term real net farm income

From 1979 to 1995, broadacre net farm income has been variable due to the variability of the wool and sheep prices, and seasonal conditions. This region has experienced low input growth over time in production inputs, resulting in low productivity though still above the Australian average.

Managerial skills

Farmer education levels have increased within all age groups during 1986 to 1991. This region has more managers who have completed secondary schooling than any other region. However less than 25% of the pastoralists from this region attended any form of informal training and still more pastoralists have higher qualifications (above secondary school education) that are not related to improving their farming management.

There has been a 95% adoption rate in the use of piped bore water supplies for stock, to spread the effects of grazing pressure around watering points. The legislative requirements of the Pastoral Land Management and Conservation Act 1989, lease conditions, maximum stock numbers, and regular inspections of land condition have also improved the stability of agriculture within this region.

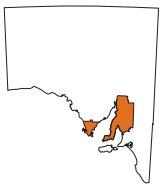
Technical journals are valued less as a source of farm management information in this region compared to the other systems in the State.

Land and water quality to sustain production

Perennial vegetation was seen to be in reasonable condition relative to the previous five years. This is largely due to the monsoonal weather influences in early 1997, which brought significant rainfall to much of the pastoral area. Severe wind erosion in this region has occurred in the Northeast areas.

Offsite environmental impacts

The potential impact of agriculture upon conservation areas within this region is low due to the low ratio of boundary length per area of conservation reserve, and the significant area conservation reserves with low disturbance.



Hilly cropping agri-ecological system

Long term real net farm income

While this region has had a very slight downward trend in the net farm income for broadacre and dairy farming, it has had the greatest growth in productivity of agri-ecological system in S.A. The downward trend in net farm income is now generally stable, as a result of good seasons, a move away from sheep into continuous cropping, and a diversification of cropping has spread income risk across a range of enterprises.

Managerial skills

A large number of farmers within this region have been involved in a number of different forms of informal training. Also a large number of farmers have mid range qualifications (certificates and vocational education). Census data collected in 1986 and 1991 show that there has been an increase in the number of farmers with qualifications that focus on farm management.

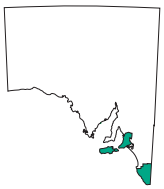
The adoption of sustainable management practices has been high with 91% of farmers using practices which manage soil structure decline and soil erosion, 88% of farmers using crop management to build up soil nutrients and 93% of farmers using stock exclusion from agricultural areas. From 1965 to 1994 this region performed best in the state in terms of water use efficiency.

Land and water quality to sustain production

From 1986 to 1996 there has been an increasing amount of potassium being applied to pastures and horticultural crops within this region. The region has a negative potassium balance with more potassium being taken off farm then is being applied, with most of the potassium being removed through cropping. There is a positive phosphorous balance in this region but a decreasing positive balance for the pastures.

Offsite environmental impacts

There is a high ratio of total area of agricultural land per total area of conservation reserves within this region.



High rainfall agri-ecological system

Long term real net farm income

In terms of broadacre agriculture and the dairy industry, this region on average has had the lowest productivity levels (though still above the Australian average) than any other region. This region is lowest in net farm income than any other region in South Australia and there is a strong downward trend in net farm income in this region.

Managerial skills

The 1986 and 1991 Population Census revealed education levels within this region are increasing with a larger number of farmers having higher qualifications than any other region. However, less than 25% of farmers within this region have attended informal training, such as property management planning workshops/activities, landcare group workshops/field days, industry grower groups or crop/pasture checking group's etc.

There have been high adoption rates by farmers of a number of sustainable management practices within this region such as soil nutrient testing (89%) and the use of improved deep rooted perennial pasture species (70%).

Land and water quality to sustain production

Despite an increase in potassium use from 1986/87 to 1994/95, much of region has levels of potassium, which are barely adequate to marginal for pastures, and marginal to low for potatoes and other vegetable crops. The negative potassium balance has been a result of more potassium being removed through pasture production than has been applied. This region however was seen to have a highly positive phosphorous balance with most of the phosphorous being applied to and being removed by grazing.

Offsite environmental impacts

The combination of intensive agriculture and the small area of conservation reserves means that there is a high level of contact between agricultural and conservation areas.

Low rainfall agri-ecological system

Long term real net farm income

Low input growth levels from 1979 to 1995 for broadacre and dairy farming, has resulted in moderate productivity gains which may be at the expense of the natural resource base. There is a strong downward trend in net farm income within this region.

Managerial skills

There are a large number of farmers with mid range qualifications (certificates and vocational education) within this region and also the largest number of farmers with only lower secondary education than any other region. The proportion of farmers that have progressed beyond secondary level education is low but a large number of farmers have attended different forms of informal training.

Land and water quality to sustain production

Marginal areas within this region have improved the least in terms of water use efficiency for wheat and barley. This may be due to a combination of factors related to climate, low profitability and the limited flexibility these regions have in their farming practices in general, and cropping rotations in particular.

There has been an increase from 1986/87 to 1994/95 in the amount of potassium being applied in this region with most of it being applied to pastures and horticultural crops. However there is a strong negative balance for potassium with most of it being removed in crop production. There is a strong positive phosphorous balance in this region, but the continuing trend of slightly decreasing phosphorous fertiliser applications and almost steady state of phosphorous removal through broadacre production is resulting in a decreasing positive trend for pastures.

Offsite environmental impacts

This region has experienced low to moderate levels of wind erosion. Practices to control soil erosion have been adopted by 71% percent of farmers within this region.

The combination of intensive agriculture and the high ratio of boundary length per area of conservation reserve means that there is a high level of contact between agricultural and conservation areas, which is due to the small size of the conservation areas.

5. SUSTAINABILITY INDICATORS AND ATTRIBUTES IN FOCUS

Indicator: Long-term real net farm income

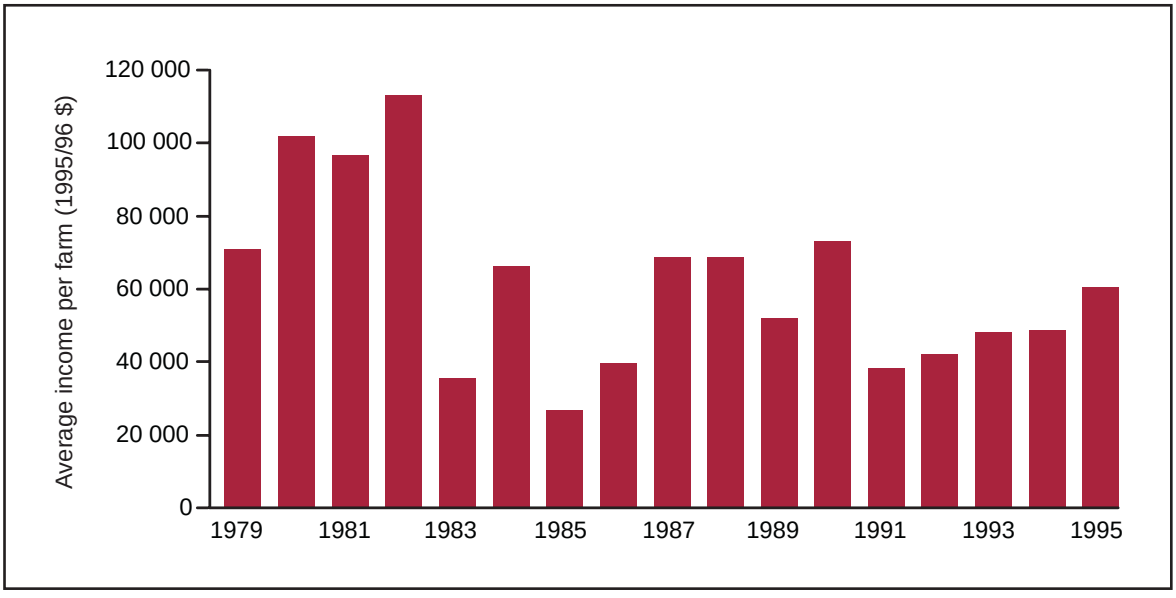
PROFITABILITY is one of the primary indicators of agricultural sustainability over the long term. It reflects the economic viability of the agricultural sector. This study assumes that this indicator will reflect changes (improvement or decline) in land quality and degradation over the long term.

Attribute: Net farm income

Long term real net farm income is defined as the change in the long-term net farm output, real value of agricultural production minus real value of farm costs.

Farm incomes from broadacre and dairy agriculture across South Australia have fluctuated widely from 1979 to 1995. There is an underlying decline in income, broadly in line with the fall in the terms of trade during the period. However in recent years there is an apparent upturn in trend in both terms of trade and average net farm incomes but it is too early to tell if this is a short term reversal or the start of a new longer term improvement in rural incomes. Note the effect of drought years from 1982.

Average broadacre and dairy net farm income for South Australia.



(Source: ABARE, Farm Survey Report)

Attribute: Terms of trade

Terms of trade measures the change in market prices of farm commodities relative to farm inputs across the industry as a whole and has a direct influence on Real Net Farm Income. Each index is derived from changes in the prices of a fixed 'basket' of goods and services that farmers purchase and sell.

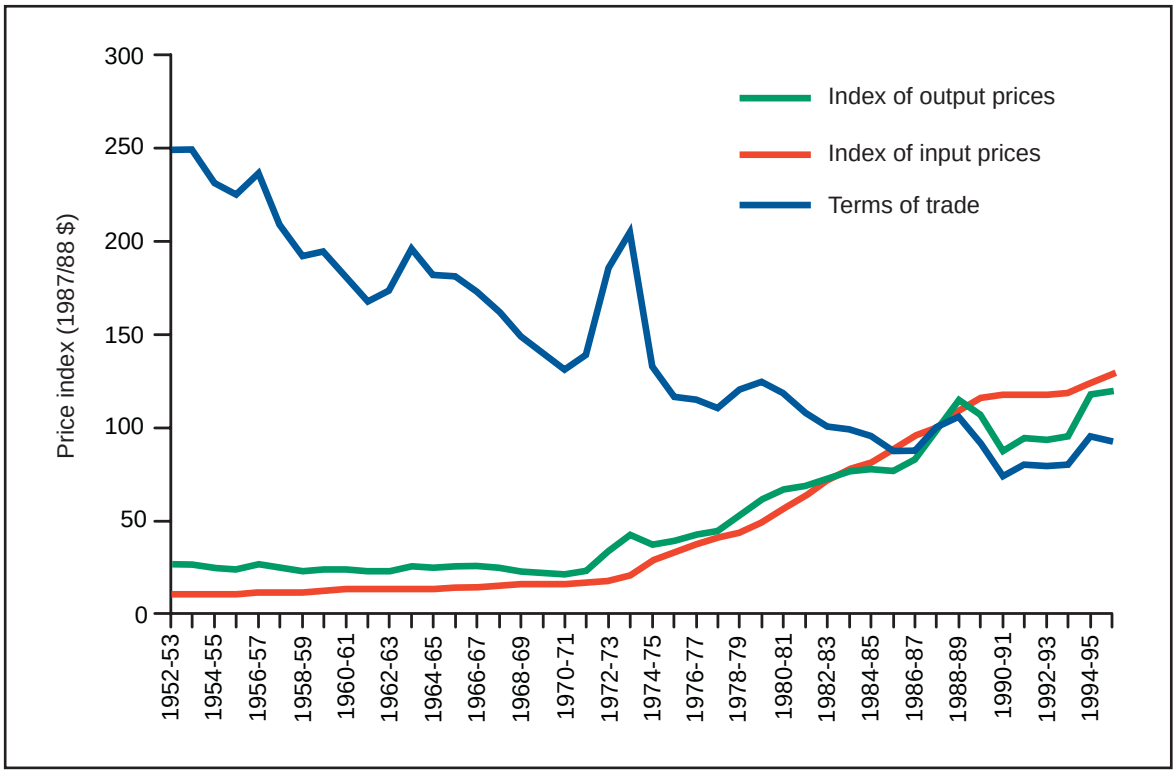
Farmers' terms of trade is the ratio:

$$\frac{\text{Index of prices received}}{\text{Index of prices paid}}$$

Input prices for the goods that farmers use has risen gradually up until 1972/73 and then sharply from then on. There are a few years in the early 1990's where the curve is almost flat. The index of output prices has also risen, although generally at a slower rate and with steeper increases and decreases in the early seventies and late eighties.

The calculated terms of trade from the two indices shows a declining trend to 1994/95. This trend in the narrowing of the margins between inputs and outputs reflects the need for farmers to continually improve productivity to maintain net incomes and to remain profitable.

Terms of trade for broadacre farms in SA – 1952/53 to 1995/96.



(Source: ABARE)

Attribute: Productivity

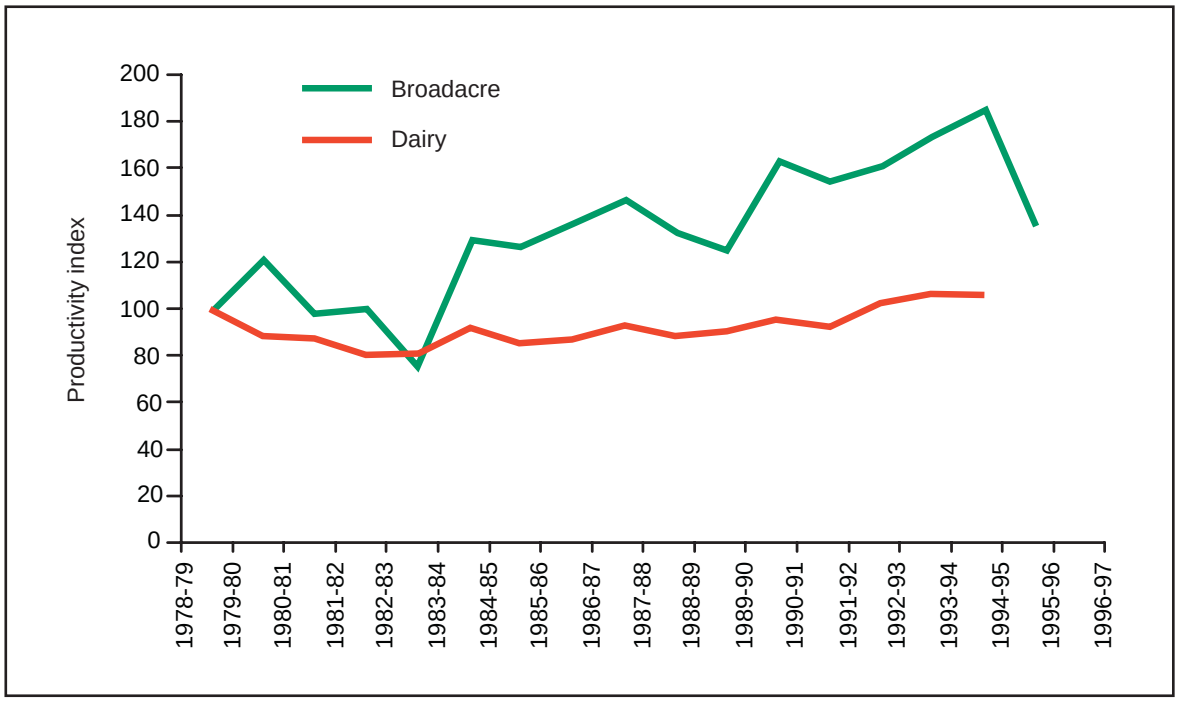
Productivity is expressed as a ratio of an index of the total value of agricultural production to the total value of farm resources used, at constant prices.

There has been a relatively steady growth in the productivity of broadacre agriculture from 1978/79 to 1994/95. The dip in productivity in the early 1980s occurred during a period of relatively high commodity prices as a result of drought years, when outputs fell.

It is notable that while outputs virtually doubled during 1978/79 to 1994/95, inputs rose by slightly less than 10%. The efficiency of production has therefore increased considerably and reflects improved technology.

This increase in productivity has occurred while farm incomes have actually fallen by some 15% during 1978/79 to 1994/95. This demonstrates the negative effect on farm incomes of the terms of trade, which have fallen by about 30% since 1979.

Productivity index for South Australian broadacre farms and dairying 1978/79 to 1994/95.



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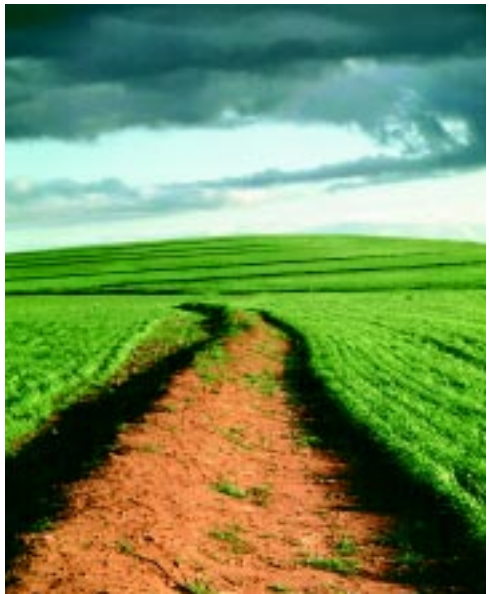


Attribute: Debt servicing capability

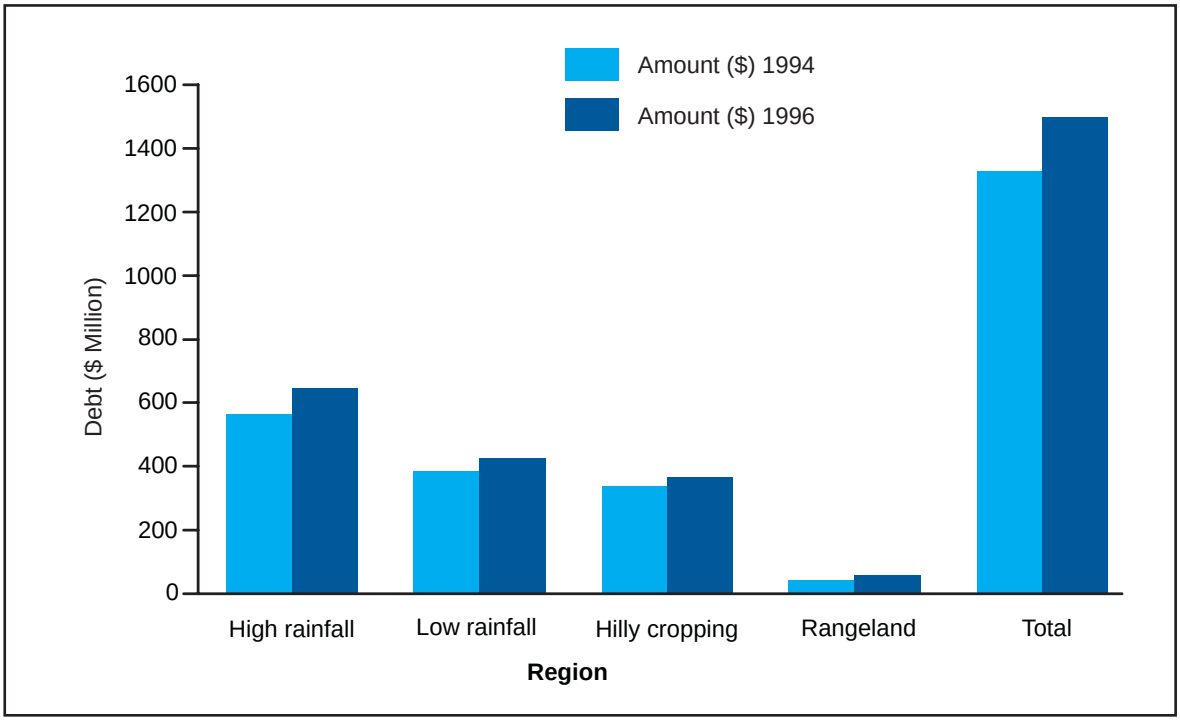
Monitoring debt provides an early warning of problems with farm business sustainability.

Overall the debt servicing capability of the rural sector in South Australia is in a good position. While detailed analysis has not been possible for subsequent years, low interest rates and a series of good seasons since then would have contributed to further significant improvements.

The two rural debt surveys of 1994 and 1996 (Durham & Kidman 1994, 1996) showed a declining trend in the proportion of farms experiencing debt-servicing difficulties. In 1994, 18% of all farmers faced deteriorating debt positions and 5% were considered beyond redemption. By 1996 these figures had fallen to 6 % and 2% respectively.

Regionally, the High Rainfall Agri-Ecological System holds 43% of the total rural debt.

Total debt in South Australia – 1994 and 1996.

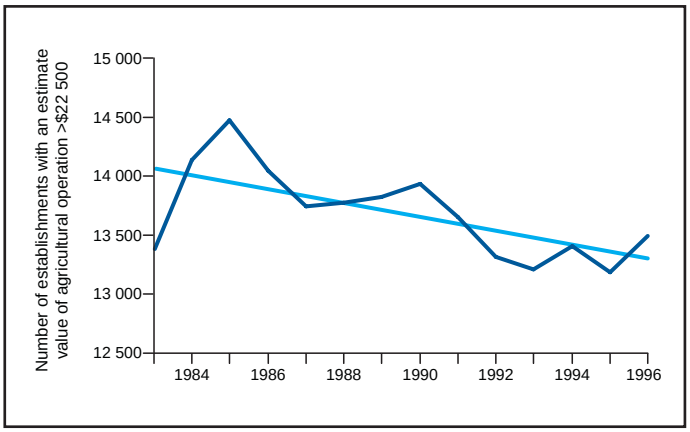


(Source: Durham & Kidman 1994, 1996)

Attribute: Numbers of farms

From 1983 to 1996 there was little to no change in the number of agricultural establishments across South Australia, with an estimated value of agricultural operation (EVAO) of greater than $22 500. Over this time there was an increase of 128 agricultural establishments (0.07% change). However, a sharp increase in the number of agricultural establishments occurred around the mid 1980's, with a peak in 1985 of 14 476 farmers.

Change in the number of agricultural establishments in SA – 1983 to 1996.



(Source: ABS)

Indicator: Managerial skills

THIS indicator is a measure of human resilience and the ability to respond to change and recover after stress. It is based on the idea that farmers should be encouraged to use information, planning and self-management as methods for withstanding normal economic and climatic fluctuations and droughts. Therefore sustainable agriculture can be measured through the changes in the level of managerial skills of farmers, landholders and land managers in finance, farming practice and environmental stewardship.

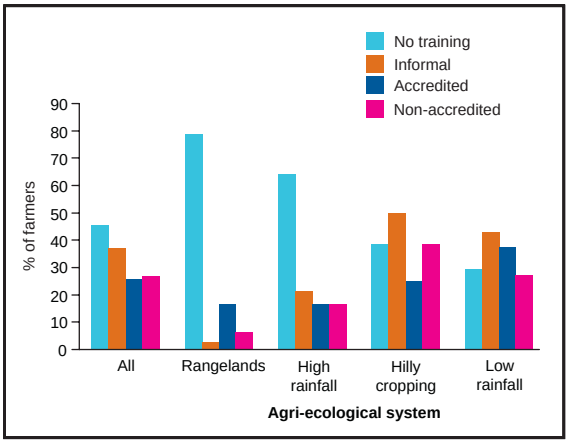
Attribute: Participation

This attribute aims to quantify the level of active commitment and involvement in activities to promote sustainable agriculture. It is designed to capture farmer participation in a range of informal training activities and participation in community groups such as Agricultural Bureau's and Landcare.

Across South Australia as a whole, more than half (approx. 55%) of all farmers had undertaken one or more informal training activity such as property management planning workshops/activities, landcare group workshops/field days, industry grower groups or crop/pasture checking groups. Most people had undertaken non-accredited short courses with a smaller percentage in accredited TAFE or distance education courses.

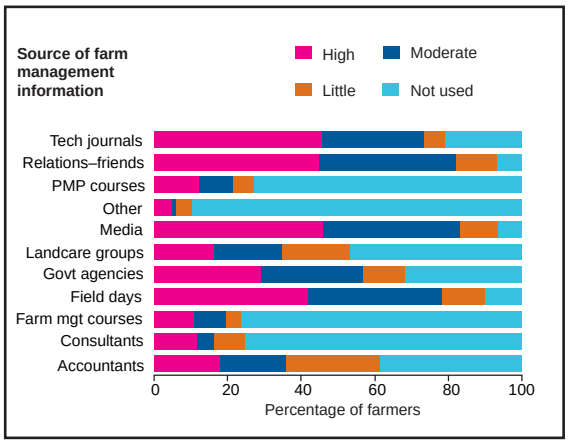
The sources of farm management information which were of most value to farmers from 1993/94 to 1995/96, were friends and relations, the various forms of media, field days and technical journals. Government agencies were of high or moderate value to a little over 50% of farmers while Landcare groups and accountants were of value too less than 40%. Property Management Planning or Farm Management courses and consultants were of moderate to high value for around 20% of farmers.

Percentage of farmers within each agri-ecological system attending training courses 1995-96.



(Source:ABARE)

The value of various sources of farm management information used in the last three years, within South Australia – 1995-96.



(Source: ABARE)

Attribute: Farmer education

This attribute is based on the premise that improved educational standards leads to better management and therefore more effective and sustainable land use. Therefore this aims to measure changes in education levels as a surrogate measure of changes in managerial skills of farmers and farm managers in the fields of finance, farming practice and environmental stewardship.

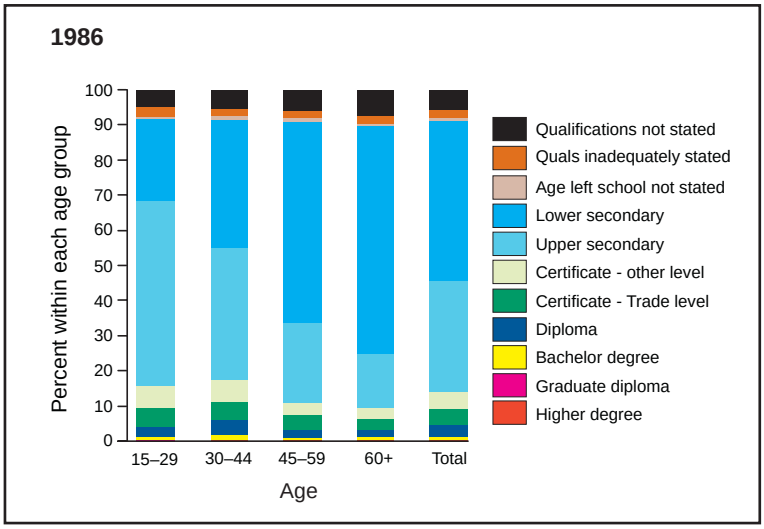
The results from the 1986 and 1991 Population Census show that generally the farming community of South Australia has become better educated through time.

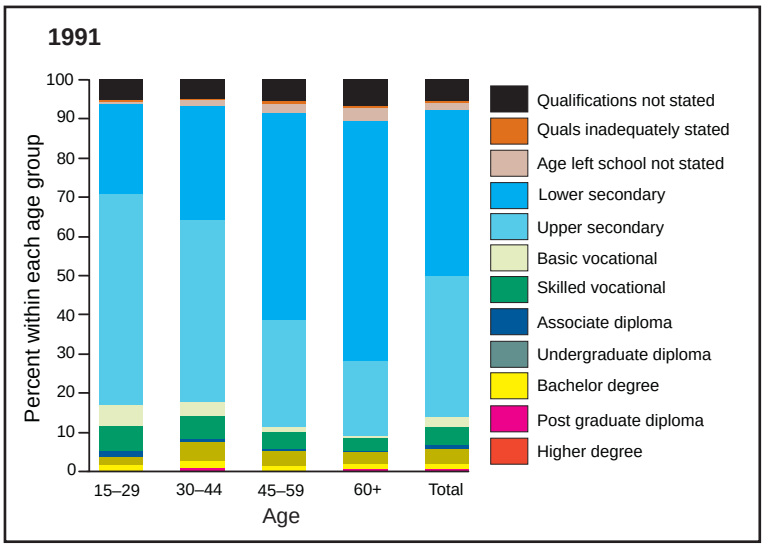
In 1986, over 68% of farmers in the youngest age group of 15-29 years had completed secondary schooling, including 16% that had gone on to further study (of which about half was relevant to farming). This compares with the oldest age group of farmers, ie. 60 years and over, who were generally educated 40-50 years earlier, where only 25% had completed secondary or higher education.

This trend continues in the 1991 census data with nearly 71% in the youngest age group of farmers completing secondary school or higher. In addition, the number of farmers with higher level qualifications, from trade certificates to higher degrees, has risen significantly.

In the 1986 census, 9.5% of farmers aged 60 years and over had higher level qualifications (beyond high school) and of these, less than a third were relevant to farming. Of the youngest cohort of farmers in 1991 (those aged 15-29 years) over 17% had higher level qualifications, of which two thirds were relevant to their farming enterprise. Data from these two census show the proportion of farmers undertaking relevant higher studies has increased by four times from 2.6% to 10.5%.

Percentage of farmers in each age group and education level.





(Source: ABS Population Census)

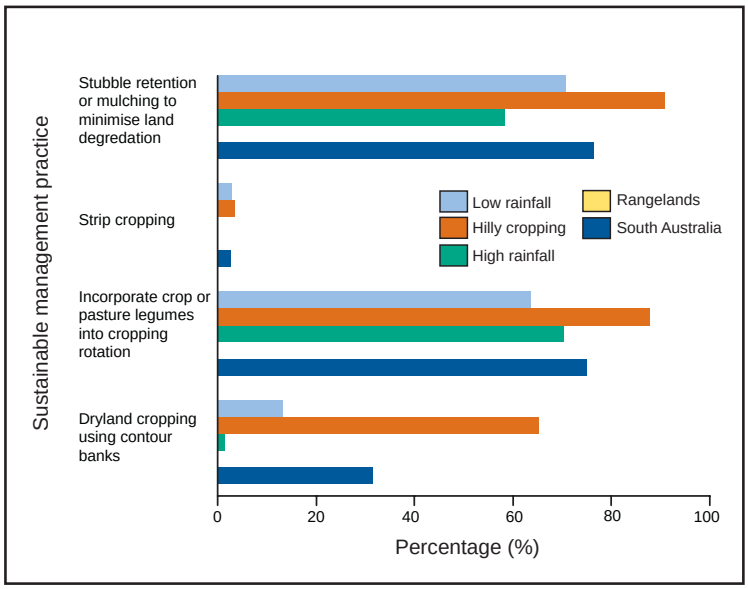
Attribute: Implementation of sustainable management practices

This attribute measures the level at which farming practices are actually being used by landholders; irrespective of education or participation in landcare.

Although these results are from a one-off survey, knowledge of past farming practices enables a judgement that in recent years there has been relatively widespread adoption of practices that protect the soil or improve its fertility and structure. This is especially so in the Hilly Cropping region where minimum tillage and stubble retention techniques are now being used by a significant majority of farmers. In the Low Rainfall region, cropping is more opportunistic with a high degree of risk and the expenditure required to change equipment may be beyond the capacity of many farmers.

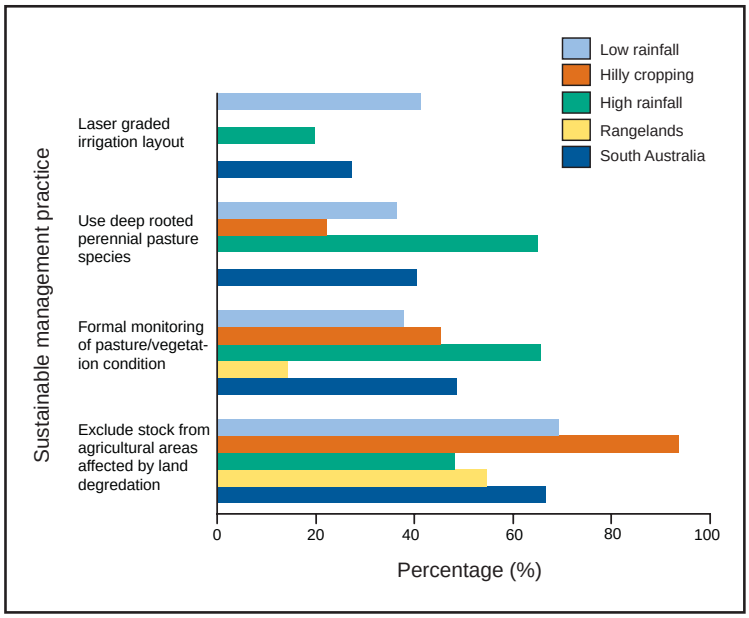
In the Rangelands, the majority of properties have reduced the concentration of grazing intensity around major waterpoints through the installation of a large number of reticulated and controlled watering points using piped water from bores and dams. This enables better management through spreading grazing pressure over a larger area and reducing the dust bowl effects previously evident in the vicinity of sparse bores, tanks and dams. The establishment of a detailed lease assessment in 1989 under the Pastoral Land Management and Conservation Act means that assessments of the condition of the land and estimates on its capacity to carry stock, have also help to improve the sustainability of agriculture within the Rangelands.

The percentage of farmers who have adopted various applicable management strategies for cropping management 1995/96.



(Source: ABARE)

The percentage of farmers who have adopted various applicable management strategies for pasture establishment and maintenance 1995/96.



(Source: ABARE)

Indicator: Land and water quality to sustain production

IF land becomes toxic, nutritionally impoverished, physically constraining or biologically diseased so that crops, pastures and animals cannot grow to at least part of the level set by their genetic potential and the climate, then agriculture will collapse. This indicator aims to show the trends in land and water in terms of "quality" which affect the long term production of vegetation and animals at levels set by climate and land capability. It therefore focuses on the maintenance and enhancement to the natural resource base for agricultural production.

Attribute: Rangeland condition

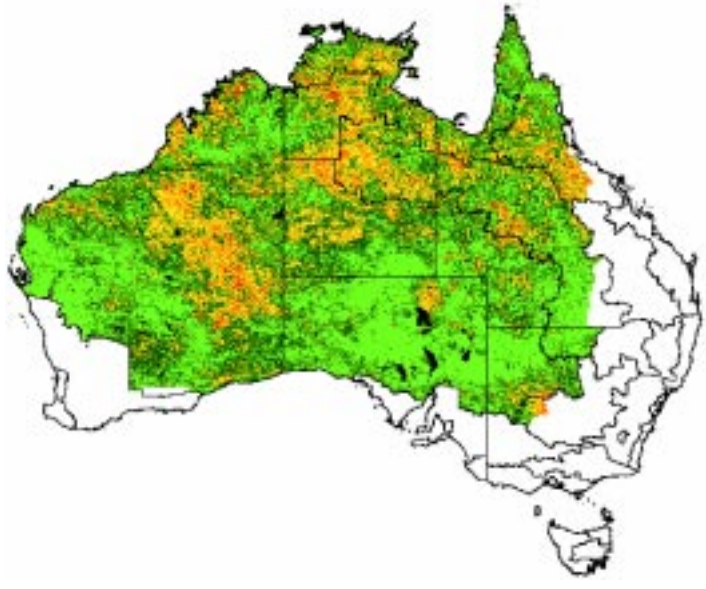
The Normalised Difference Vegetation Index (NDVI) is used as a surrogate measure for Rangeland condition. It measures the greenness of vegetation cover as an indication of the condition of the Rangelands. It is interpreting short to medium term changes in the amount of green material by measuring the change in baseline NDVI. This measure is useful to indicate areas that show an abnormal response relative to a baseline. It largely indicates the response to recent rainfall.

These results indicate that in 1996/97 the South Australian Rangelands were in a reasonable to good condition relative to the previous five years. This is largely due to heavy monsoonal rainfall in early 1997, which brought significant rainfall to much of the pastoral area.

In contrast to the other states only a small portion of the South Australian Rangeland was in the yellow to orange spectrum. For example those pixels for which the 1996/97 values were in the middle to bottom third of the observed values for this time series. Most of the pixels in this category were in the region of the Simpson Desert, to the north and north east of Lake Eyre. This is an area for which the NDVI analysis is of limited value due to the nature of the desert itself which is mostly clay pans with naturally very low levels of perennial vegetation.

Photographic monitoring sites installed on pastoral leases indicate a general improvement in condition since the 1970's. Over time these sites together with remote sensing technology, should provide more quantitative indications of those trends.

Rangeland condition index map – 1996/97.



Key to pixel colours

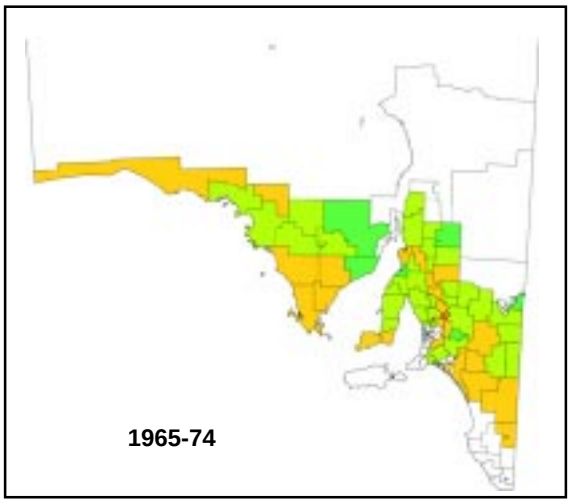
Green	Equal to or higher than the previously observed highest greenness value.
Khaki	In the top third of previously observed range of greenness values.
Yellow	in the middle third of the previously observed range of greenness values.
Orange	In the bottom third of the previously observed range of greenness values.
Red	Equal to or lower than the previously observed lowest greenness value.

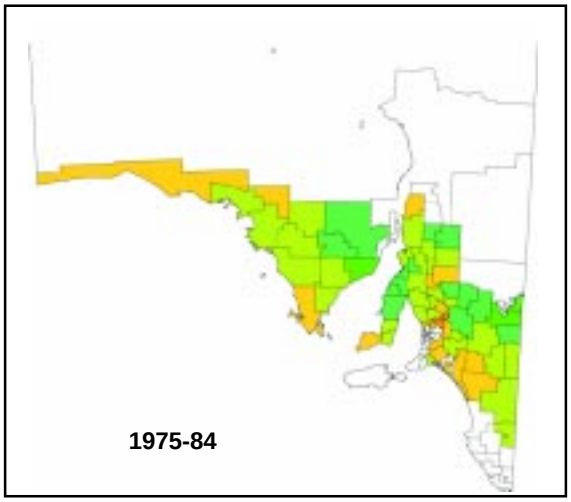
(Source: NCPISA, 1998)

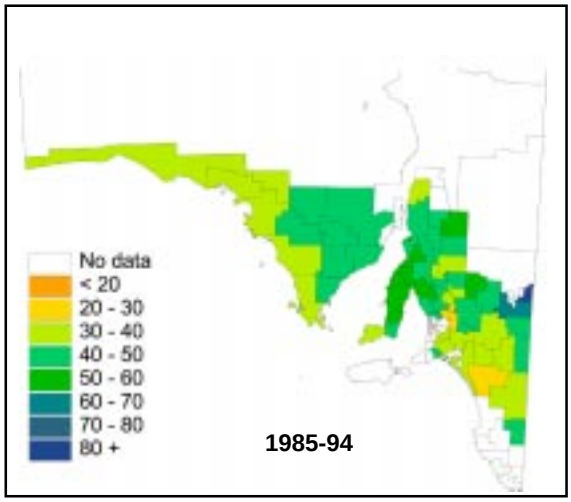
Attribute: Water use efficiency

Water use efficiency is defined as the proportion of all water inputs used by the total plant cover. Increases in run-off, percolation below root zones and soil evaporation, result from or are the result of reduced water efficiency which means inefficient water use which can have off site effects.

Water use efficiency of wheat and barley.







Note: Water use efficiency information has been displayed in these maps for each whole statistical local area, these areas do include areas which are not used for wheat and barley production.

The French-Schultz model enables the calculation of theoretical wheat and barley crop yields based on rainfall during the growing season from April to October (French and Schultz, 1984). Substantial variation from the predicted yield can be due to other limiting factors such as lack of adequate plant nutrition, weeds, diseases and poor timeliness of cultural practices. It is used as a benchmark against which to gauge management practice, with 80% water use efficiency being judged a good result.

The water use efficiency of wheat and barley for three separate decades from 1965 through 1994 show that generally there has been a significant improvement in water use efficiency in South Australia. In all Local Government areas but Quorn water use efficiency has improved by between 2% and 40%. This is generally indicative of improved cropping and soil management during this time. The better utilisation of rainfall also means that less water is being lost to runoff and to percolation below the root zone from where it could cause rising water table problems. These are good signs for sustainability. However, there are some areas in the Low Rainfall region where the water use efficiency results indicate some problems.

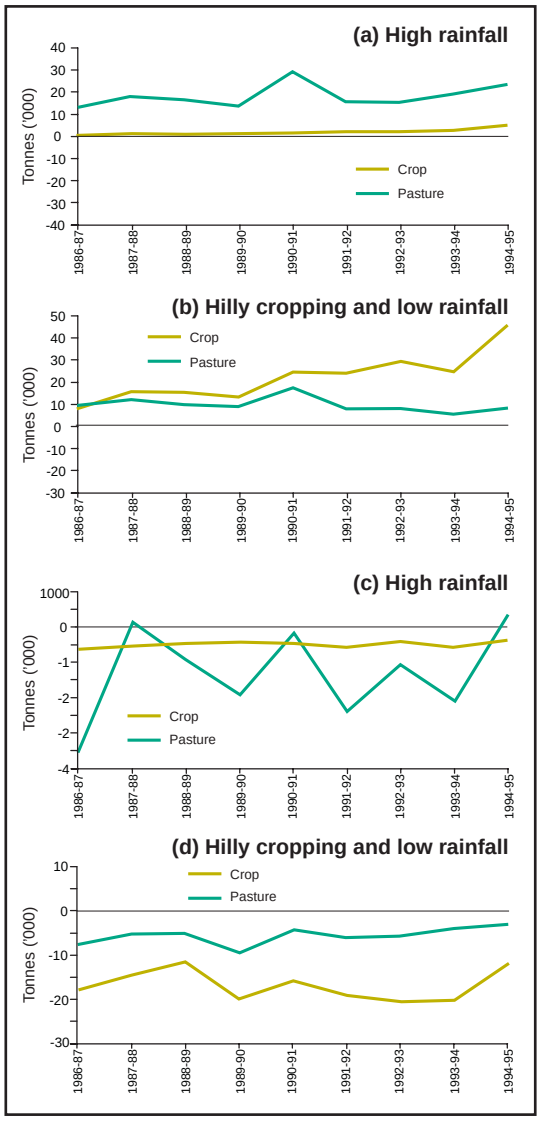
Attribute: Nutrient balance

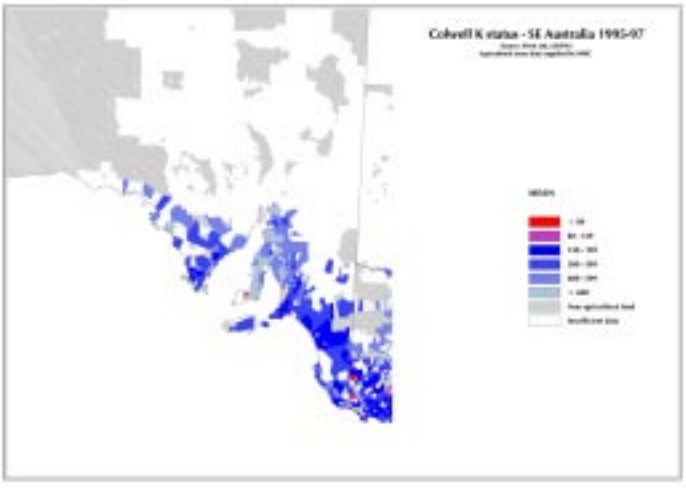
The issue of long-term nutrient balance is crucial for sustainable farming, which maintains or enhances the resource base. This attribute measures the nutrient balance in the soil by comparing the level of input through fertiliser application and the level of output through nutrients being exported in farm produce, at a regional scale for broadacre agriculture.

From 1986/87 to 1994/95 potassium and phosphorous fertiliser usage in South Australia has dramatically increased.

From 1986/87 to 1994/95 very little phosphorous fertiliser has been applied to horticulture in South Australia while the amount applied to pastures has remained relatively constant and the amount being applied to crops has increased dramatically. The soils in this state are naturally poor in phosphorous and without the constant application of fertiliser the soil would loose its capacity to sustain the productivity of current farming systems.

Potassium fertiliser use in South Australia has increased over time from 1986/87 to 1994/95 with most of the potassium fertiliser being applied to pastures. Both the High Rainfall region and the combined Hilly Cropping and Low Rainfall region have extremely negative potassium balances. In the Hilly Cropping Low Rainfall region significantly more potassium is being removed through crop production then is being applied through fertiliser application. However soil test data for 1995-97 reveals that the Low Rainfall and Hilly Cropping Regions of South Australia generally have a moderate to high level of potassium in the soil. On the other hand much of the higher rainfall regions in the Fleurieu Peninsula, Mt Lofty Ranges, Lower Eyre Peninsula and the Southeast regions have low levels of potassium.





Above: **(a) and (b) Phosphorous balance for broadacre agriculture.**

Above: **(c) and (d) Potassium balance for broadacre agriculture .**

Left: **Soil test data for Potassium Levels in South Australia.**

Indicator: Offsite environmental impacts

SUSTAINABLE agriculture requires that the off-site or external effects of agriculture on other ecosystems be kept within acceptable bounds so that other ecosystems can be maintained. This off-site environmental indicator provides an opportunity to describe off-site problems in terms of their potential on-site causes. It also provides information on how agriculturists have taken appropriate actions to mitigate undesired consequences, and it provides feedback on the success of these actions.

Attribute: Impact on conservation areas

Agricultural activities may affect the ability of conservation reserves to maintain ecological processes and conserve biodiversity. The degree of impacts depend upon:

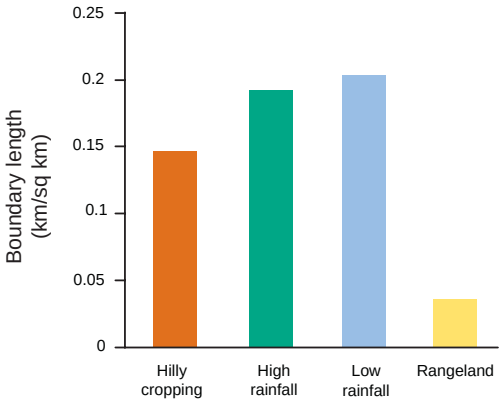
1. Boundary length per area of conservation reserve: Conservation areas adjacent to agriculture may be impacted by weeds, feral animals, nutrients, agricultural chemicals and altered microclimate and hydrology.

2. Extent of natural habitat in relation to agriculture: Low ratio of conservation to agricultural areas within a region increases the potential for problems such as salinity and waterlogging to affect the health of the conservation areas.

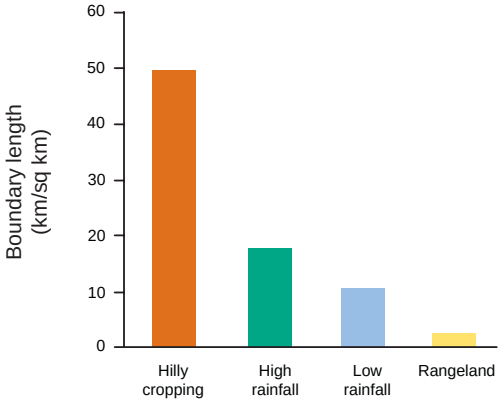
3. Intensity of agricultural land use: High impact agricultural practices tend to be associated with intensive agriculture.

The potential impact of agriculture on conservation areas is lowest in the Rangelands, which is the result of large conservation areas and low intensity agriculture within this region. Although the High Rainfall, Hilly Cropping and Low Rainfall regions have the highest impact in separate categories they are relatively close in impact in the measures of boundary effects and intensity. The Hilly Cropping region stands out as the prominent Agri-Ecological System potentially at risk as it has the highest ratio of total area of agricultural land per total area of conservation reserves. The Low Rainfall region had the highest ratio of boundary length per area of conservation reserve and the High Rainfall region had the highest rating in agriculture intensity compared to any other region.

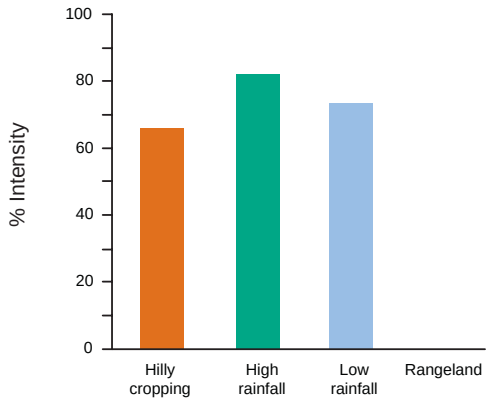
Boundary length per area of conservation reserve

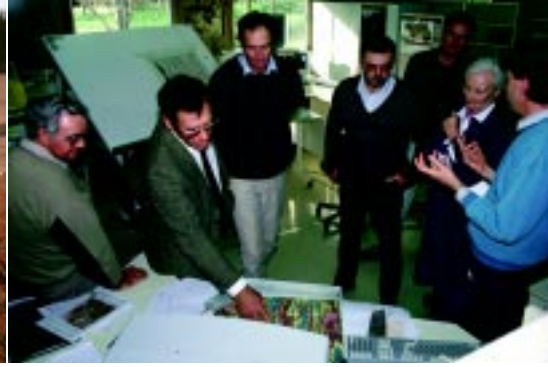


Area of agricultural land/area of conservation land



Intensity of agriculture





Attribute: Accelerated wind erosion

Soil loss, due to wind erosion, has both an on-site effect, caused by the loss of valuable soil and nutrients, and an off-site effect, caused by the negative influences of dust storms and atmospheric pollution. Dust storms are natural processes and their frequency and intensity may have been accelerated by agriculture and other land use activities. However, climatic conditions and in particular the occurrence of drought have an overriding influence on dust storm occurrence. This attribute aims to identify agriculture's contribution to wind borne dust.

The methodology, data manipulation, and analysis for this attribute were done for the whole of Australia, under the auspices of the National Collaborative Project for Indicators of Sustainable Agriculture (NCPISA).

There are three components to this attribute.

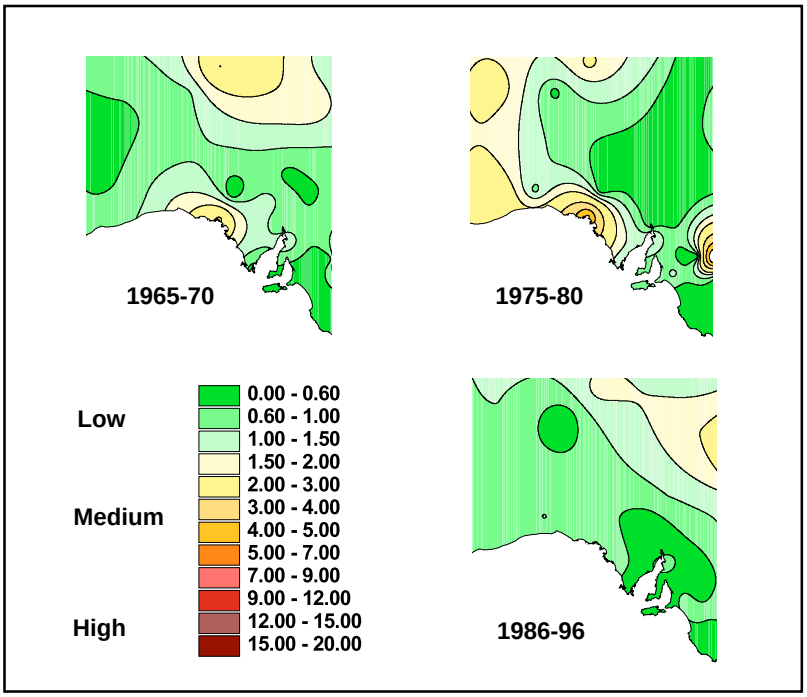
- Dust Storm Index (DSI): Is a measure of actual wind erosion rates which were calculated from Bureau of Meteorology observation data weighted according to severity of the dust event.
- Effective Moisture (Em) Model (after Burgess *et al.*, 1989) which estimates wind erosion rate under natural conditions.
- The Accelerated Erosion Index (AEI) in which the impact of agriculture is isolated by comparing the actual rates of wind erosion (as measured by the DSI) with the rates predicted by the Em Model.

The major agricultural areas in the south of the State have low levels of wind erosion. The rates for the Western Eyre Peninsula are in the low to moderate range whilst severe erosion occurs in the north east of the State in areas which are largely semi-dry salt lakes and unutilised desert.

The study showed that from 1986 to 1996 very little of the erosion that occurred was directly attributable to agriculture. Relatively low levels of accelerated erosion rates above what is normally expected, occurred only in the far north east of the State.

The erosion status of the northern pastoral areas improved from the late 1960s to the late 1970s while in the agricultural areas, especially Eyre Peninsula, it declined slightly. These trends were reversed again in the period from 1975-80 to 1986-96 where there was a marked improvement in the agricultural areas.

Accelerated wind erosion index.



(Source: NCPISA, 1998)

6. FUTURE DIRECTIONS

PROGRESS is already under way on a new sustainability indicators project which will greatly enhance the work contained within this report. The new project titled Sustainability Indicators for Regional Natural Resource Management, focuses on increasing the effectiveness of natural resource management polices and programs at the regional level through:

- The incorporation and use of environmental, economic, managerial, and social sustainability indicators for natural resource management into policy and program planning, monitoring and evaluation.
- Improved access to key information on the impact of resource use for policy advisers, natural resource managers and planners.
- Natural resource managers, planners and community groups skilled in the interpretation and use of sustainability indicators.

The new indicators project will continue to link with other projects of a similar nature such as:

- The State of the Environment Report,
- Natural Heritage Trust Performance Indicators,
- National Land and Water Resources Audit, and
- Regional Monitoring and Evaluation Strategies.
- Land Condition Monitoring

This report and each full indicator report are available on our website at:

www.pir.sa.gov.au

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