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A Commonwealth Government Initiative

AGRICULTURE IN AUSTRALIA

A summary of the National Land and Water Resources Audit's
Australian Agriculture Assessment 2001

www.nlwra.gov.au/atlas



Managing the land

NATIONAL LAND AND WATER RESOURCES AUDIT

Assessing the condition and capacity of Australia's natural resources

The National Land and Water Resources Audit (Audit) is conducting the first Australia-wide assessments of:

- water availability and quality
- dryland salinity
- vegetation
- rangelands
- agricultural productivity and sustainability
- Australians in natural resource management
- catchments, rivers and estuaries
- biodiversity

It is the first time Commonwealth, States and Territories, industry, and research organisations have collaborated on such a broad program.

Australian Agriculture Assessment 2001 provides:

- the first comprehensive assessment of water-borne erosion and sediment transport for agricultural catchments, rivers and estuaries
- nutrient budgets and changes in nutrient loads to rivers and estuaries
- changes in landscape water and nutrient budgets and an assessment of farm nutrient balances
- implications for on-farm nutrient management
- current and future extent of acidity and acidification for agricultural soils and their impact on production

PROVIDING ACCESS TO INFORMATION

Australian Natural Resources Atlas

The Australian Natural Resources Atlas (Atlas) provides information on Australia's natural resources including summary data and information at national, State and regional scales as well as the complete *Australian Agriculture Assessment 2001* report.



www.nlwra.gov.au/atlas





ASSESSING AUSTRALIA'S AGRICULTURAL RESOURCES

Agriculture contributes \$17.6 billion worth of exports each year to the Australian economy and employs about 400 000 people.

Use of fertiliser, legumes and irrigation has increased our capacity to undertake broadacre agriculture and meet an ever increasing demand for high quality food and fibre products despite a variable rainfall and generally low fertility soils.

Agriculture—part of the landscape

Agriculture has significantly changed Australia's landscapes and catchments.

- Vegetation cover has been altered, accelerating soil erosion and dryland salinity.
- Harvesting plants and animals has changed landscape nutrient balances.
- Rates of soil acidification have increased by addition of fertilisers.

These unintended consequences of agriculture are often insidious but are now affecting farm production and reducing water quality in rivers and estuaries.

Agriculture—managing the landscape

We need to adapt land management practices to better suit Australia's environments. Farmers are innovative, adopting new ideas and practices to reduce off-farm impacts while maintaining productivity.

Australian Agriculture Assessment 2001 includes assessments of:

- nutrient use and how it affects farm production; and
- soil erosion and the effect of moving soil and nutrients off farm and into rivers and estuaries.

It provides the information on land use and on-farm and off-farm impacts to help assist decision making.

For more information on topics covered in *Australian Agriculture Assessment 2001* as well as on dryland salinity, vegetation and water resources please visit <www.nlwra.gov.au/atlas>.





Irrigation boosting productivity in a dry land

ON-FARM—NUTRIENT USE AND PRODUCTIVITY*

Fertilisers boosting agricultural production

Introduction of fertilisers has significantly boosted Australia's agricultural production.

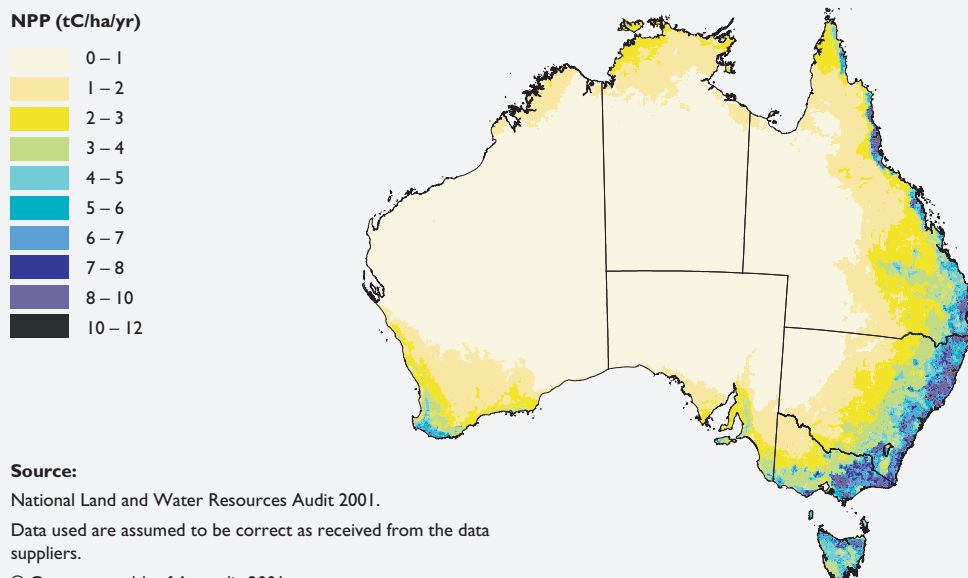
- Each year more than 5 million tonnes of fertilisers are added to agricultural soils.
- Use of nitrogenous fertilisers has almost doubled since 1990.
- Approximately 18 000 GL (1 GL = 1000 million litres) of water are used for irrigation each year.

Greater productivity and soil fertility

Fertilisers have boosted plant production and soil nutrient levels.

- Australian landscapes now store twice as much carbon in soil and plants as they did under natural conditions.
- Mineral soil nitrogen stores have increased by 13%.
- Mineral soil phosphorus stores have increased by 8%.
- With a few exceptions potassium, calcium and magnesium levels are meeting plant production needs.

Figure 1. Mean annual net primary productivity with current climate and agricultural inputs. Net primary productivity is a measure of plant biomass gain measured in tonnes of carbon per hectare per year.



* A landscape scale model to track nutrients, carbon and water through the landscape was developed to estimate net primary productivity. It considers soil, and atmospheric and organic inputs. Further information can be found at www.nlwra.gov.au/atlas

Nutrients lifting
production



ON-FARM—NUTRIENT USE AND PRODUCTIVITY

Fertilisers boosting agricultural production

Changes in nutrient levels in the landscape depend on local water and light conditions as well as agricultural inputs.

Net primary productivity, for example, is:

- comparatively lower in Tasmania because of less available light during the growing season;
- higher in urban fringes due to intensive horticulture and livestock enterprises; and
- significantly enhanced with nutrient inputs and irrigation across much of south-eastern Australia.

Increase in fertiliser use

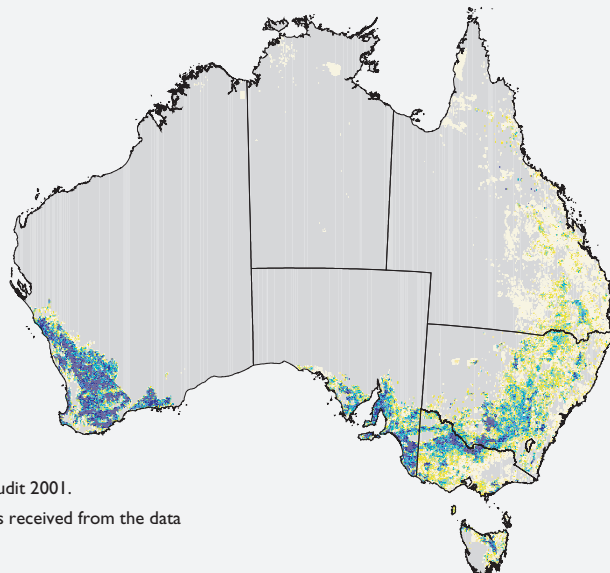
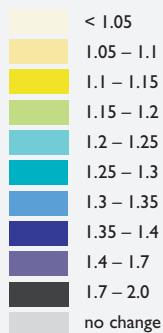
The increased demand for fertiliser nutrients arises from changing conditions and farm practices including:

- more intensive crop rotations;
- new varieties;
- minimum tillage;
- the demand for higher protein wheat; and
- decline in the effectiveness of pasture legumes.

Figure 2. The difference between net primary productivity of the landscape with and without agricultural inputs. The comparison is a ratio. These increases are relative to natural productivity and reflect the role of fertilisers and farming systems in improving soil fertility and the consequent increase in production.

The largest increases occurred in the cropping regions of Western Australia, South Australia, Victoria and New South Wales.

NPP ratio (agric/no agric)



Source:

National Land and Water Resources Audit 2001.

Data used are assumed to be correct as received from the data suppliers.

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Harvesting plants—nutrient exports

ON-FARM—NUTRIENT BALANCE AND PRODUCTIVITY

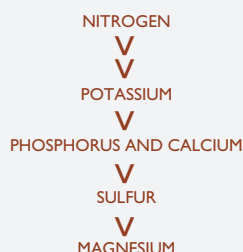
Balancing inputs and exports

Optimum agricultural production means delivering the right amount of nutrients and water at the right time. However, in some parts of Australia, excess nutrients are applied. This could result in landscapes losing nutrients to the atmosphere and landscape.

The balance sheet approach

To determine an on-farm nutrient balance requires an estimate of nutrient inputs (fertilisers, soil conditioners, legume nitrogen fixation) and nutrient exports (e.g. harvesting agricultural products; loss to groundwater, rivers and atmosphere).

How much nutrient leaves a farm depends on land use, nutrient inputs and local conditions (e.g. soil, climate). The relative amounts of nutrients exported from Australia's agricultural soils are:



Getting our money's worth

The balance sheet approach enables an estimate of the potential for nutrients to leak off farm and be wasted.

Results across Australia suggest:

- regular superphosphate applications, particularly in southern Australia, have improved the nutrient status of agricultural lands compared with their natural state—especially phosphorus;
- attention should focus on areas with low or marginal soil nutrient status and highly negative balances; and
- addressing on-farm nutrient management using the balance sheet approach will benefit production and reduce the potential for nutrients to leak.

On- and off-farm impacts

Applying too much or too little fertiliser is not just a waste of money. It can also accelerate soil acidification (see page 9), retard production and reduce water quality (see pages 12 & 13).

POSITIVE NUTRIENT BALANCE: INPUTS > EXPORTS

A positive balance suggests:

- more nutrients are being applied than necessary; and
- a greater potential for nutrient leakage.

NEGATIVE NUTRIENT BALANCE: INPUTS < EXPORTS

A negative balance suggests:

- soil nutrients are progressively being depleted, although in some cases, the soil's nutrient reserves may meet plant requirements; and
- the potential for soils to be mined of their nutrient stores

ON-FARM—NUTRIENT BALANCE AND PRODUCTIVITY

NEGATIVE (inputs < exports)

NEUTRAL (inputs = exports)

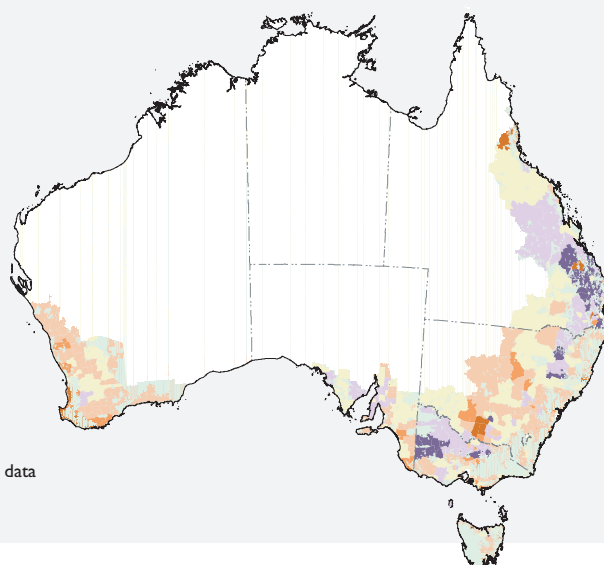
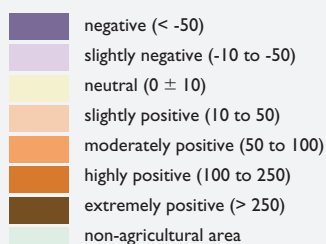
POSITIVE (inputs > exports)

Table 1. Agriculture's scorecard: a summary of nutrient use and balances.

	Use	Nutrient balance
Nitrogen	cropping and horticulture	<ul style="list-style-type: none"> highly positive balances in predominantly dairying and horticultural regions and the Riverina negative balances in south-east Queensland, the Wimmera, Goulburn–Broken regions and north-west slopes and plains of New South Wales
Phosphorus	most agricultural soils	<ul style="list-style-type: none"> neutral or slightly positive over large areas of the agricultural zone most positive balances occur where horticulture and dairying coexist negative balances in south-east Queensland, the Riverina, Wimmera, north-east Victoria and northern New South Wales
Potassium	dairying, horticulture sugar cane areas	<ul style="list-style-type: none"> moderate to highly negative in regions where no potassium applied (large areas) positive balances where dairying and horticulture coexist
Sulfur	most agricultural soils as fertilisers and gypsum	<ul style="list-style-type: none"> neutral to highly positive in most regions slightly negative balances in some parts of Queensland
Calcium	most agricultural soils as fertilisers and soil conditioners (lime, dolomite and gypsum)	<ul style="list-style-type: none"> neutral to highly positive across southern Australia (linked to superphosphate and soil conditioner use) slight negative balances in parts of Queensland
Magnesium	applied mainly as dolomite with some fertiliser use	<ul style="list-style-type: none"> negative in parts of Queensland, New South Wales and South Australia positive in dairy and horticultural regions of Victoria, Tasmania and New South Wales

Figure 4. Farm gate nitrogen balance (kg N/ha) with all agricultural land uses combined (averaged 1992–1996).

Nitrogen balance
(kg N/ha)



Source:

National Land and Water Resources Audit 2001.

Data used are assumed to be correct as received from the data suppliers.

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Legumes providing nitrogen

ON-FARM—SOIL ACIDITY LINKED TO NUTRIENT USE

Striking a pH balance

Soil acidification is insidious and one of the major soil degradation issues across agricultural Australia. *Acidification* is a natural process. *Induced* acidification results from a soil imbalance caused by:

- excessive leaching of soil nitrate (e.g. from nitrogen fertilisers or legume crops); and/or
- harvesting plants and animals that would otherwise have a neutralising effect on the soil.

Induced acidification can change the soil chemical balance and is a significant problem to agricultural industries.

- Acid soils ($\text{pH}_{\text{Ca}} < 4.8$) release toxic levels of aluminium and manganese, reducing the effectiveness of fertilisers and water use by plants, thereby reducing plant productivity.
- Once the subsoil becomes acid, it is difficult to treat.

How much soil acidity?

Extent and rate of acidification depends on land use (crop type, pasture versus crops), soil characteristics and land management. The Audit estimates the extent of acid soils in Australia's agricultural zone to be:

- 50 million hectares of surface soil; and
- 23 million hectares of subsoils.

Large parts of New South Wales, Western Australia, Victoria and Tasmania are acidic.

Restoring the balance

Australian soils can absorb or buffer some but not all induced acidity. Beyond this point, soil acidity can be tackled by:

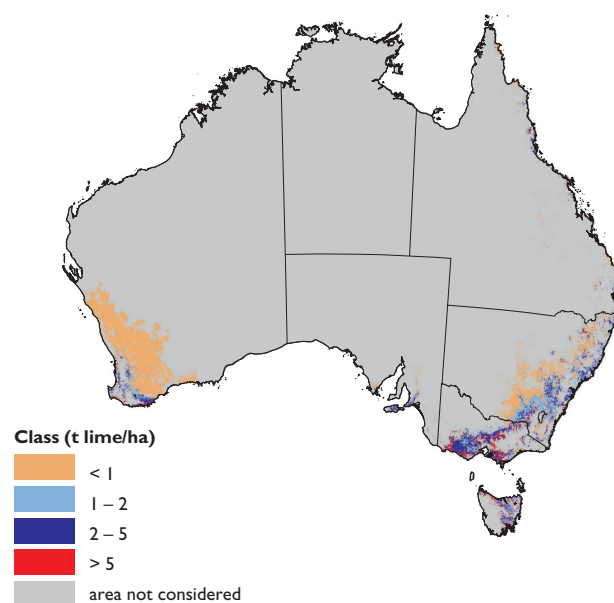
- changing fertiliser management;
- growing acid tolerant plants; or
- applying lime.

Measuring soil acidity

	pH_{Ca} range*
Acidic	$\text{pH}_{\text{Ca}} \leq 5.5$
Moderately acidic	$4.8 < \text{pH}_{\text{Ca}} < 5.5$
Highly acidic	$4.3 < \text{pH}_{\text{Ca}} < 4.8$
Extremely acidic	$\text{pH}_{\text{Ca}} \leq 4.3$

* measured in 0.01M CaCl_2

Figure 5. Lime application rates required to increase or maintain Australia's highly and extremely acidic soils to $\text{pH}_{\text{Ca}} 4.8$.



ON-FARM—SOIL ACIDITY LINKED TO NUTRIENT USE

Restoring capacity of the land

Lime application

Lime is the most common method for treating soil acidity. It can restore the pH and agricultural productivity.

About 2 million tonnes of lime are applied to agricultural soils each year, but it is estimated that Australia's acid soils need one-off lime applications of some 5 to 6 times current levels to lift or achieve a pH balance. Even so, lime must continue to be applied to counteract acidifying effects of crops or pasture. The Audit estimates that between 50 and 250 kg/ha/yr will be necessary (the variation depends on local conditions).

- Most of Australia's *acidic* soils (78% or 3 million hectares) require small amounts of lime to increase or maintain soil pH_{Ca} of 5.5.
- Most of Australia's *highly acidic* soils (89% or 11 million hectares) require less than 2 t/ha/yr to increase or maintain a pH_{Ca} of 4.8.

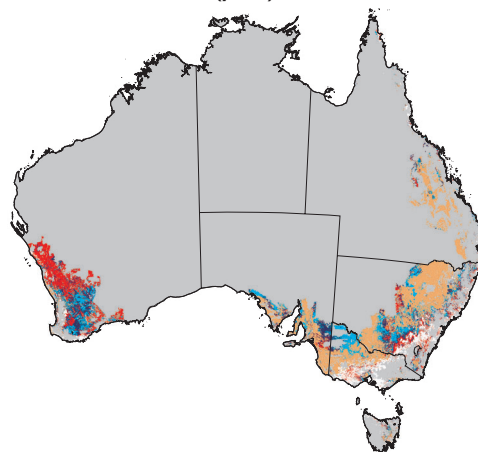
Use of lime varies with different farming systems (including types of crop or fertiliser) since each has different acidifying effects.

Acid-tolerant crops

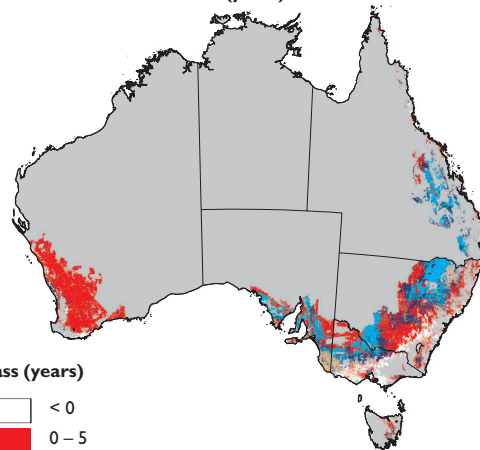


Figure 6. Models showing the estimated time for Australia's agricultural soils to become highly acidic (pH_{Ca} 4.8) under current farming condition without soil treatment.

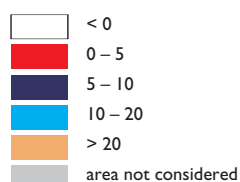
A minimum estimated time (years)



B maximum estimated time (years)



Class (years)



Source: Australian Soil Resources Information System.

National Land and Water Resources Audit 2001.

Data used are assumed to be correct as received from the data suppliers.

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Contour banks—minimising erosion

OFF-FARM—SOIL EROSION

Losing a valuable resource

Managing soil and nutrients on-farm can improve productivity, reducing off-farm impacts.

- Soil erosion causes silting in rivers, dams and reservoirs.
- Nutrients carried off farm cause algal blooms that smother and destroy habitat, and render water unfit for drinking.

Soil erosion is a natural process, particularly in steep country or high rainfall areas. Disrupting the soil surface, through clearing, or overgrazing, increases risks of further soil erosion, particularly water-borne erosion.

Water-borne soil erosion is a major and continuing issue for Australian agriculture and catchment management. Valuable topsoil, nutrients and organic matter are lost and soil structure is destroyed.

Basin size, climate, land use, soil type and topography determine the extent of soil erosion. Typically soil erosion far exceeds the rates of soil development making soil a non-renewable resource.

Water-borne soil erosion

Sheetwash and rill (hillslope) erosion

Sheetwash or *surface wash* erosion is the removal of a relatively uniform layer of soil by raindrops and/or by surface run-off during intense storms. It occurs in areas where soil is not protected by vegetation cover.

Rill erosion occurs where water (or rainfall) forms tiny channels or rills ranging from a few centimetres to 50 cm deep.

Gully and riverbank erosion

Gully erosion occurs when soil is removed by running water. These gullies tend to form in upland areas, have steep sides and usually transport soil to relatively small drainage areas. Gullies are at least 50 cm deep. They erode unchannelled valleys and dips and eventually become vegetated and infill. This distinguishes gullies from depressions that have permanent streams.

Clearing native vegetation in the riparian zone exacerbates *riverbank erosion*.

Figure 7. Mean annual sheetwash and rill erosion rate.

Current sheetwash and rill erosion
(t/ha/yr)

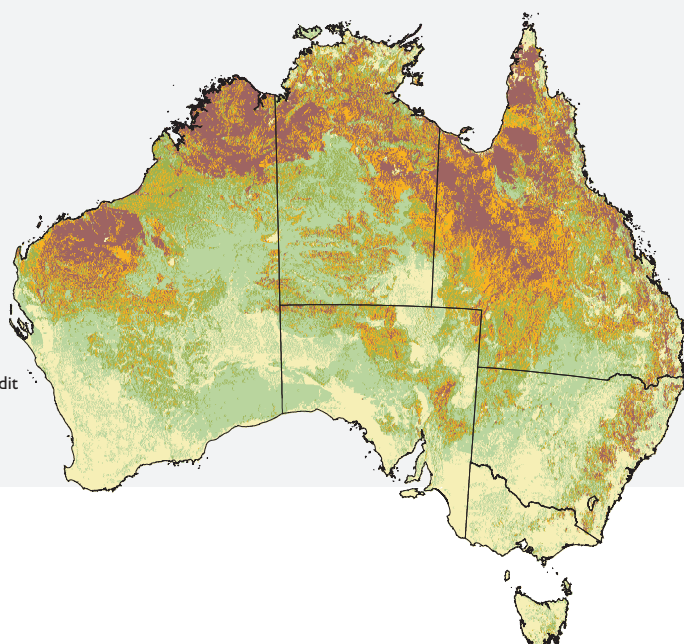
0 – 0.5	very low
0.5 – 2.5	low
2.5 – 5.0	medium
5.0 – 10.0	high
> 10.0	very high

Source:

National Land and Water Resources Audit 2001.

Data used are assumed to be correct as received from the data suppliers.

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OFF-FARM—SOIL EROSION

Losing a valuable resource

Australia's scorecard: how much water-borne soil erosion?

Sheetwash and rill (hillslope)

- highest in tropical northern Australia
- average erosion rate 4.4 t/ha/yr
- on average hillslope erosion is 3 times higher than the natural rate

Gully and riverbank erosion

- main source of sediment delivered to streams in southern Australia
- 4.4 billion tonnes of soils have been lost to erosion from 325 000 km of gullies since European settlement
- gully sediments cause poor water quality and require targeted restoration

River sediment loads and deposition

- major problem in eastern Australia—native vegetation cleared from the riparian zone of two-thirds of streams in agricultural areas
- 30 000 km of streams have sand and gravel from gully and stream-bank erosion, impairing stream health
- 14 million tonnes of sediment is transported to the Queensland coast, and 3 million tonnes to the New South Wales coast each year
- river sediment loads are generally 10 to 15 times higher than pre-European settlement in some river basins
- on average 90% of suspended sediments reaching estuaries comes from 20% of the catchments
- sand deposits are significant in the Murray–Darling Basin, coastal New South Wales, south-east Queensland and the Glenelg region of Victoria and are moving slowly down the low energy river systems causing problems for dams and weirs

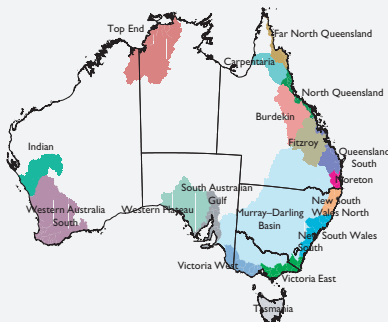
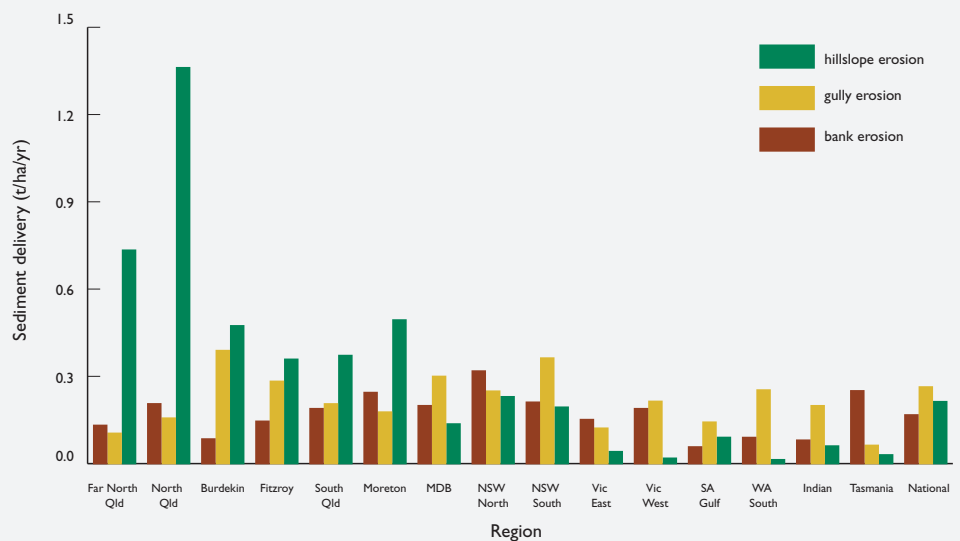


Figure 9. Estimated amounts of sediment supplied to streams from each erosion process in the 15 regions assessed. Note the national averages.





Rivers—transporting nutrients and sediments

OFF-FARM—NUTRIENT EXPORTS

Money down the drain

Nutrients move from the catchment to the coast either bound to sediments (e.g. soils) or dissolved in water. The amount of nutrients transported (e.g. phosphorus or nitrogen) depend on their source (e.g. soil erosion) and how efficiently they are transported through and across the landscape (e.g. river flow). Nutrient exported in sediment depends on the same factors that affect soil erosion.

Nutrient sources and transport: a new understanding

Nutrients enter rivers and estuaries from point sources (e.g. sewage treatment plants or storm water outlets) and diffuse sources (e.g. run-off from agricultural lands).

Some of the nutrient load in our rivers will be exported to the coast and some will remain within the catchment. Floodplains and reservoir sediments are major nutrient sinks, tapping both nitrogen and phosphorus.

The capacity of streams to tolerate, absorb or breakdown nutrients varies considerably. As in other parts of the landscape, resilience depends on nutrient levels and the local system.

Measure to manage: calculating a nutrient budget

The first step in managing nutrient export is to determine the source and amount of nutrients to calculate a nutrient budget. We need to know:

- where nutrients are coming from (e.g. hillslope versus gully erosion);
- what happens to nutrients (e.g. is there natural attrition?); and
- how much nutrient ends up in estuaries or coastal ecosystems.

The Audit agriculture assessment demonstrates that nutrient budgets vary across Australia according to the source and type of nutrient.

Models to track nutrients

The ANNEX and SedNet models developed by CSIRO can trace the path of nitrogen and phosphorus through the landscape. The models improve our ability to identify and quantify sediment and nutrient sources and where and how they are deposited.

The advantage

- Better identify landscapes and land uses to reduce nutrient inputs into rivers and estuaries
- Better water quality management as a result of a better understanding of nutrients pathways



OFF-FARM—NUTRIENT EXPORTS

Money down the drain

Sources

Nutrients mainly come from diffuse sources unless there are significant point sources within a catchment. Important sources include:

- sheetwash and rill erosion (sediment bound) in northern regions of Australia;
- gully erosion (sediment bound) in southern regions; and
- run-off with respect to dissolved nitrogen in southern regions.

Phosphorus

- Queensland and New South Wales: over 50% from hillslope erosion
- Coastal Victoria, South Australia, West Australia and Tasmania: gully and river bank erosion; dissolved phosphorus in run-off
- Australia-wide: some urban point discharges

Nitrogen

- Queensland and coastal New South Wales: hillslope erosion
- Murray–Darling Basin: hillslope and dissolved nitrogen
- Coastal Victoria, South Australia, Tasmania and West Australia: dissolved nitrogen

Sinks

Sinks reduce the proportion of nutrient (and sediment) reaching the coast. Important sinks include:

- floodplains in large basins (e.g. Murray–Darling Basin, Fitzroy and Burdekin);
- reservoirs in Queensland; and
- the atmosphere in southern regions (nitrogen is lost through denitrification).

Nutrient export to the coast

Phosphorus

- Nearly 19 000 tonnes of total phosphorus are predicted to be exported down rivers to the coast each year from areas of intensive agriculture
- Efficiency of phosphorus delivery from rivers to coasts varies from 3% in the Murray–Darling Basin to over 90% in Tasmania

Nitrogen

- Nearly 141 000 tonnes of nitrogen are predicted to be exported down rivers to the coast each year from areas of intensive agriculture
- Efficiency of nitrogen delivery from rivers to coasts varies from 14% in the Murray–Darling Basin (low energy river systems) to over 90% in Tasmania

Changes in nutrient river load

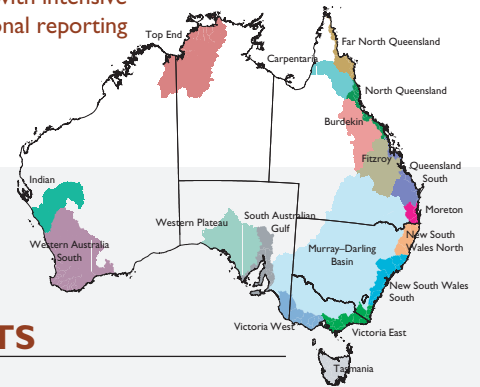
Phosphorus

- Annual loads are nearly triple the estimates for pre-European settlement levels

Nitrogen

- Annual loads are double the estimates for pre-European settlement levels

River basins with intensive agriculture for regional reporting



OFF-FARM—NUTRIENT EXPORTS

Phosphorous on the move

Figure 11. Proportion of phosphorous (%) from different types of erosion in the assessed regions.

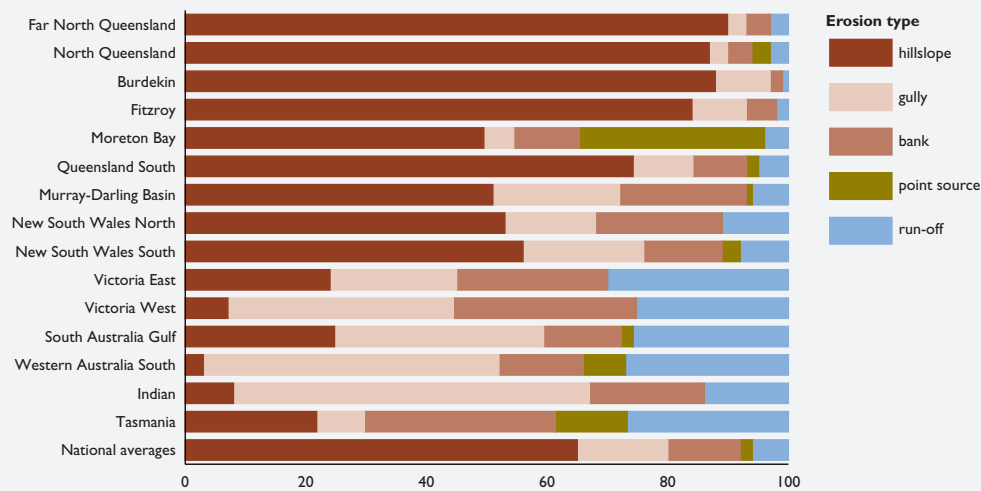
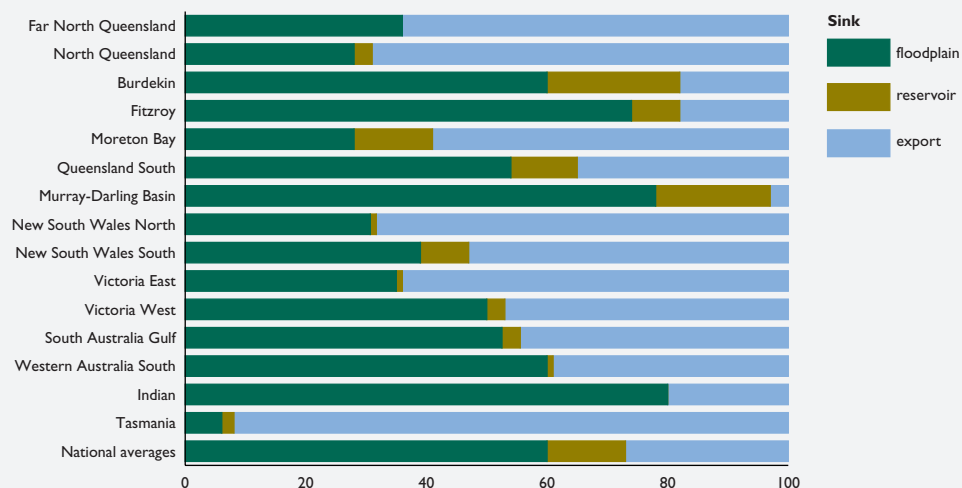


Figure 12. Proportion of phosphorous (%) to different types of sinks and exported to the coast in the assessed regions.



OFF-FARM—NUTRIENT EXPORTS

Nitrogen on the move

Figure 13. Proportion of nitrogen (%) from different types of erosion in the assessed regions.

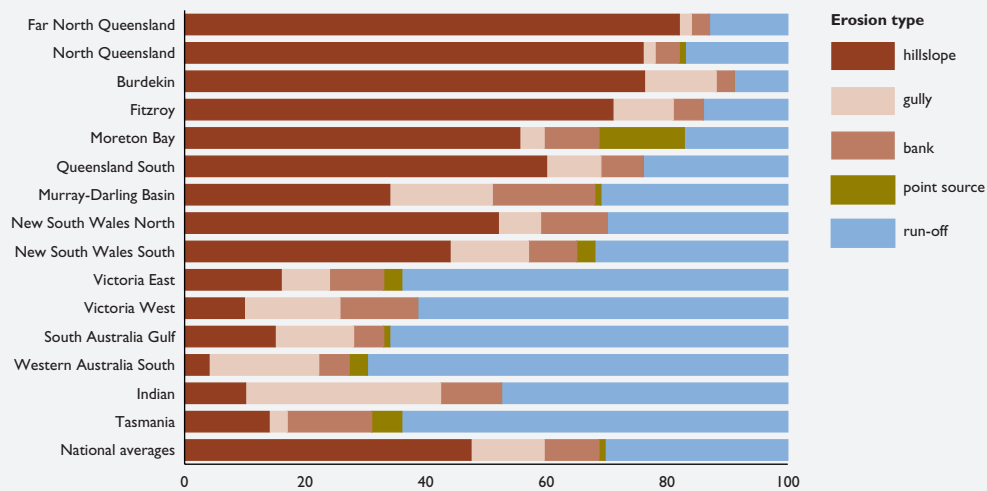
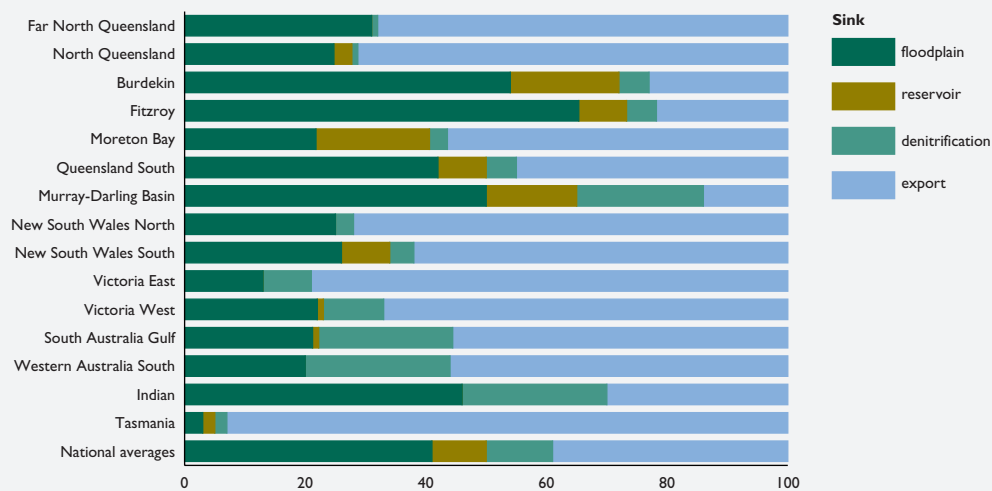


Figure 14. Proportion of nitrogen (%) to different types of sinks and exported to the coast in the assessed regions.





Maintaining riparian
vegetation

MANAGING THE FARM TO MANAGE THE LANDSCAPE

Productivity, nutrients, acidity, erosion

Inside the farm gate

Effective soil and nutrient management on-farm creates a win-win situation that provide benefits for both agricultural productivity and the environment. It reduces:

- soil and fertiliser loss by soil erosion and transport;
- land loss from soil acidification; and
- off-farm impacts.

Australia's agricultural industry continues to adopt new ideas and improve current practices including:

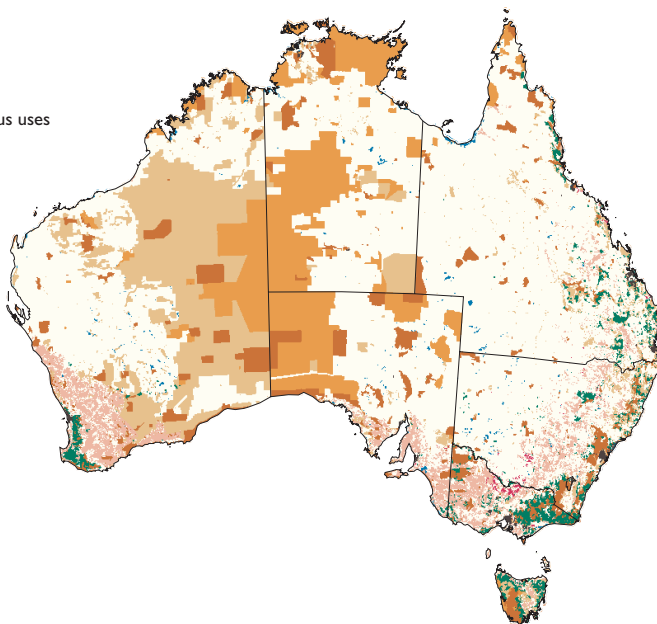
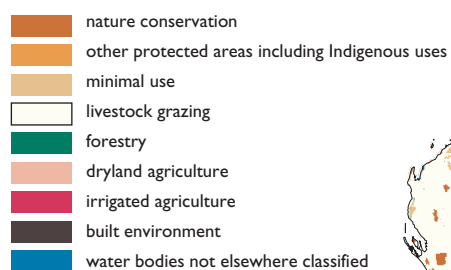
- improved crop rotations;
- reduced tillage and stubble retention (reducing soil erosion by wind and water);
- green trash blanketing (reducing soil erosion); and
- applying potassium fertiliser and lime (managing nutrient deficiency and soil acidity).

Agricultural industries are committed to developing and adopting best management practice. Fundamental to achieving best practice, is maintaining profitability and a commitment to environmental stewardship. This requires:

- recognising the causes and effects of farming systems on the environment;
- understanding the processes within a catchment context;
- refining farm management and devising new management techniques; and
- developing and implementing codes of practices.

The Audit assessments provide new information to help guide management decisions and support innovation and adoption of best management practices.

Figure 15. Land use in Australia.





Reducing land degradation

MANAGING THE FARM TO MANAGE THE LANDSCAPE

Productivity, nutrients, acidity, erosion

Options to improve nutrient management

- Taking a balance sheet approach to nutrient use based on a knowledge of soil fertility status
- Reviewing and implementing the timing and frequency of nutrient application rates
- Considering rainfall patterns and reviewing irrigation schedules with regard to plant water requirements

Examples include:

- adopting crop rotations to make the most effective use of legume nitrogen;
- optimising fertiliser and soil conditioner applications through integrated farm planning; and
- using contour banks/grassed rivers.

Options to improve soil conservation management

- Maintaining vegetation cover and minimising soil disturbance
- Changing agricultural practices to maintain the integrity of riparian areas and minimise gully erosion

Examples include:

- minimum or zero tillage
- stubble retention rather than burning
- cultivating during low erosion risk periods
- grazing management (particularly in erosion-prone areas)
- implementing paddock feedlots, fodder conservation, intensive strip grazing and cropping, and improving degraded river and stream edge buffer zones
- chemical fallowing
- reducing impacts of feral animals



Information for better
management

FACILITATING DECISIONS

Providing access to information

Good information on soils, landscapes and their properties is fundamental to sustainable agricultural development. As part of this agriculture assessment, a new Australia-wide information service has been established—the Australian Natural Resources Atlas (Atlas) <www.nlwra.gov.au/atlas>.

The internet-based Atlas provides access to the extensive range of data and information collated by the Audit. It contains information on land, water and vegetation resources. This data can be downloaded from the Australian Natural Resources Data Library <adl.brs.gov.au>.

The Australian Soil Resources Information System is a fundamental component of the Atlas and contributor to the data library. It draws on extensive soil survey information collected and collated by State and Territory agencies since the 1970s and contains information on a range of topsoil and subsoil attributes important to agricultural production, environmental process and soil health (Table 2).

Looking to the future

The Australian Soil Resources Information System is a collation of existing data. It also establishes a framework for the future by providing:

- tool sets for preparing future soil attribute maps;
- national database of quality soil point data for future applications; and
- partnerships between Commonwealth, and State and Territory agencies to maintain, update and develop new information products.

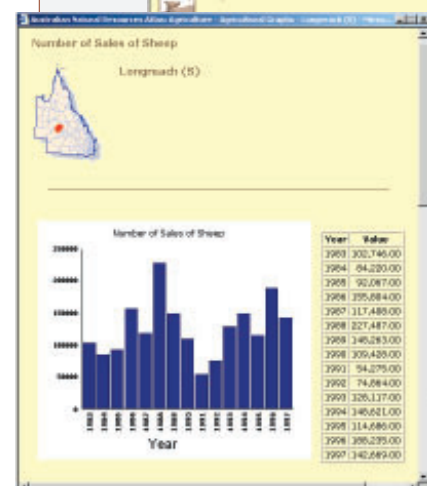
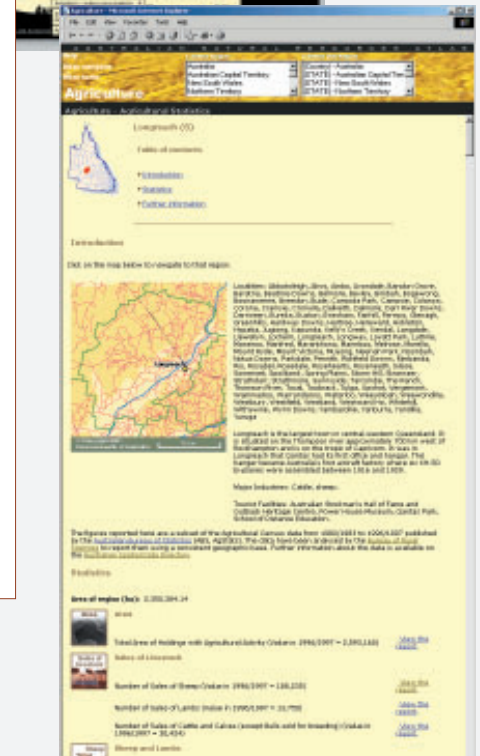
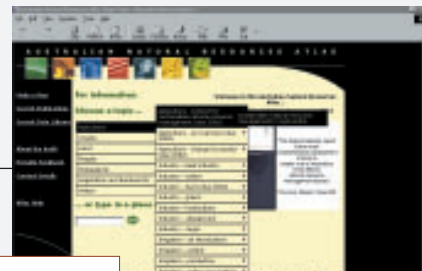
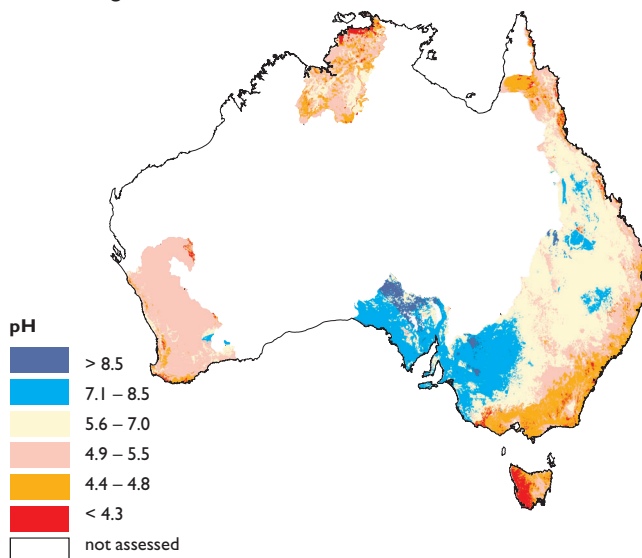
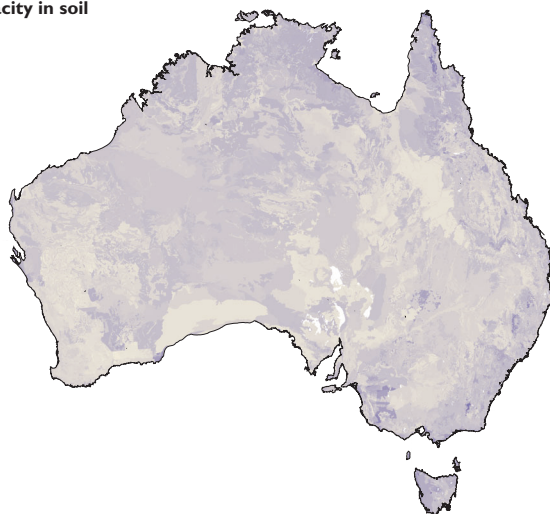
The challenge will be to keep the information up to date and to incorporate important industry data as it becomes available.

Table 2. Soil attributes in the Australian Soil Resources Information System for river basins containing intensive agriculture and Australia wide. In most cases maps are available for the first two layers (topsoil and first subsoil).

RIVER BASINS CONTAINING INTENSIVE AGRICULTURE		AUSTRALIA-WIDE SOIL COVERAGE*	
Soil attribute	Unit	Soil attribute	Unit
pH	pH scale 1–14	Clay percentage	% fine earth fraction
Organic carbon	%	Silt percentage	% fine earth fraction
Total phosphorus	%	Sand percentage	% fine earth fraction
Extractable phosphorus (New South Wales and Victoria)	%	Thickness	m
Total nitrogen	%	Solum depth	m
Texture	texture class	Bulk density	g/cm ³
Clay percentage	% fine earth fraction	Available water	Mm
		Saturated hydraulic conductivity	mm/hr
		Erodibility	t ha hr/ha MJ mm

* Data quality and accuracy is variable across Australia. Land resource information is limited in Australia's arid regions.

Australian Natural Resources Atlas



IN PARTNERSHIP

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CSIRO Land and Water	www.clw.csiro.au
Agriculture, Fisheries and Forestry – Australia Bureau of Rural Sciences Australian Bureau of Agricultural and Resources Economics	www.affa.gov.au

New South Wales

New South Wales Agriculture	www.agric.nsw.gov.au
Department of Land and Water Conservation	www.dlwc.nsw.gov.au

Northern Territory

Department of Lands, Planning and Environment	www.lpe.nt.gov.au
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Victoria

Department of Natural Resources and Environment	www.nre.vic.gov.au
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Queensland

Department of Natural Resources and Mines	www.dnr.qld.gov.au
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Tasmania

Department of Primary Industries, Water and Environment	www.dpiwe.tas.gov.au
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South Australia

Primary Industries and Resources South Australia	www.pir.sa.gov.au
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Western Australia

Agriculture Western Australia	www.agric.wa.gov.au
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Fertilizer Industry Federation of Australia

www.fifa.asn.au

Dairy Research and Development Corporation

www.drdc.com.au

Australian Dairy Farmers Federation

www.adff.com.au

Horticulture Australia Ltd

www.horticulture.com.au

Murray-Darling Basin Commission

www.mdbc.gov.au

Numerous industry groups and research and development corporations who contributed data, information and case studies.

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