



Government
of South Australia

SARDI



SOUTH AUSTRALIAN
RESEARCH AND
DEVELOPMENT
INSTITUTE

*Directions:
knowledge and people are
SARDI's foundations*

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Affiliate Professor
Pauline Mooney
Executive Director

Foreword

SARDI exists to deliver robust scientific solutions for primary industries. From the sea and the land to the market, our scientists are driven to translate results into opportunities to position food, fibre and bioscience industries as internationally competitive and ecologically sustainable.

Since its establishment in 1992, SARDI has built its reputation on delivering quality outputs, applied solutions, products and technologies.

SARDI Directions is a milestone in the evolution of the organisation, setting out a shared understanding of the organisation, its science programs and the pathway forward. The plan demonstrates how SARDI will invest, define and redefine activities to make it clear where SARDI delivers value.

The production of the plan reflects the commitment of staff to support competitive and ecologically sustainable primary industries. It also signifies the goodwill and collaboration of our science partners in working together to embrace an important chapter in our development.

SARDI Directions crystallises the comprehensive strategic planning to position SARDI as the provider of excellence in scientific endeavour in our core disciplines. This will enable SARDI to attract and retain major capability for South Australia, grow as a business in targeted research fields and maintain its relevance to its key stakeholders.

Together with its partners, SARDI has identified current capabilities and identified capability gaps that need to be addressed. An analysis of our business and areas for future focus is presented.

Highlighted are opportunities to realise goals that align with the South Australian Strategic Plan and the State's Science Plan (STI10) priorities, the National Primary Industries Research, Development and Extension framework, South Australian and National Industry Development plans, and PIRSA's focus on economic growth, environmental responsibility, resilient communities and innovative local industries.

To survive in a commercial world with rising expectations, SARDI needs to offer a multi-pronged approach that focuses on and develops competencies that recognise the changing priorities.

The plan identifies where SARDI:

- » Is exceptional in core competencies
- » Offers unique and distinctive skills to complement collaborative national approaches
- » Leads in the development of enabling technologies
- » Offers proven research solutions.

SARDI Directions sets a path for the Institute's development, ensuring it can continue to deliver strong science programs that offer a depth and breadth of expertise to support primary industries.

Science is central to building industry and business capability and we are pleased to present how SARDI science programs will meet the challenges and opportunities ahead.



Introduction and background

The work from which SARDI Directions emanates began as a business planning process. In recent years SARDI restructured to form four research divisions, each of these headed by a Chief responsible for the leadership of the science division. The research divisions collectively undertake research across 21 Science Programs. The formation of this portfolio of science programs involved substantial stakeholder consultation inside and outside SARDI resulting in considerable change. But this was change with a purpose, bringing about an organisation more able to clearly focus on its strategic imperatives and stakeholder outcomes.

In consultation with the Research Division Chiefs, the Science Leaders prepared business plans for their Science Programs for the three years ending 30 June 2012.

A key component of the plans was a review of resource allocations – a rigorous process to direct scarce resources into projects that would enable SARDI to deliver timely innovations and solutions, as well as develop current capabilities and attract new capabilities needed for the future.

- » With these Science Program plans as a base, divisional plans were developed, ensuring that the combined operating plans, as far as possible, limited inefficiencies while maximising the creation of knowledge and its flow.

In developing the strategic initiatives outlined in *SARDI Directions*, several important principles were upheld to ensure optimal benefits to South Australia. As a result, the plan:

- » Is future-focused, but leveraged off SARDI's strong research foundations
- » Develops a clear strategy for South Australian Government investment in primary industries research and development

- » Strengthens SARDI's position within the R&D value chain
- » Maintains and promotes the development of critical competencies
- » Leverages research outputs through collaborative research arrangements with other agencies
- » Supports State Government strategic initiatives for the agriculture, food and bioscience industries.

This document is structured in five parts:

- » A statement of SARDI's vision and values
- » An overview
- » The key drivers of change
- » Key relationships
- » Future directions.

Vision and Values

Excellence Relevance & Innovation

A division of PIRSA, SARDI is the South Australian Government's science institution underpinning vibrant primary and food industries.

Vision:

Reinvigorating South Australian primary and food industries through the pursuit of exceptional science.

Mission:

Deliver robust scientific solutions to position South Australia's agriculture, food, aquatic and bioscience industries as internationally competitive and ecologically sustainable.

SARDI's role:

- » Generate knowledge, technologies and products to create opportunity and address barriers impacting on economic growth of South Australia's primary industries. SARDI's research solutions promote the growth, productivity, and adaptability of aquatic, agricultural, food and bioscience industries, while ensuring they remain ecologically sustainable.
- » Match scientific advance with industry opportunity while meeting client needs through the provision of the best scientific solutions.
- » Promote collaborations with state, national and international collaborators, partners and investors to achieve synergies which maximise performance and the efficient use of resources.
- » Underpin the South Australian government innovation, science and technology policy and the state strategy development and agenda by providing robust and independent research data and knowledge and scientific advice.
- » Contribute scientific and technical inputs into PIRSA policy and development programs.

Values:

- » Scientific excellence
- » Progressive, economic and technologically advanced methodologies
- » Accurate and timely delivery
- » Professional and ethical standards
- » Care for our people and environment.

SARDI's values guide the delivery of research and development. We strive to be exceptional in our core competencies. Applied in origin, we excel in extending developed knowledge into applications useful at every step of the food value chain. Where we push boundaries in the discovery domain of science, we strive to place South Australian research and development at the forefront of world scientific advances.

As a multidisciplinary organisation, we actively promote interactions across science programs to draw on the talents of innovative thinkers at the forefront of knowledge transformation.

Driving Forces

The external environment plays an important role in determining research agendas and SARDI remains responsive to changes in those external environments, fine tuning programs on a regular basis.

The South Australian State Strategic Plan is an important driver for SARDI. Aspects of that plan addressed by SARDI's research and development include:

Objective 1 Growing prosperity

Through research that supports the food and bioscience industries in South Australia.

Objective 3 Attaining sustainability

With particular attention to soil protection, salinity, marine biodiversity, zero waste, greenhouse gas emissions and other aspects of sustainable industry.

Objective 4 Fostering creativity and innovation

By judicious use of public resources, the commercialisation of research and encouraging private industry investment in R&D.

To remain internationally competitive over the long term South Australian food and bioscience industries must address and develop solutions for the cost pressures they face. SARDI's research is directed towards this problem, and those arising from:

- » **Emissions Trading and Carbon Footprint:** Plans have been announced by the Australian government to introduce an emissions trading scheme from 2011. Whilst final details are not yet available, the scheme's introduction will certainly result in higher input costs for South Australia's primary industries.
- » **Sustainability issues:** In particular soil salinity and acidity, water availability and use, and generally sustainable practices within the food and bioscience industries will add to the cost pressures experienced within primary industries.

To remain nationally relevant and competitive, SARDI's research and development must also address the changing expectations of business, governments and consumers:

- » **Accountability:** All public sector agencies are expected to be increasingly transparent and accountable for the public funds invested in them. Social and public returns must exceed investment costs.
- » **Food Security in Australia:** The availability of water, usable land, climate change, growing salinity levels, biosecurity and production costs all contribute to issues of food security – addressed by all Australian governments.
- » **Animal Welfare:** There is a noticeable, growing public concern for the health and welfare of animals grown for consumption.
- » **Consumer Drivers:** The key consumer-driven attributes for food selection are pleasure, novelty, convenience, well-being and social responsibility.

A growing segment of Australian society is using its purchasing power to contribute to their health and well-being, and derive pleasure through food. This is accompanied by the flexing of a collective conscience through the preferential purchase of food and beverages which have been produced in both a socially responsible and environmentally sustainable manner.

- » **Food Safety:** Consumers require guarantees that the food products they consume are safe.
- » **Technological advances:** Technology development is evolving rapidly, particularly in the areas of diagnostics and molecular genetics, and SARDI needs to continue to embrace these advances to deliver research outcomes on time and to specification.

The structural changes occurring within the Australian government sector and the Australian economy as a whole are also addressed:

- » **Specialisation:** Under the auspices of the Primary Industries Ministerial Council (PIMC) and Primary Industries Standing Committee (PISC), state research agencies are increasingly working in conjunction with their counterparts in other States to deliver stakeholders' outcomes within a nationally oriented framework. Each State is taking responsibility for leading components of the national effort, and the development and maintenance of core capabilities for delivery of outcomes across Australia. This will reduce duplication of effort as agencies seek to exploit their research strengths.
- » **Adding value in the food supply chain:** Long an exporter of commodities and fresh food, there is a growing interest amongst Australian food processors to add value to that fresh food, increasing the proportion of the consumer food spend that is earned by the Australian food manufacturing sector.

Considerable importance is placed on the global changes occurring in markets, expectations and trading conditions:

- » **World Food Supply:** World food reserves are presently very low. Food producing acreage has moved to biofuel production in several key world food production areas, exacerbating this supply issue and causing relatively strong food price inflation. Those areas of SARDI's research program that address productivity will help to alleviate pressures through research that aims to produce commercial biofuels from a non feedstock - microalgae.

- » **Climate Change:** Primary industries are particularly susceptible to climatic changes and increased variability, leading to greater risks in production and land suitability.
- » **Market access:** Australian export markets are becoming more prescriptive in relation to food content, food safety and the use of herbicides and pesticides.
- » **Global financial crisis:** The combination of a very high level of economic uncertainty and a very low level of economic confidence may have long lasting effects on the availability of research funding. Most western governments will be faced with deficit budgets over the next few years making the potential for any substantial increase in government provided funding unlikely. Drives for funding reductions are more likely.

The private sector is also likely to monitor research and development expenditures more closely. Major increases in private sector funding will be difficult. If the present failure of the credit market to provide adequate debt funding to industry continues, the continued viability of some industry sectors will be at risk.

From these driving forces emerge the strategic opportunities and associated threats that are addressed by the divisional plans.

SARDI - an overview

Programs are specifically aligned to South Australia's Science Plan (STI10) to:

- » Meet specific industry priorities
- » Increase industry productivity and economic performance
- » Pursue innovation in environmental issues
- » Attract investment and develop critical infrastructure.

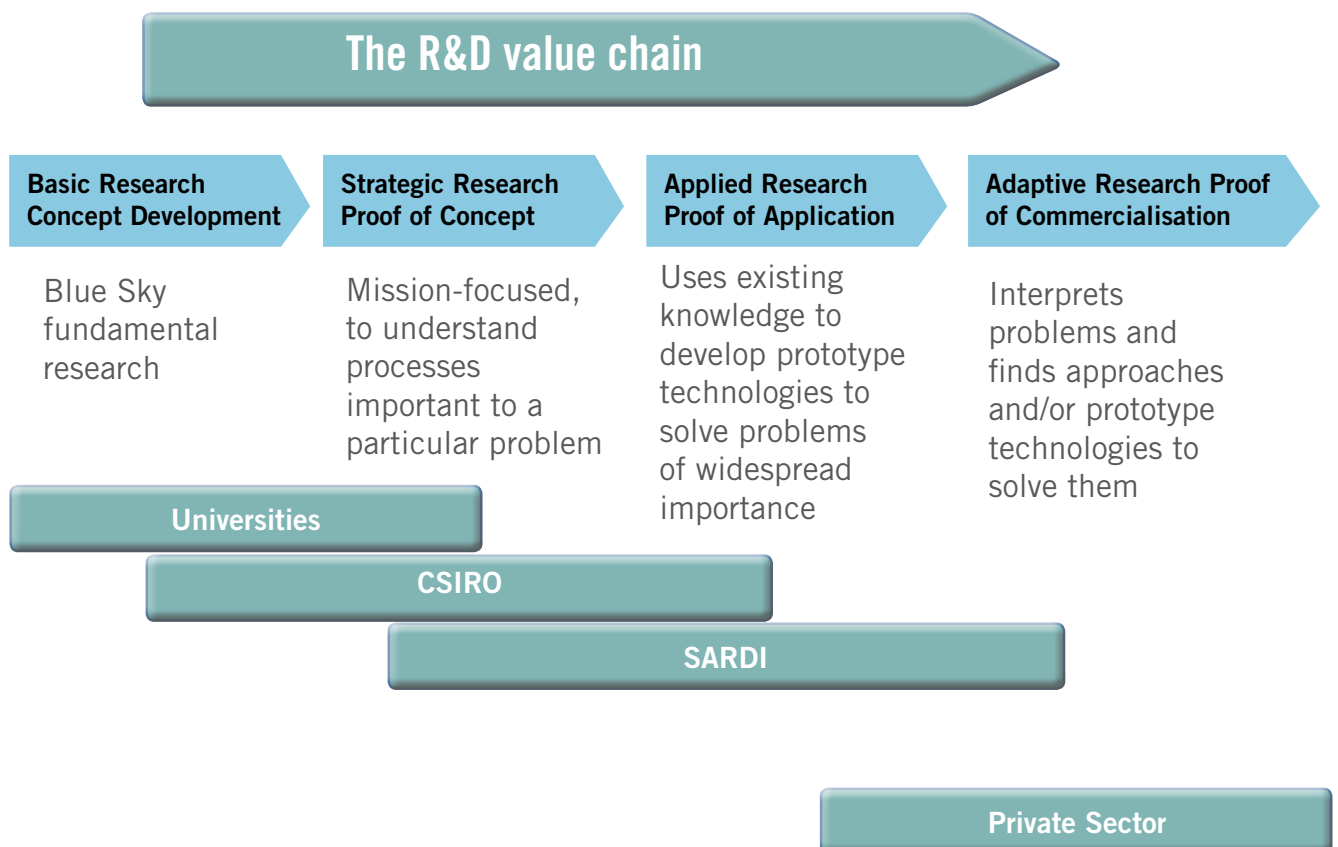
Within the Primary Industries portfolio, SARDI identifies these priority issues and challenges:

- » Value chain linkages
- » Natural resource and climate adaptation
- » Product integrity requirements

- » Innovation capability
- » Research competitiveness
- » Research facilities
- » Technology/knowledge access
- » Supplier competitiveness
- » Biosecurity and Response.

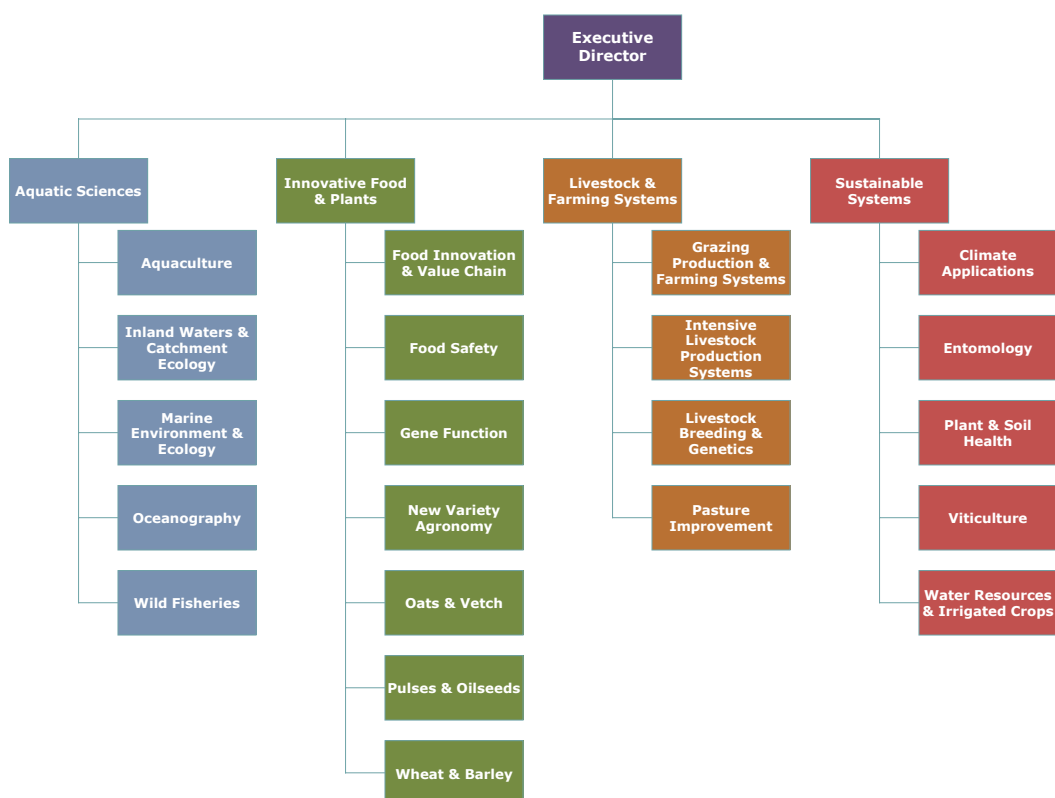
Figure 1 below shows SARDI's position in the R&D value chain. SARDI is positioned strongly in the strategic and applied research segments, overlapping the private sector in times of market failure to undertake adaptive research.

Figure 1: SARDI's position in the R&D value chain



SARDI operating structure

Figure 2: SARDI's operating structure



As shown in Figure 2, SARDI's science programs are aligned within four research divisions – Aquatic Sciences, Innovative Food and Plant, Livestock and Farming Systems and Sustainable Systems.

The 21 science programs offer a depth and breadth of expertise, enabling the organisation to rapidly bring together multidisciplinary, flexible teams to address complex issues. The culture and a flat management structure are designed to promote interactions to draw on the talents of innovative thinkers at the forefront of their fields.

Knowledge and people are SARDI's foundation.

The key output from SARDI's research and development activities is new knowledge that can be applied to benefit the State's food and bioscience industries. Whilst SARDI is organised into 21 Science Programs, they all interlinked. SARDI's structure fosters a multi-disciplinary approach to our efforts, ensuring timely delivery of research outputs and flexibility in dealing with industry requirements.

SARDI has acknowledged strengths in many areas, the most important being:

- » SARDI's reputation for excellence in applied research
- » A clearly defined position in the R&D value chain
- » Externally collaborative and strong relationships with funding agencies, other research agencies and industry
- » Internally collaborative with knowledge shared between science programs
- » Committed high calibre staff and leadership team
- » Strong focus on science areas in which it can take a leading research role
- » Facilities that are modern and relevant
- » Strong management systems.

SARDI's relatively few weaknesses include:

- » Comparative high dependence on external funding sources
- » Project funding base leads to a higher than desired staff turnover rate
- » Focused science areas may lead to a loss of capability from the State
- » Ageing workforce means that succession of key personnel is an issue
- » Some infrastructure is ageing.

Over the period to 30 June 2011, total employment (on a full time equivalent basis) is expected to remain fairly constant. Changes will occur in divisional make up as resources are directed towards water resources, plant and soil health, aquaculture, intensive livestock production systems and food innovation.

Finance and Investment

SARDI funds its core capabilities, maintenance and development through a General State Appropriation of the South Australian budget.

SARDI actively tenders for R&D contracts through other funding programs available within Australia, particularly through the Research & Development Corporations. SARDI's management finds a balance between maintenance and development of core capabilities and their exploitation through applied research programs.

SARDI Employment (January 2010)

	Aquatic Sciences	Innovative Food & Plants	Livestock & Farming Systems	Sustainable Systems	Business Support	Total
Full time science professionals	81	57	61	59	5	263
Part time science professionals	9	10	16	18	-	53
Project support	17	3	18	5	9	52
Management	6	8	5	6	6	31
Total	113	78	100	88	20	399

Key Relationships

To achieve its goals, SARDI must maintain strong relationships with many organisations – funding, research, industry and government bodies. The plan for the next three years is to maintain and strengthen these relationships and develop further key relationships as opportunities arise.

SARDI's Key Investment Partners

Australian Pork Limited
Fisheries Research and Development Corporation
Grains Research and Development Corporation
Grape and Wine Research and Development Corporation
Horticulture Australia Limited
Meat and Livestock Australia Limited
Rural Industries Research and Development Corporation
Australian Wool Innovation
South Australian Grains Industry Trust

The National Resource Management Boards, Food Standards Australia & New Zealand and the Murray-Darling Basin Commission are important investment partners.

Collaborative research partnerships are in place with the CSIRO, all other Australian State research and development agencies, state and national industry groups, all three South Australian universities and numerous other universities and tertiary institutions in Australia and around the world.

National Initiatives

Cooperative Research Centres

SARDI maintains strong relationships with and partners in many Cooperative Research Centres:

Australian Poultry CRC
Australian Seafood CRC
CRC for Beef Genetic Technologies
CRC for an Internationally Competitive Pork Industry
CRC for Irrigation Futures
CRC for National Plant Biosecurity
CRC for Sheep Industry Innovation
eWater CRC
Future Farm Industries CRC
Invasive Animals CRC
Molecular Plant Breeding CRC

National Collaborative Research Infrastructure Strategy

SARDI's capabilities in oceanography have resulted in key investments from the Australian government through the National Collaborative Research Infrastructure Strategy (NCRIS) with the Integrated Marine Observing System (IMOS) and the Southern Australian node, SAIMOS being established in partnership with the South Australian Government.

NCRIS has also invested in partnership with the South Australian Government in a photobioreactor to investigate algal production systems to produce usable and useful by-products, in particular biofuels from microalgae.

Winter Cereals Pre-breeding Alliance

The Australian Winter Cereals Pre-Breeding Alliance (AWCPA) has been established to promote collaboration and cooperation among cereal pre-breeders. The AWCPA's objective is to maximise the national pre-breeding effort and shorten the time frame between genetic enhancement and the development of new, improved crop varieties. This is being pursued through a greater level of coordination in pre-breeding activities with the aim of enhancing the speed of delivery of traits to Australian winter cereal breeders and to bring together research teams and skills to tackle the challenging and economically significant problems facing the industry.

Pre-breeding is the identification of genetic solutions for target traits and accompanying selection methods for use by breeders to develop new high-value varieties for the Australian domestic and international markets. Institutions contributing to the development of the alliance include CSIRO, Department of Agriculture and Food WA (DAFWA), Queensland Department of Employment, Economic Development and Innovation (DEEDI), Victorian Department of Primary Industries, Industry & Investment NSW, SARDI, Australian Centre for Plant Functional Genomics (ACPFPG), Grains Research and Development Corporation (GRDC) and Adelaide University representing the agricultural universities through the Deans of Agriculture Council. Details of the AWCPA and Guidelines can be found at: www.grdc.com.au, (type AWCPA into the search function).

Pulse Breeding Australia

Pulse Breeding Australia (PBA) is an unincorporated joint venture between the Victorian Department of Primary Industries, SARDI, Queensland Department of Employment, Economic Development and Innovation (DEEDI), Industry & Investment NSW, Department of Agriculture and Food Western Australia (DAFWA), University of Adelaide, Pulse Australia and the Grains Research & Development Corporation (GRDC), with the common goal of producing better pulse varieties faster. PBA provides a single world class breeding and germplasm enhancement program for chickpeas, field peas, faba beans, lentils and lupins in Australia. PBA aims to fast-

track the release of new pulse varieties to Australian grain growers that have better disease resistance, improved quality, are higher yielding and are adapted to Australian conditions.

SARDI is a major partner in PBA through leadership of the germplasm enhancement component and collaborating in developing improved lines of lentils, chickpeas, peas and beans for SA.

South Australia Collaborations

SARDI is involved in several collaborative partnerships with other research agencies, government agencies and industry groups based in South Australia.

Constellation SA

Constellation SA is a mechanism for enhancing collaboration between research organisations and industry in SA, and provides a framework for state government investment in research for innovation. The initiative consists of a number of individual projects which underpin these dual intentions, and are collectively 'badged' as Constellation SA (see www.constellationsa.sa.gov.au).

SARDI has recognised and accepted its responsibility as the lead government agency for promoting the state's science research and development agenda within the agriculture, food and wine sector. For example SARDI played a major role in the development of Marine Innovation SA (MISA) and the Wine Innovation Cluster (WIC), and is hosting the development of the Food Science, Plant BioScience and Animal Sciences clusters in collaboration with the Department of Further Education, Employment, Science and Technology.

Marine Innovation SA (MISA)

South Australia's seafood industry has the potential to more than double its gross revenue value to \$2 billion by 2015 according to the South Australian Seafood Industry Plan 2010-2015.

Marine Innovation SA (MISA) is helping to drive this through knowledge and innovation, by integrating and expanding South Australia's marine research capabilities, technology transfer and education and training pathways.

The program is an initiative of the South Australian Government, representing a partnership between SARDI,

Flinders University, the University of Adelaide, the South Australian Museum, Primary Industries and Resources SA (PIRSA), the South Australian seafood industry and regional communities

MISA's vision is to establish South Australia as an internationally recognised and vibrant centre for marine science, education and ecologically sustainable seafood development and its focus is on four high priority research areas: seafood quality and value-adding, aquaculture innovation, ecosystem services and biosecurity (see www.misa.net.au).

Food Science Cluster

Contained within SARDI, the CSIRO divisions represented in South Australia, and the State's universities, the Food Science Cluster brings together a number of nationally and internationally competitive groups working on food-related research and development programs.

It aims to create a forum to enable cohesive interaction between the various agencies in the food research sector and the local food industry. The Food Science Cluster will seek to provide:

- » a mechanism for facilitating the translation of research outcomes into new technologies and product opportunities
- » a competitive advantage at the national and international level for research and development investment opportunities
- » alignment of the research sector with policy and program initiatives around food arising from both the state and federal governments.

The Food Science Cluster is expected to be a partnership between SARDI, the University of Adelaide, the Australian Centre for Plant Functional Genomics Pty Ltd, CSIRO, Flinders University, the University of South Australia, Primary Industries and Resources SA and South Australian Food Industry Associations.

Plant BioSciences

South Australian scientists have a long and proud history researching cereal grains such as wheat and barley, and have been responsible for many improvements developed over the years in crop yield, grain quality and farming efficiency.

The Plant BioScience Cluster, representing collaboration between South Australia's key research institutions, aims to ensure the state continues to be at the forefront of cereals science, education and industry development. Through the partnership, the Cluster will undertake innovative research programs to enable the farming community to respond in a sustainable way to the challenges created by the demands of an ever growing world population and the threat of environmental change.

Together with SARDI, the Plant BioScience Cluster (the University of Adelaide, the Australian Centre for Plant Functional Genomics Pty Ltd, CSIRO, Flinders University and the University of South Australia), will seek to further consolidate South Australia's position as a world-leading research and development provider in this sector.

Animal Science Cluster

Healthy Animals, Healthy Environment is the theme for the Animal Science Cluster being developed as part of the Constellation SA Agriculture, Food and Wine Alliance. Key participants in the cluster are SARDI and the University of Adelaide School of Animal and Veterinary Science. An early imperative has been to develop a comprehensive vision and direction for the cluster that will deliver outcomes of importance to the future economic growth of South Australian animal industries with due consideration of social and environmental impacts. Programs in development are also relevant to the significant global challenges facing commercial animal production enterprises in many parts of the world.

Five focused research programs are being developed for the cluster:

- » Environmental footprints under more diverse climatic conditions (Environment & Climate Change)
- » Animal welfare programs driven through community engagement (Animal Welfare)
- » Integrated supply chains contributing to food integrity and security (Food Security and Supply Chains)
- » Diagnostics and treatments for animal linked human diseases (Biosecurity)
- » Large animal models for advancing human health discovery (Human Health).

There is a strong emphasis in the programs on activities that address anticipated future industry / community / government concerns and that will deliver high value outcomes relevant to all Australian communities.

Research and infrastructure investment will be sought for integrated research activities and solutions lead from South Australian that captures aspects of healthy animals, healthy environments, healthy humans and healthy food.

Wine Innovation Cluster

The cluster brings four leading grape and wine research agencies together with a single goal in mind: collaboration to achieve results that would not be possible working as stand alone agencies. Agencies involved are SARDI, the Australian Wine Research Institute, CSIRO and the University of Adelaide.

Between them, the collaboration partners possess the major share of Australian research, extension and education capabilities over the whole of the grape and wine value chain.

Each of the agencies remains a stand alone, independent enterprise. But the boundaries can quickly disappear and focus the combined capabilities on any problem in any part of the industry value chain (see www.wineinnovationcluster.com).

NRM Alliance

The Natural Resource Management Research Alliance is a collaboration between Department of Environment and Heritage (DEH), Department of Primary Industries and Resources (PIRSA), Department of Water Land and Biodiversity Conservation, Natural Resource Management Councils, Flinders University, University of Adelaide, University of South Australia, CSIRO, the South Australian Arid Lands Natural Resources Management Board, and the Northern and Yorke Natural Resources Management Board.

The purpose of the Research Alliance is to:

- » Foster and strengthen linkages between the users and providers of NRM science, technology and innovation
- » Foster and strengthen collaboration between providers of NRM science and technology
- » Drive innovation to increase capacity and capability
- » Provide strategic advice on the adoption of NRM science, technology and innovation
- » Attract and direct investment into NRM science, technology and innovation that will support improved NRM outcomes.

In doing so, the Research Alliance will drive innovation through science and research to develop new systems and technologies for NRM.

SA Food Centre at Regency

The South Australian Food Centre is a partnership between Primary Industries and Resources SA (PIRSA), the South Australian Research and Development Institute (SARDI), Department of Trade and Economic Development (DTED) and TAFE SA, and has been established under the South Australian Food Plan 2007-2010 to achieve the target of 8% growth in finished foods per year.

The Centre combines the state's leading industry experts under one roof. It aims to give businesses easy access to key industry and government services, as well as offer hands-on assistance in the areas of packaging, testing, food science and product development. It provides a tangible hub of expertise for business to tap into leading government and industry food resources, all in the one place.

The SA Food Centre will help South Australian businesses grow and prosper, identify and cultivate new markets and provide greater opportunities to expand their operations through innovation and promotion. SARDI's contribution to the centre is through provision of applied research and development and food technology expertise to support new product development and processing efficiency.

Future Directions - as an organisation

From the sea and land to the market, SARDI is driven to deliver innovative science solutions and translate research results into opportunities that position South Australia's food and bioscience industries as internationally competitive and ecologically sustainable.

SARDI will continue to push boundaries wherever the Institute has unique, distinctive skills and leads in developing enabling technologies of the future.

SARDI's revised organisational structure installed in 2007 has changed the way SARDI is managed to achieve momentum, focus and efficiencies, providing a positive precursor to approaching business planning. The structure was formulated after extensive consultation with national science leaders, staff, stakeholders and industry focus groups and realigned SARDI's capabilities to shifting strategic priorities within the State and National agenda.

The revised structure aligns SARDI's 21 science programs into four research divisions, which emphasise core competencies for which SARDI is known, or is positioned well for future success. The process clarified SARDI's position as a provider of applied solutions leveraged off these fundamental knowledge platforms - a pivotal ingredient of SARDI's present and future success.

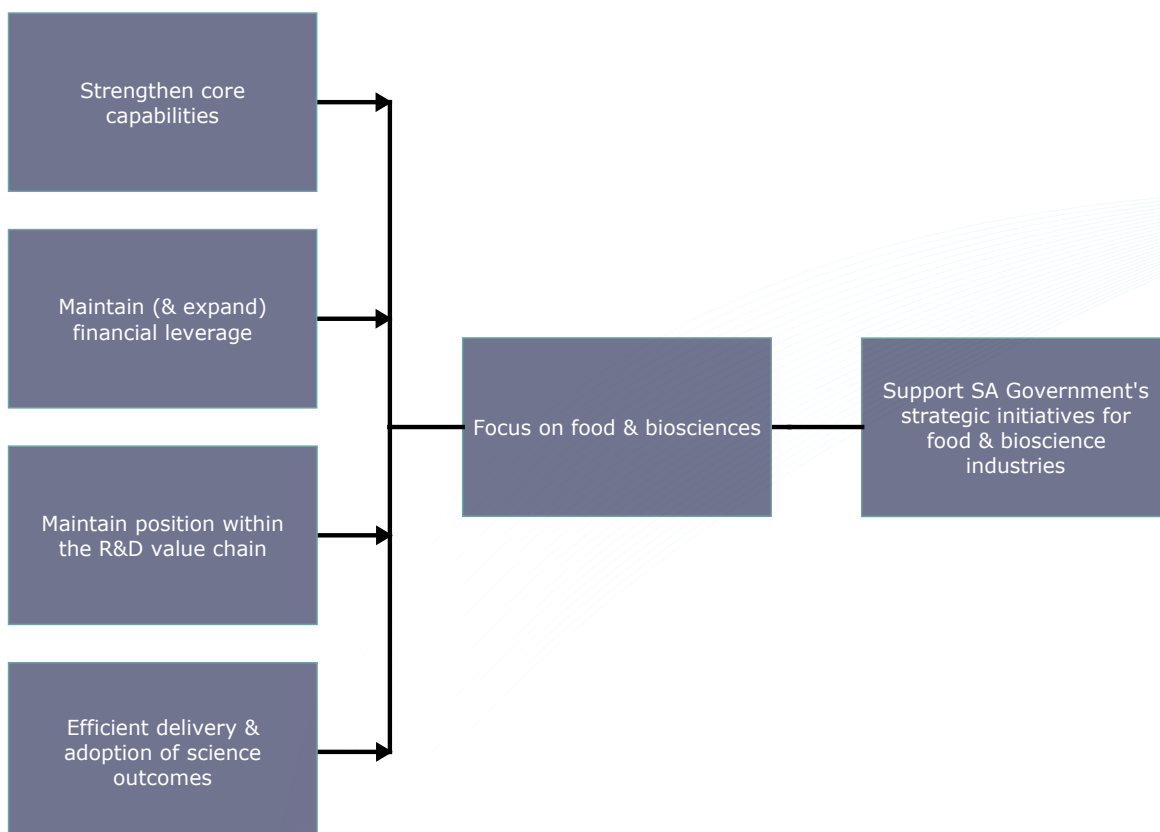


Figure 2: Rationale used to identify focus for science programs

The structural realignment laid the foundation for business planning, and was supported on the basis that it:

- » improved SARDI's contribution to State and National Research frameworks and priorities
- » strengthened core capabilities
- » enhanced science leadership and initiative
- » made sound operational sense
- » supported efficient delivery and adoption of science outcomes.

The defined 21 science programs are aligned to industry and community needs within the state, national and global context, all of which collectively demand a strong economic focus, sustainable production, a healthy population and a science capability that drives innovation.

The programs are also well-placed to provide critical capability to meet State requirements to address issues relating to biosecurity, food safety and product integrity, (for example providing a preparedness to act against locust plagues), or to maximise export opportunities.

Each science program has produced a business plan that provides a clear articulation of the market space it occupies, a financial business plan, key performance indicators, communication and technology plans, and outputs aligned with industry goals. This follows careful analysis of forces in the external environment, opportunities ahead and SARDI's strengths.

An important component has been identifying ways to professionally deliver relevant solutions to industry, while pursuing opportunities to excel in scientific endeavour.

Development of the business plans has coincided with a nation-wide review of science by the Federal Government's Primary Industries Standing Committee. The business plans accordingly have addressed areas where SARDI will lead the national effort, or provide a significant contribution to the national research effort, or operate as a link - simply accessing information already available through other research providers.

A common theme across all the plans is the aspiration to:

- » Be valued as a first choice provider of applied research and development through delivering outstanding science solutions
- » Maximise return on investment by stakeholders through collaborations
- » Deliver projects on time within cost
- » Support staff development, ensuring access to emerging tools and thinking in science.

The following processes have been highlighted as needing further development:

- » Client relationship capability management
- » Enhanced risk management
- » Increased profile, recognition and visibility of research outcomes – to increase awareness and access to research knowledge; particularly to increase peer reference in high impact publications
- » Consistent project management to deliver projects on time within cost – and to strike a balance between the effort to source funds to completing work
- » Succession planning
- » Performance management and development of staff
- » Secure high-priority capital upgrades through the presentation of strong business cases.

Aquatic Sciences

Chief:	Affiliate Associate Prof Rob Thomas
Locations:	West Beach, Port Lincoln, Mount Gambier
Significant Physical Assets:	South Australian Aquatic Sciences Centre, West Beach; Lincoln Marine Science Centre, Port Lincoln; Deep Sea Research Vessel (Ngerin) and Fleet; Pool Farm and Hatchery; Southern Australian Integrated Marine Observing System; National Collaborative Infrastructure Strategy (NCRIS) Photobioreactor
Science Program Areas	Aquaculture Inland Waters & Catchment Ecology Marine Environment & Ecology Oceanography Wild Fisheries
Key Internal Knowledge Relationships:	All science programs within the division share their knowledge and understandings. Aquaculture is a key knowledge node within the SARDI knowledge flow system and is the main conduit by which Aquatic Sciences knowledge reaches other divisions. There are particularly strong links with Innovative Food and Plants.



Aquatic Sciences carries out research for government-funded programs and commercial clients to ensure the sustainable development of aquaculture industries and sustainable management of fisheries resources for the benefit of South Australia (SA).

Recognised for excellence in aquatic sciences at both state and national levels, Aquatic Sciences is nationally and internally competitive, and is highly regarded as a centre delivering quality scientific, educational and interpretive services to government, industry and the community.

The core skills offered by Aquatic Sciences include aquaculture nutrition, genetics and propagation, marine and freshwater ecological research and environmental assessment together with fisheries biology, assessment and modelling. Aquatic Sciences also includes newly developed capacities in oceanography and aquatic

biosecurity. Research is currently delivered through five Science Programs comprising Aquaculture, Wild Fisheries, Marine Environment and Ecology (ME&E), Inland Waters and Catchment Ecology (IW&CE), and Oceanography.

National Primary Industries PISC RD&E Framework - SARDI Fisheries and Aquaculture RD&E focus

Major	Support	Link
Fisheries Oceanography Threatened, endangered and protected species	Fisheries Population biology Biometrics	Seafood economics Recreational fishing
Aquaculture Aquaculture production systems Animal health and welfare Microalgal production systems	Marine ecology and environment Benthic ecology Environmental and ecological impacts	Inland freshwater aquaculture Climate change Climate modelling
	Climate change Climate adaption	

Major: SARDI leads, develops and facilitates a national approach to research and development.

Support: SARDI contributes to the national research and development effort.

Link: SARDI will access high quality research knowledge and resources from other research providers to meet client needs.

Aquaculture

Science Leader: Steven Clarke

Focus

Aquaculture is a major industry in South Australia worth more than \$550 million to the state. The Aquaculture team provides scientific and technical leadership to support this industry, which is predicting significant growth in response to a clear market need for seafood that delivers human health benefits.

Research addresses the development of new sites, species and technologies, enhanced production and product quality, reduced operating costs and minimised environmental risks. Expertise within the program includes nutrition and feed technologies, genetics and reproduction, propagation and rearing systems and the health and welfare of aquatic animals. Synergistic science programs at SARDI include Food Innovation and Value-Chain and Environmental Ecology.

Opportunities and Future Directions

The Aquaculture team program aims to expand an ecologically sustainable industry that generates products of optimal quality and market value.

The program will continue to develop novel species, technologies and locations, and work with aquaculture enterprises to lift volume, reduce operating costs, enhancing product quality, safety and premium prices.

The program will maintain capacity to address regulatory requirements and fulfil community expectations. It will also develop improved protocols and a better understanding of environmental processes to minimise risks associated with aquaculture; and support skills and technology development through the provision of research facilities and involvement in education and training.

Spotlight – Pumping capability into aquaculture

SARDI's Aquaculture program has been a driving force behind the phenomenal expansion of South Australia's aquaculture industry over the past 20 years.

The industry has grown from an initial worth of around \$200,000 per year in the late 1980s to now having an economic impact on South Australia of more than \$500M.

Aquaculture industry sectors that have directly benefited from SARDI's research expertise and knowledge include southern bluefin tuna, Pacific oysters, greenlip ne, yellowtail kingfish, barramundi, salmon, mulloway, yabbies, marron and a range of aquarium species.

The program also pursues development of new aquaculture sectors with two innovative areas of activity currently underway: cockle/pipi farming and microalgal culture for the production of biofuels.

SARDI's team of talented researchers have worked closely with existing industry sectors, as well as individuals and companies interested in initiating new aquaculture sectors to nurture this growth. In many cases, the team's track record in forecasting industry needs has provided the confidence for industry to continue to invest in aquaculture. Vital training and capacity development for industry is also supported through supervising a large number of post-graduate research projects targeting areas of high industry need.

Underpinning SARDI's Aquaculture research and development capabilities are impressive facilities to undertake small-scale environmental controlled experiments, and larger pre-commercialisation scale activities associated with proof-of-concept and pilot scale demonstrations. Facilities include: a shellfish and a finfish hatchery; small and large indoor and outdoor tank facilities for crustaceans, fish and molluscs; an extruder and associated equipment to manufacture aquafeeds; microalgal bags, photobioreactors and raceways; and under construction, a biosecurity facility for fish health research.

The Program was recognised in early 2010 by the Institute of Marine Engineers, Science and Technology, an international organisation for professionals, with a certificate for "Applied Research, Development and Innovation for South Australian Aquaculture".

Inland Waters and Catchment Ecology

Science Leader: Dr Qifeng Ye

Focus

The Inland Waters and Catchment Ecology program underpins the conservation, management and rehabilitation of Australia's freshwater ecosystems, providing research knowledge to support PIRSA in its regulatory and management responsibilities.

The team has unique strengths in fish passage, fish and habitat ecology; fish population dynamics, aquatic and riparian vegetation, environmental flows and habitat ecology and ecosystem response models. It provides freshwater/estuarine fish ecology, electrofishing and radio telemetry expertise in SA as part of its research efforts to rehabilitate native fish populations and is a leader in freshwater invasive species research.

The research scope includes fish ecology, plant ecology, invasive species, climate and catchment ecology. Strong relationships with funding and partner agencies are central to its success, with natural resource management agencies the major beneficiaries of its research. The science program enjoys an extensive and diverse collaborative network with national and international researchers and engagement with all users of water resources and associated ecosystems including irrigators, water authorities, recreational and commercial fishers and the broader community.

Opportunities and future directions

River Murray issues will continue to dominate the work flow, with the need for ecological projects surrounding stock assessment, management of invasive species, care for wetlands closed due to drought, and baseline and ecological data on threatened species.

In the longer term, the group will instigate new work in the arid-zone including the Cooper Creek and Lake Eyre Basin and expand research in the state's South East.

Climate impact as it affects aquatic habitats and biota in the inland waters, estuaries and catchments represents an increasing area of focus. The group will pursue avenues for funding support to address the impacts of climate change and support PIRSA through providing research advice on drought response, invasive species and threatened species.

The group will continue to develop fish ecology research capacity and expand capabilities in plant ecology and research on invasive species control to expand knowledge and understanding of the ecology and management of inland waters and associated catchments.

Spotlight – The Living Murray

Researchers from the Inland Waters and Catchment Ecology group have designed a breakthrough prototype carp cage. It contains special traps that exploit two behaviours unique to the invasive pest: jumping over and pushing under in-stream obstacles. All fish can enter the first section of the cage, but only carp push or jump into the inner cage, allowing native fish to be released back into the river unharmed. The trap was a resounding success during trials at the refilling of the Banrock Station wetlands, catching four tonnes of carp in just one month. Researchers hope that the trap will eventually be used to help control carp throughout the Murray-Darling Basin.

Since 2004, the program has carried out more than \$5 million in research and monitoring projects for the Murray-Darling Basin Commission. Based in the River Murray Channel, Chowilla, Coorong, Lower Lakes and the Murray Mouth, the projects are part of the commission's Living Murray and Native Fish Strategy programs and underpin vital policy decisions for NRM. Study subjects have included fish and macrophyte ecology studies, environmental regulator risk assessment for fish and weeds in Chowilla, larval fish ecology and fish monitoring for floodplain, aquatic and riparian vegetation, threatened species and estuarine fish and plants.

Marine Environment and Ecology

Science Leader: Dr Jason Tanner

Focus

The Marine Environment and Ecology science program provides scientific and technical advice in the management and remediation of marine environments.

Current research focuses on priority concerns such as causes of seagrass loss and techniques for rehabilitation, the effects of dredging and desalination plants on the marine environment, interactions between the environment and aquaculture, the effects of fishing on the ecosystem, distribution and ecological impacts of marine pests, development of novel genetic methods for assessing the health of the sea bed near aquaculture, the ecological status of reefs and commercial environmental impact assessments.

There are five research themes: Mitigation and Rehabilitation, Aquaculture Environment, Marine Pests, Benthic Ecology, and Threatened, Endangered and Protected Species. Research capabilities include habitat mapping, environmental impact assessment, and the ecology and management of human impacts on marine systems.

Opportunities and Future Directions

There is an increasing emphasis on pre and post border biosecurity research to create systems to prevent incursions by exotic pests. The group will build its capability in marine biosecurity research, including the development of an aquatic biocontainment facility to allow for advanced research.

There are excellent opportunities for the future in plant ecophysiology, especially photophysiology. More concentration in these areas will allow research into algae as a potential species to mitigate the impacts of finfish farming, and into seagrasses to preserve and enhance essential fish habitat.

In conjunction with the SARDI Oceanography program, Marine Environment and Ecology will undertake fieldwork and develop advanced models to determine the carrying capacity of new aquaculture zones, and allow aquaculture to be developed in the most environmentally appropriate areas.

With the community increasingly demanding sustainable management of fisheries, the program will provide ongoing rigorous technical assessments of the status of endangered and threatened species to inform public policy and assist industry to minimise impacts. It will also pursue innovative solutions to monitor and rehabilitate aquaculture areas and areas impacted by humans to ensure sustainable production.

Spotlight: Seagrass loss and restoration

Waste water and storm water have been discharged into Adelaide's coastal waters for many years with little understanding of the environmental consequences. As a result, over the last 40 years, more than 5200 hectares of seagrass has been lost, resulting in the retreat of the blue line, increased sand movement and decreased recreational fishing opportunities. SARDI Aquatic Sciences played a key role in the Adelaide Coastal Waters Study, which sought to identify the causes of this seagrass loss, undertaking studies to examine seagrass distribution and tolerances to stresses such as reduced light and salinity.

At the same time, the group has been pioneering a new low-cost technique to rehabilitate seagrass meadows. Most seagrass rehabilitation efforts have involved intensive transplantation of adult plants, or the use of seeds in sheltered areas. These traditional methods are time-consuming, expensive and have the potential to damage donor meadows. SARDI researchers have developed a technique using hessian sandbags to enhance natural recruitment. While further work needs to be undertaken to improve survival rates, this method is showing promise, as a low-cost rehabilitation technique that can be quickly deployed over large areas.

Spotlight: Science to underpin aquaculture planning and management

With Aquaculture a growing industry in South Australia, it is essential expansion is properly managed. The Marine Environment and Ecology program has been providing both PIRSA Aquaculture and industry with scientific advice on where to locate aquaculture zones and their potential carrying capacity. The flagship project is *Risk and Response: understanding the tuna farming environment*. This collaboration with CSIRO Marine and Atmospheric Research, along with Adelaide and Flinders universities, has developed an integrated hydrodynamic, sediment and biogeochemical model of the tuna farming zone off Port Lincoln, as well as nearby inshore areas. This model allows researchers to examine the fate of nutrient inputs into the system, and the potential biological impacts that these nutrients will have, as well as the consequences of other activities for both aquaculture and the environment. The model is spatially explicit, making it possible to identify where impacts are likely to occur, what these are likely to be, and what the consequences of varying stocking rates will be.

Oceanography

Science Leader: Prof John Middleton

Focus

It is increasingly recognised that the ocean environment plays a crucial role in local climate, severe weather and in the maintenance and change of our coastlines, marine habitats and fisheries.

Oceanographic research conducted by the program seeks to describe, understand and predict this environment through the role of oceanic currents in transporting heat, sediments, nutrients, marine biota and pollutants over the continental shelf and in our gulfs.

A second aim is to use this information to understand and predict the fundamental planktonic ecosystems that support fisheries, seals, whales and the living marine environment. To support this research, the Oceanography Program is leading the establishment of the \$6.4M Southern Australian Integrated Marine Observing System (SAIMOS) off the SA and Victorian Shelves – see below. In addition, a super-computer ocean modelling facility is being built that will assimilate this data and provide calibrated solutions to marine issues for both industry and government.

Future Opportunities

This fundamental research, supported by the modelling facility and SAIMOS, will provide a holistic view of the marine environment. This will underpin application driven research at both the large scale (eg. climate) and small scale (eg. bays) that is sought by SA government and industry. These will include the determination of sustainable aquaculture sites and carrying capacity, the spread of pathogens and pollutants, the impacts of desalination plants and sewage outfalls, the dispersion and settlement of larval species and impacts on fisheries and the connectivity of marine regions to inform government for the establishment of Marine Parks. The development of a wave modelling facility with the Bureau of Meteorology will extend opportunities further to include studies of sand and habitat erosion and change.

The research undertaken will also position SA strongly in efforts to understand the climate and natural variability of our coastal oceans, planktonic systems and fisheries. Such an understanding is a prerequisite for understanding the impacts of global climate change and in the determination and development of informed responses by government, industry and the SA community.

A formal alliance has now been established between SARDI Aquatic Sciences and the Victorian Marine and Freshwater Fisheries Institute and new opportunities are presenting both for the growth of SAIMOS, and for the parallel development and provision of oceanographic services for Victorian government and industry.

Spotlight – Southern Australian Integrated Marine Observing System (SAIMOS)

SAIMOS is a \$6.4 million observing system being built for the SA and west Victorian regions. It will provide knowledge to advance the understanding of the impact of climate change on the ocean systems that underpin SA's valuable fisheries. The system is made up of cutting edge technologies that include underwater moorings, programmable marine gliders, acoustic curtains for tagged fish and autonomous underwater vehicles. In addition, HF ocean radar provides 'real time' information on surface waves and currents, aiding search and rescue operations and improving weather prediction during bushfires. The project is being run in partnership with the National Collaborative Research Infrastructure Strategy, South Australian Government, Marine Innovation SA, SARDI Aquatic Sciences, Flinders University and the University of Adelaide.

Wild Fisheries

Science Leader: Dr Tim Ward

Focus

With a commercial wild fishery worth nearly \$200 million a year and about 328,000 people enjoying recreational fishing every year, South Australia's wild fish stocks are a vital part of both the state's economy and its lifestyle.

At the same time, fish stocks have never been under greater pressure. SARDI's Wild Fisheries program provides the high quality scientific information that is the basis for state and federal agencies to manage our marine resources, ensuring there will be fish now and for future generations.

One of the main branches of the group's work is in stock assessment of key species, requiring the scientific teams to conduct biological, ecological fisheries research and modelling. Projects include investigations to better understand life history and ecology to determine the effects of fishing on populations and research to measure the success or failure of management changes.

Subprograms include offshore crustaceans (including southern rock lobster and giant crab), inshore crustaceans (western king prawns and blue swimmer crab), molluscan fisheries (abalone, calamari, cuttlefish and bivalves), finfish fisheries (including pelagic, sardines, King George whiting, snapper, garfish and mulloway) and fisheries modelling, which provides leadership in stock assessment models, statistics, survey design and data analysis.

Staff work closely with state and commonwealth fisheries research agencies, industry organisations and other stakeholders and several of the group's scientists are recognised internationally as leaders in their fields.

Opportunities and Future Directions

The community and fisheries industries have high expectations for scientific agencies, expecting the timely delivery of objective information relating to the management of commercial and recreational fisheries. To continue to meet this expectation, there is a need to boost capacity and update critical infrastructure. The group has identified the need to access new capability in fisheries modelling, a social-recreational fishing scientist and seafood economist.

In partnership with PIRSA, the group is enhancing its existing science programs to create an integrated, comprehensive science program to support the future management of South Australia's fisheries. It plans to foster collaborative partnerships to deliver on client needs where it does not have the required capacity. It will also embrace the National Research Agenda to diversify its client base, increasing the number, size and scope of research and monitoring projects undertaken for fisheries management agencies in other jurisdictions.

Spotlight – Mackerel marvel

Ground breaking research has identified a valuable new Australian fishery brimming with the essential fatty acid, Omega 3: mackerel. The fish are found in the Great Australian Bight and off eastern Australia. Limited amounts are fished for bait, a situation similar to the calamari fishery before it was developed into a consumer fishery. A similar species of mackerel is a popular table fish in Europe and an important source of Omega 3, a good oil with many health benefits, including reducing the incidence of heart disease and improving brain function. Four years of research by the Wild Fisheries group has revealed much about the fish's biology and shown that there are large, potentially-valuable commercial stocks. Importantly, the new fishery will be properly managed from the start.

Innovative Food & Plants

Chief:	Dr Andrew Pointon
Locations:	Glenside, West Beach, Waite, Regency, Clare, Port Lincoln, Struan
Significant Physical Assets:	Plant Research Centre Glasshouses
Science Program:	Food Innovation & Value Chain Food Safety Gene Function New Variety Agronomy Oats & Vetch Pulses & oilseeds Wheat & Barley
Key Internal Knowledge Relationships:	All science programs within the division share their knowledge and understandings. Food Innovation & Value Chain, Food Safety and Gene Function are key nodes through which the division's knowledge flows to the rest of the SARDI system. Those science programs also have prominent positions within the SARDI knowledge network with strong links to all other divisions.



The Innovative Food and Plants Division brings together SARDI's post farm-gate/post-harvest R&D capacity to increase its market responsiveness and new product development services. It also provides capacity to maintain production and quality improvements for the SA cereal industry.

Food Innovation and Value Chain brings new capacity for food businesses and sectors to support growth through new product development, process innovation, and value-add and cool chain management.

Food Safety works across supply chains to identify food safety risk management options to inform policy and food safety program development and support market access.

Wheat and Barley, Pulses and Oilseeds and Oat and Vetch all support the development of crop varieties with enhanced consumer quality, improved yield, disease resistance and reduced susceptibility to abiotic stress (e.g. drought, frost, low rainfall).

Gene Function directly supports breeding efforts of crops relevant to SA industries through gene analysis and gene markers for disease, quality and abiotic stress tolerance traits to assist selection of superior crops.

New Variety Agronomy evaluates new cereal crop varieties under a range of environmental and farm management practices to provide industry with reliable information to improve overall productivity.

National Primary Industries PISC RD&E Framework - SARDI Food and Plant RD&E focus

Major	Support	Link
Grains Wheat Oat Vetch Winter pulses Food and nutrition Food safety Export market access Import risk assessment New product development Seafood value-adding Value chain technologies Post-harvest storage and handling	Crop improvement Wheat Barley Oilseeds Winter pulses New technologies Hybrids Phenomics Marker selection	Temperate vegetables Temperate fruit Food science Bioactives

Major: SARDI leads, develops and facilitates a national approach to research and development.

Support: SARDI contributes to the national research and development effort.

Link: SARDI will access high quality research knowledge and resources from other research providers to meet client needs.

Food Innovation and Value Chain

Science Leader: Dr Andrew Barber

Focus:

Opportunities for economic growth within the food industry lie largely beyond the farm gate. To capture them, the Food Innovation and Value Chain science program offers capacity in product development, process innovation, value-adding, cool chain management and market access.

One of its primary aims being the achievement of maximising marketability and financial returns within the finished food sector. Finished foods include both processed food and foods with the highest value as natural, unprocessed food. Initiatives within this dynamic program will contribute to the ability of South Australia's food industry to increase the value of finished foods per year by eight per cent growth a year, a key target of the SA Food Plan.

The team will assist food businesses to troubleshoot problems, identify new market opportunities and overcome technological barriers, drawing on expertise in areas such as new product development, food processing optimisation, sensory evaluation, market access, value-adding, cool chain management and packaging innovation.

Opportunities and Future Directions

Projects within the Food Innovation Value Chain science program will boost the food industry's capability in securing market access, value adding, processing and finished food innovation through industry skills development, providing quality information and applied solutions.

The SA Food Centre established at Regency International Centre for Hospitality, Leisure and Food Studies has

access to an extensive range of facilities for food and beverage production, including packaging machinery, food microbiology and analytical laboratories. The SA Food Centre development was made possible through the SA Food Council which supports the development of product quality and food innovation capability in SARDI's Food Innovation and Value Chain program.

This program will develop a suite of projects to allow local businesses to capitalise on opportunities in food innovation and new product development such as developing foods with endorsed functional food claims, boosting product quality and developing systems to maintain market access, food quality and shelf life. It will support the introduction of new technologies through large-scale demonstrations, including trials of new equipment at Regency, and increase the technical capacity available to businesses through graduate and student placements.

Food Safety

Science Leader: Dr Andreas Kiermeier

Focus

SARDI Food Safety has a multi-disciplinary team working to identify risks to food safety. Its work helps ensure safe food in supermarkets and restaurants around the state, but also keeps export markets open to local food businesses and informs policy development.

The group's research covers food microbiology, risk modelling, statistics, veterinary public health, toxicology, epidemiology, molecular epidemiology, dietary modelling of residues and risk communication. This provides vital information to food producers and policy makers alike.

The program has a reputation for credibility and reliability, working closely with government, industry and individual businesses. Its public health sector is a vital one, responding to emergencies, identifying hazards and reducing risk while allowing food safety authorities to assess industry performance, formulate policy and set standards. The group also works with industry on long-term, strategic programs aimed at managing and anticipating food safety risks, ensuring compliance with regulations and maintaining export markets, while its assistance to agri-food businesses concentrates on tactical studies that add value after the farm gate.

Opportunities and future directions

The seafood sector holds significant opportunities for the future of food safety research. There is the potential for the establishment of a national seafood safety centre to support the sector's market access development. The Food Safety group also aims to work with the seafood industry to develop a database of nutrition and residues to be used in the development of nutritional claims for seafood and during market access negotiations.

The application of new technologies will feature strongly in Food Safety's future. For example, the group sees opportunities in new genome technologies in the area of epidemiology for microbial food-borne pathogens, high-pressure processing and carrying out chemical safety assessments on plant bioactives for both standards agencies and industry groups.

Spotlight – National retail baseline survey of chicken meat in SA and NSW

Salmonella and *Campylobacter* are two important pathogens with significant public health impacts in Australia and overseas. Handling and consumption of chicken meat have been identified as major routes of human infection. Retail baseline surveys are a common starting point in addressing the public health risk from chicken meat across many countries. The data collected as part of this survey indicates that contaminated chicken meat and associated packaging could cause human illness due to undercooking and cross-contamination via hands and surfaces, particularly for *Campylobacter*. The data provides an estimate of the level of contamination as an indicator of consumer exposure at retail outlets and will allow risk managers to set targets to reduce contamination linked to both pathogens.

Spotlight - \$38:1 from food safety tuna research

A report to the Aquafin CRC has valued the residue and productivity integrity research projects provided by SARDI for Southern Bluefin Tuna industry at \$112 million. The project has generated \$38 for every dollar invested. The research has boosted market access through demonstrating product compliance and a harmonisation of analytical methods and changes to national standards in importing countries.

Gene Function

Science Leader: Dr Klaus Oldach

Focus

SARDI's Gene Function group supports crop breeding in South Australia through molecular genetics and genomic analysis. Its scientists contribute to the better understanding of important traits such as those that cause defects or boost yields, adding to farmers' incomes and boosting the state's economy.

The group works across agriculture and horticulture, in crops from cereals to pulses and pasture to stone fruit, helping to produce superior strains suitable for use in various climatic conditions around SA. Its researchers identify gene markers for various diseases and select for desirable traits such as stress tolerance, providing molecular approaches, tools and interpretations that create real economic benefits for local growers.

Opportunities and future directions

The program plans to maximise its benefits to South Australian agriculture by redirecting its research focus away from high throughput wheat and barley genotyping and towards gene identification and characterisation, adding to a fuller understanding of the genetic basis of crop traits that are useful in SA.

High-protein crops, such as grain and pasture legumes, have the potential to become more important to South Australia in view of the increasing global demand for protein and the shift towards perennial crops. The Gene Function program is supporting the breeding of these crops, especially in view of the likelihood that GM solutions will become more acceptable in agriculture and markets internationally.

The group aims to better exploit its skills and strengths by moving from being mainly a service provider towards a role as a co-investigator, offering ideas for project development and working towards innovative solutions. Good opportunities exist in cereal quality research with new export markets in mind. In 2008 the Premiers of South Australia and Manitoba formalised a joint agreement between South Australian and Manitoban research institutes involving \$600 000 to search for genes that offer tolerance to drought. Such collaborations will strengthen and increase the international standing of the group.

Genetic answers to biotic stresses show promise for the future, with possible funding interest from the GRDC. The Gene Function group already has a strong focus in this area, with particular success in nematode resistance, and will continue to build that capacity. It already has expertise in areas such as *Rhynchosporium secalis*, a fungal pathogen that damages barley leaves, but has no funding yet to carry out the needed research.

Spotlight

The Gene Function team has discovered a crucial gene that can boost pasture growth by as much as 50 per cent. The gene is responsible for reducing the sensitivity of legume pasture to traces of commonly used herbicides. The discovery means plant breeders have the means to detect the presence of the valuable gene in days, rather than months, allowing them to rapidly advance legume breeding programs.

The team's other achievements of gene function research include molecular tools that have been widely adopted by Australian breeding programs. New varieties are under development addressing consistency in grain quality and quantity, which are the two major constraints in Australian cereal crops, as well as value-added grain for emerging markets such as Asia. The molecular markers are used to:

- » Eliminate the quality defect of pre-harvest sprouting that is common in Australian white-grained wheat varieties.
- » Provide colour stability in Asian noodle products, a critical determinant of quality and consumer acceptance.
- » Develop barley varieties with high amylose or waxy starches that are beneficial to human health, particularly the prevention and management of diabetes, coronary heart disease, obesity, colon and rectal cancers, constipation and diverticular disease.

New Variety Agronomy

Science Leader: Rob Wheeler

Focus

The New Variety Agronomy program evaluates new cereal, pulse and oilseed crop varieties to provide industry with reliable, independent information.

The program covers all major winter field crops, including cereals, pulses and oilseeds and takes into account a variety of environmental and farm management conditions.

Its high-quality on-farm research is carried out on private sites and research centres across the state's grain-producing areas, ensuring growers have accurate and locally-relevant information. The group's scientists carry out field research on crop stress tolerance, adaptation, agronomy and management to provide accredited, unbiased information on performance and management guidelines to help growers achieve the full potential of new varieties.

With its industry-driven focus, the group won the right to be SA's representative in the National Variety Trial and has earned a reputation for transparency and integrity.

Opportunities and future directions

Demand for independent evaluation services such as that offered by New Variety Agronomy will only grow as industry and government requirements increase for accountability and transparency. Its strength in field research and agronomic expertise means it has excellent potential to become involved in cooperative research centres such as the Future Farm Industries CRC, in collaboration with the University of Adelaide and with regional NRM boards. The national drain in the area of agronomy is also likely to boost demand for the group's skills.

There is a range of opportunities in adapting farming systems to meet the challenges of climate change, through measures such as improving water use efficiency and introducing perennial species. New DNA technologies also hold great potential for agronomic research, such as soil pathogen research and crop DNA, and New Variety Agronomy is well-placed to take advantage of these research areas.

Spotlight – Getting crop industries on their feet and keeping them there

New agronomy research has led to the development of cost-effective disease management strategies for local pulse growers. The research has aided in the re-establishment of a thriving chickpea industry following destructive disease outbreaks that halted production for five years, and has also protected the state's faba bean industry from a similar setback.

Ongoing research into the tolerance of new crop varieties to commonly-used herbicides when applied at the rate recommended on the label has identified large potential losses in grain among some recently-released cereal and pulse varieties. The ramifications to grower profits are significant and the research information is now being conveyed to grain producers through newly established internet channels to enable them to either opt to grow herbicide-tolerant alternatives or use less damaging herbicides.

Oat and Vetch

Science Leader: Dr Pamela Zwer

Focus

SARDI's internationally-recognised Oat and Vetch group represents national breeding programs for the genetic improvement of oat and vetch varieties suitable for use in southern Australia. The area sown to the two crops is on the increase as growers and end users begin to understand their unique advantages in areas such as feed, green manure (vetch) and as crops that are adapted to climatic challenges.

The program supports the development of crop varieties with improved quality, yield and disease resistance and reduced susceptibility to harsh environmental conditions. Its scientists are involved in National Oat and Vetch Breeding Program projects and have an excellent reputation with both RDCs and industry for collaboration and output delivery.

Opportunities and future directions

The group's oat program has developed a successful path to market, including a whole-of-supply chain for milling and hay varieties. The next step is to develop a new path with a global perspective. India and China are the growing markets for milling grain and hay varieties, while countries such as Korea are interested in vetch as a cheaper source of soil nitrogen.

The Vetch Breeding Program has the potential to develop a high-protein dryland variety to replace irrigated fodder crops, an option with implications for the State Government's Save the Murray Plan.

There is a need for new molecular markers to reduce the high cost of the bioassays used for plant disease evaluation, a market niche that the Oat and Vetch group is ideally placed to exploit.

The oat breeding program aims to move into completely new and innovative areas. Future marketing opportunities for oat take in new end uses such as functional food, nutraceuticals and cosmetics.

Spotlight – New oat and vetch varieties released

The program is a prolific producer of quality varieties of oat and vetch that enjoy significant market success. The Wintaroo, Brusher, Kangaroo, Mulgara and Tungoo hay varieties offer higher hay yield, improved disease resistance and greater flexibility in farming systems. In the

area of milling oats, SARDI's milling varieties have been embraced through the food chain - by growers for their field performance, millers for their processing efficiency and consumers for their taste. The Possum and Mitika varieties provide high grain yield potential with good milling quality characters, while Yallara provides excellent disease coverage and tops milling yield – every one per cent increase in milling yield is worth about \$100,000 per 40,000 tonnes of grain processed to the milling industry. SARDI's Rasina vetch variety represents higher grain yield potential, lower toxin content and improved disease resistance compared to current varieties

Spotlight - Oats program sows opportunity

Every dollar invested in the SARDI-led national oaten-hay breeding program has returned an impressive \$42, a recent cost-benefit analysis by the Rural Industries Research and Development Corporation shows. SARDI-bred oaten hay varieties have claimed prime position in market share, spurring on an 800 000 tonne strong export hay industry, built on supplying dairy and beef feedlots throughout Asia.

Pulses and Oilseeds

Science Leader: Dr Maqbool Ahmad

Focus

South Australia's pulse and oilseed industries are relatively new compared to its well-established cereal cropping sector, yet are responsible for feeding millions of people worldwide. Annual farm gate turnover stands at \$150 million for pulses and \$100 million for oilseeds, with the industry expected to gather strength in the mid to long term.

SARDI's Pulses and Oilseeds group supports the development of new and better varieties with qualities such as increased yields, better economic value and resistance to disease and stresses such as drought, frost and low rainfall.

The program's pulse and oilseed breeding programs develop and deliver improved varieties of chickpeas, lentils, faba beans, lupins, canola and mustards. Its scientists select for specific plant characteristics such as yield potential, quality, disease resistance, regional adaptation and production and marketing benefits, always with an eye for a new or innovative use such as biofuel or fortified foods.

Through its germplasm section, the group is the national leader in pulse germplasm enhancement through its association with Pulse Breeding Australia, while the two breeding areas both have integral roles in national breeding programs.

Opportunities and future directions

There is great potential for the group to develop new varieties of pulses and oilseeds to meet the challenges and opportunities of climate change and drought through improved water use efficiency and climate risk management.

Developing germplasm and varieties for specific end uses such as healthy foods also offers significant opportunities. The full health benefits of pulses and oilseeds have not yet been exploited, leaving room for future research growth and potential intellectual property benefits.

The group aims to collaborate in developing 'ready to go' style pulse products such as chickpeas and lentils. It hopes to identify commercial partners early in the development process to build market intelligence and believes it could link in to the SA Food Plan.

Spotlight – Crop programs on the pulse

Through its collaboration with national pulse breeding programs, the group has released a number of new pulse varieties to SA growers including PBA Flash, PBA Bounty, Nipper and Boomer lentils, PBA Slasher, Genesis 509, 509 and 090 chickpeas, Sturt and Bundi field peas, Nura faba beans and Mandelup lupins. The group has also generated specific management information for growers to enable them to realise the benefits of the new varieties.

Climate change has seen a rise in the frequency of spring frosts, causing major losses in crop production and grain quality in southern Australia. To overcome this stress, the Pulses and Oilseeds group has developed two frost-tolerant field pea parent lines.

As part of the national oilseed breeding programs, crosses and selections were made, leading to the commercialisation of two new canola varieties ideally suited to local farming conditions, namely Tarcoola, an early maturing conventional type with high oil content, and ATR-Barra, a mid to late maturing variety with triazine tolerance.

Wheat and Barley

Science Leader: Dr Hugh Wallwork

Focus

South Australian cereal crops put bread on tables across the nation and in countries around the world, with about 3 million hectares of our farm land planted to wheat and barley every year. SARDI's Wheat and Barley program supports the growth of this important industry by developing new crop varieties with improved quality, yield and disease resistance and reduced susceptibility to stress factors such as heat and salinity.

The group researches the genetic control of a range of problems from fungal infections to the effects of drought and is a valuable source of information on disease control for growers and industry alike. Its experienced scientists are known nationally for their expertise in cereal pathology, genetics, wheat quality and in vitro technologies.

Opportunities and future directions

As global demand increases for protein-rich crops, there is great potential for the Wheat and Barley group to become a national focus for research into wheat proteins and their effect on overall grain quality.

In response to the challenges of climate change, the group aims to take a leading role in research into the genetics of stress tolerance that will focus on drought tolerance.

An opportunity exists for the group to create a niche role for itself as an expert in germplasm development through the GRDC pre-breeding initiative and its strong links to breeding programs.

The group is focusing on reviving the ailing durum industry by developing germplasm and varieties resistant to crown rot, the main limitation to development of the industry in SA. Work is already underway and being conducted in close association with the University of Adelaide, with emphasis on ensuring the resistant varieties also have high yields.

Spotlight – Leadership in high-tech breeding

SARDI's plant cell culture laboratory has developed and implemented new methods of doubled haploid (DH) technology for fast-tracking the breeding of wheat and barley varieties. Varieties released include three barley varieties (Dhow, Sloop SA and Flagship, all through the University of Adelaide Barley Program) and three wheat varieties (Gladius and Axe from Australian Grain Technologies and Crusader from Longreach Plant Breeders). DH technology meant these varieties could be released an average of three years earlier than would have been the case otherwise, resulting in considerable financial benefits to the grains industry. The technology is now being extended into oat breeding programs.

SARDI is leading an international project on drought tolerance in wheat involving partners in Adelaide, Sydney, Mexico, India, Pakistan and Morocco. The project is revealing key genetic factors that contribute to higher yield under moisture-stressed environments. Genes involved in drought tolerance change expression in different environments and seasons. This project is teasing out some of the important interactions between specific plant traits and environment to identify genetic tools that will help fast-track the development of drought-tolerant varieties. Molecular markers will allow the immediate implementation of these findings in wheat breeding programs.

Livestock & Farming Systems

Chief:	Prof Simon Maddocks	
Locations:	Roseworthy, Glenside, Waite, Minnipa, Turretfield, Struan	
Key Physical Assets:	Roseworthy, Glenside, Waite. Research farms at Minnipa, Turretfield, Struan	
Science Program:	Grazing Production & Farming Systems Intensive Livestock production Systems Livestock Breeding & Genetics Pasture Improvement	
Key Knowledge Relationships:	All science programs within the division share their knowledge and understandings. Grazing production & Farming Systems are strong adapters of knowledge developed elsewhere within SARDI as are the other science programs, albeit to a lesser extent. In particular, knowledge developed by Pasture Improvement is shared and adapted across all divisions.	

The sheep and cattle industries contribute more than \$18 billion to Australia's economy, but are under increasing pressure to maintain margins for producers while meeting market demands for quality assurance, eating quality and greater transparency of production processes.

SARDI's Livestock and Farming Systems will increase its focus on intensive animal industries, pastures and grazing management systems, and integrated farming approaches. Its objective is to encourage technological improvement to help animal industries yield greater and sustainable levels of high quality and competitively priced produce.

The Program's headquarters at Roseworthy Campus is to be designated the Livestock Biosciences Cluster under the Constellation SA initiative. This will put the spotlight on animal reproductive technologies, animal health and

veterinary science. The Program will exit dairy and wool research and reduce its efforts in pasture germplasm development and maintenance.

The national Primary Industries Standing Committee (PISC) has also established that SA will lead the Australian effort in pig and poultry research.

The core expertise of the Livestock and Farming Systems program includes livestock genomics, gene discovery, trait identification for genetic gain, large animal cloning, juvenile and in vitro embryo transfer, transgenics, embryo culture, production efficiency sheep and cattle, animal health and disease, nutrition and feed development, animal production systems (intensive and extensive), animal therapeutics, and large animal models for application into gene expression and therapeutic trials.

National Primary Industries PISC RD&E Framework - SARDI Livestock and Farming Systems RD&E focus

Major	Support	Link
Pigs Reproduction technologies Nutrition	Beef (southern) Sheep (meat/lamb)	Dairy Wool
Poultry Health and welfare Nutrition	Pastures Breeding and improvement Dryland and low rainfall farming systems	

Major: SARDI leads, develops and facilitates a national approach to research and development.

Support: SARDI contributes to the national research and development effort.

Link: SARDI will access high quality research knowledge and resources from other research providers to meet client needs.

Grazing Production and Farming Systems

Science Leader: Dr Ian Carmichael

Focus

Australian beef and lamb are undeniable favourites on plates at home and abroad and SARDI's Grazing Production and Farming Systems is helping to keep them there. The program concentrates its efforts on beef and sheep meat production and the sustainability of farming systems to raise productivity on Australian farms.

Working in areas including breeding, genetics and animal health and with a strong reputation for its on-farm work, the program maintains demonstration flocks, develops information to boost productivity, examines the economic impacts of changing farm practices, defines best practice and creates practical management solutions for farmers.

A driving purpose for the program is to act as a conduit between research, development and extension between the high level science community and the end-users of agricultural technology - farmers and advisers. Teams of farmers, researchers and advisors support the development of responsive farming systems that have a detailed understanding of their production, natural, financial and human resources.

Grazing Production and Farming Systems has a nation-wide reputation among the industry, with key clients including the South Australian Government and the national Cooperative Research Centres and the Rural Research & Development Corporations representing the beef, sheep meat and wool industries.

Opportunities and future directions

With concern continuing to grow about the effects of climate change on all types of primary production, Grazing Production's future lies in research related to environmental change. The program does not have to make major immediate structural adjustments to take advantage of these opportunities. The current extended drought has had an impact on grazing, but livestock production will remain the most important yardstick of successful or unsuccessful environmental utilisation and Grazing Production and Farming Systems is in a prime position to lead research in the area. Research projects are directly in line with state development plans by virtue of a long history of close interaction between the program, industry and PIRSA in the definition of broad future research requirements.

Intensive Livestock Production Systems

Science Leader: Prof Paul Hughes

Focus

Through the nationally-recognised Pig and Poultry Production Institute, SARDI's Intensive Livestock Production Systems aims to become the Australian leader in pig and poultry research. The program already hosts activities in two national Cooperative Research Centres (the Pork CRC is headquartered on the Roseworthy Campus) that provide the local pork, egg and chicken meat industries with specialist research and development in areas including nutrition, reproduction, housing, production and welfare. Its work not only provides practical solutions to growers, but feeds into policy and industry regulation.

The institute works with industry, producers, vets, engineers, nutritionists and food and pharmaceutical manufacturers, and also has strong collaborative links with national and international research groups. Expertise and technology developed by the institute for the pork and poultry industries have gone on to be adopted by other industries including producers of emu, ostrich and deer.

The institute is also a nationally-recognised expert in pork industry training, through its National Centre for Pork Industry Training and Education, and provides teaching services to students at the University of Adelaide and TAFE.

Opportunities and future directions

Intensive Livestock Production Systems has an excellent opportunity to consolidate its position as a national centre for pig and poultry research. Changes under way at state-level in livestock research mean individual states are moving towards specialisation in key research areas. SARDI is already involved in discussions with interstate primary industries departments to make it clear that it wishes to take on pig and poultry research and begin discussions on transferring research programs and staff.

There are opportunities for Intensive Livestock Production Systems to build wider links with South Australia's university sector; links that would be advantageous when seeking funding. As part of this, the program proposes to lead the establishment of a South Australian-based Centre of Excellence in Livestock Reproduction. The centre would also take in SARDI's Livestock Breeding and Genetics reproductive group, the University of Adelaide's Animal Science Group and reproductive physiologists at the university's Department of Obstetrics and Gynaecology. The program also hopes to become the preferred provider

of pig and poultry teaching and research to the University of Adelaide's new veterinary science program.

The next five years are expected to offer significant prospects in education and training. While being a training provider has not been a priority for SARDI in the past, the program sees the chance to build on the success of its National Centre for Pork Industry Training and Education, with the possibility of taking an Australia-wide role in capacity building. Succession planning for the group is a priority.

Spotlight – Practical approaches to poultry welfare issues and baby health

Researchers recognised early that banning beak trimming in Australia could result in a \$15 million annual loss to the egg industry due to cannibalism. SARDI studied production, physiological and anatomical aspects, ultimately proving that break trimming was a creditable practice. The results led to the introduction of a world-first beak trimming accreditation program for the Australian egg industry, and the work culminated in the publication of a textbook, handbook and training manual on beak trimming.

The group's expertise is in high demand, with researchers involved in a joint project with the Adelaide Women's and Children's Hospital aimed at improving brain development in young children. The study is exploring the possibility of enhancing arachidonic acid levels in eggs. The acid, which is an important factor in the development of young children's brains, can be lacking in formula-fed babies.

Livestock Breeding and Genetics

Science Leader: Dr Forbes Brien

Focus:

SARDI's Livestock Breeding and Genetics group has a reputation for excellence in applied genetics, molecular genetics and reproductive biology. Combined this expertise boosts Australia's pastoral industries by contributing to genetic gains, breeding efficiency and product quality, all of which contribute to better returns for farmers and a stronger state economy.

The group is advancing the understanding of the genetic and environmental control of traits, covering gene function and discovery and analysis tools from the molecular to the phenotype. It is also involved in novel approaches to genetic improvement.

Livestock Breeding and Genetics has developed a significant international reputation for its specialised expertise in state-of-the-art in vitro embryo culture methodology, embryo manipulation and animal reproductive technologies in both sheep and cows. It produced Australia's first cloned sheep, developed the techniques of juvenile in vitro embryo transfer and mature in vitro embryo transfer to commercial application and, most recently, developed technology allowing embryo storage without significant loss of viability.

Opportunities and Future Directions

Livestock industries are under increasing pressure to maintain margins for producers while meeting market demands for quality assurance, eating quality and greater transparency of production processes. This in turn creates greater demand for tools and technologies supporting genetic improvement programs in livestock species.

Spotlight – Gene markers building better beef

Placing juicy, tender, high quality beef on the plates of consumers every time is the focus of a visionary genomics project under way in the Livestock Breeding and Genetics Group. The project is part of a Beef CRC program which is striving to add more than \$50 million to the value of the beef food chain within four years. The project involves getting to the crux of how and when cattle carrying genes for tender beef deliver the expected quality and product integrity – and when they don't. Researchers have sifted through about three billion gene pairs, looking for the markers for tenderness, marbling and flavour and are increasing their understanding as to how genes are switched on and off by environmental influences.

Pasture Improvement

Science Leader: Dr Alan Humphries (Acting)

Focus

Australia's grazing industries are worth \$14 billion to the economy, and pasture production underpins the industry. SARDI's Pasture Improvement program forms the core expertise in Mediterranean pasture and fodder systems in Australia and has an excellent success rate in delivering new commercial varieties to growers.

The group's scientists coordinate national and international projects in pasture improvement and work on collaborative projects with interstate and overseas researchers and the farming and seed industries.

The program works with a wide range of indigenous and exotic plants including herbaceous legumes, grasses, herbs, shrubs and trees, supporting both agriculture and environmental stabilisation. It is involved in germplasm and breeding programs, developing best practice pasture management systems, field evaluation, the use of perennial plants and shrubs in dryland farming systems and enhancing the adoption of pastures by producers.

Opportunities and future directions

The group is focusing on developing new pasture varieties to meet a range of agricultural and environmental needs. Successful new varieties will meet the challenges of a changing climate and hostile soils, including factors such as acidity, salinity or erosion. Adapting pasture plants for natural resource management solutions and rehabilitating mining sites also offer potential, as does using shrub-based farming systems to provide sustainable productive land use in challenging environments. It also sees opportunities in exploiting molecular plant breeding tools to speed up and enhance pasture group outcomes.

Spotlight – Prolific pastures

Pastures and the pasture seed industry are important features of agriculture in SA, contributing some \$1 billion value across the agricultural sectors. Much of this is driven by the development and release of leading cultivars by SARDI. In recent years three SARDI lucerne varieties, SARDI 7, SARDI 10 and SARDI 5, have topped the market as Australia's leading lucerne series. This reputation for excellence will be further enhanced when Australia's first grazing-tolerant lucerne, SARDI Grazer, hits the shelves in 2010.

The group has also released Angel, a world-first sulfonylurea herbicide-tolerant medic; Australia's first 2 sulla varieties, a high-quality, high-yielding perennial pasture; a new sub-clover called Mintaro; the clovers SARDI Rose and SARDI Persian; and the salt-tolerant, spineless burr medics Scimitar and Cavalier. Seed production is strongly focused in SA for both Australian and export sales. The Pasture Improvement group's ground-breaking work continues, ensuring the supply of a pipeline of future SARDI pasture cultivars with traits such as tolerance of salt, drought, acid soil and herbicide.

Sustainable Systems

Chief:	Dr Kathy Ophel-Keller
Locations:	Waite, Nuriootpa, Loxton, Lenswood.
Key Physical Assets:	Plant Research Centre, Nuriootpa Research Farm, Loxton Research Centre, Lenswood Research Farm, Wine Innovation Central Building.
Science Program:	Climate Applications Entomology Plant & Soil Health Viticulture Water Resources & Irrigated Crops
Key Knowledge Relationships:	All science programs within the division share their knowledge and understandings. Molecular diagnostic capabilities within the group are a core competency accessed throughout SARDI's research divisions.



Sustainable Systems provides science driven solutions that support sustainable production aimed at protecting the valuable resource base upon which they rely. Sustainable Systems undertakes research across plant industries to ensure sustainable production of crops in the face of risks from climate variability and change, water and salinity stress, and pest and disease threats, both endemic and emerging. Recognised for scientific excellence and strong collaborative linkages at both state and national levels, Sustainable Systems aims to deliver science-based information to assist industries to better manage risk.

Sustainable Systems has core competencies in the management of climate risk and optimisation of water use efficiency for viticulture and broad-acre industries and water resource, soil health management and irrigation technologies for viticultural and irrigated crops. The capability and critical mass in entomology, plant health and molecular diagnostics make the Sustainable Systems division key players nationally in integrated pest and disease management for broadacre, viticultural and horticultural industries, as well as supplying science-

based solutions for biosecurity. The molecular diagnostics expertise and infrastructure at SARDI underpins diagnostic testing for market access, assessment of disease risk from soil-borne pathogens across plant industries, as well as environmental and pest assessment in marine environments.

National Primary Industries PISC RD&E Framework - SARDI Sustainable Systems RD&E focus

Major	Support	Link
Wine Viticulture Climate change Climate Adaption Risk management Water use in agriculture Soil health (grains) Water use efficiency Root zone salinity	Plant biosecurity Entomology Plant pathology Horticulture Integrated pest/disease management Water use in agriculture Irrigation management Grains Pastures & pulses Pest and disease management	Climate change Climate modelling Weed science Plant nutrition

Major: SARDI leads, develops and facilitates a national approach to research and development.

Support: SARDI contributes to the national research and development effort.

Link: SARDI will access high quality research knowledge and resources from other research providers to meet client needs.

Climate Applications

Science Leader: Dr Peter Hayman

Focus

Climate Applications works with primary industries in southern Australia to improve the management of climate risk, covering both season-to-season climate variability, and longer-term climate change. As the driest state, SA is vulnerable to both and the longer term outlook is for hotter and drier conditions with more extreme weather.

The climate applications group works across two areas:

- » assessing impacts, risks and opportunities from a variable and changing climate; and
- » adapting and improving production systems at a national, regional, farm and crop level.

Although natural and agricultural systems in South Australia are exposed and sensitive to changes and fluctuations in climate, there are many coping strategies available from existing and emerging technologies. SARDI Climate Applications is highly regarded nationally for leading applied adaptation research projects such as investigations into the mechanisms of heat stress and frost stress in crops and improving the water use efficiency of grain farming systems.

With viticulture a significant industry in SA, Climate Applications has worked closely with SARDI Viticulture to improve the coping ability of the industry for a warmer and water-constrained future, and has become a national leader in the field.

Insights generated from the science program's research are accessed nationally and integrated into scientific knowledge to drive policy to use resources more efficiently and advance efforts to develop new crops and land management systems suited to changing conditions.

Opportunities and Future Directions

The SA Strategic Plan identifies the need to grow food and wine exports while reducing ecological impacts and restoring environmental flows to the Murray-Darling Basin, confirming the need to research and apply climate tools to make targeted and wise use of resources.

SARDI Climate Applications will address this through:

- » Targeted modelling and analytical tools for climate systems applications
- » Strategic field work on adaptive climate application research

- » Maintaining strong industry groups emphasising delivery of solutions to end-users – delivering new production options, tools and knowledge to enhance decision-making
- » Strategic partnerships with relevant scientific groups and partners to provide efficiencies.

The team will continue to maintain leadership in viticulture climate applications, physiology and modelling, dryland farming and livestock. New directions will place more emphasis on enhancing natural resources and biosecurity.

One of the group's strengths is its high degree of industry involvement and interaction in exploring the adaptive capacity with land managers ensuring research solutions are delivered on the ground.

Spotlight: Heat stress on grapevines

In an Australian first, SARDI researchers published evidence of the impact of recent warming in grapevine development. They discovered measurable effects in the acceleration of grapevine maturity ranging from half a day to three days a year since 1995. Against this background, significant and sustained improvement in wine quality has been measured for the last two decades in all major wine regions of Australia. Advancements in technology have kept the industry ahead of any putative damage caused by warming. Preliminary studies on short episodes of heat stress revealed a greater than expected tolerance of Shiraz in the Barossa. This research is building new knowledge in the physiology and climatology of heat stress essential for the adaptation of the Australian wine industry to a warmer future.

Entomology

Science Leader: Greg Baker

Focus

Between 30% and 50% of global production of crops, livestock and stored foods are estimated to be lost to pests, making insects a significant issue for primary producers. The entomology team is working to find solutions to the problems posed by insects, but also to take advantage of their benefits.

The second-largest of SARDI's science programs, it is divided into three areas:

biosecurity, sustainable biosystems and molecular entomology. Scientists produce biological controls for insects and weeds, develop pest management systems for agriculture and urban areas and protect our export markets against insect incursion. They also work to manage key state pests such as fruit fly, plague locusts, thrips and the invasive weed Salvation Jane.

Through its research, SARDI Entomology is recognised as one of the nation's leading entomological groups, renowned for developing innovative responses to current problems and future issues, while also contributing to the evolution of policies that manage and maximise the benefits of insects.

Opportunities and future directions

Insects are increasingly being recognised as sources of important biological compounds, presenting enormous opportunities for the future.

Biosecurity continues to be a major issue for Australian production, both in terms of guarding against exotic pests and protecting access to our export markets. With the growth in imports of horticultural products such as nursery plants and timber, new pests and diseases may be accidentally introduced into the country. While this increases demand in incursion management, it also presents research opportunities such as developing new detection and diagnostic tools.

Invertebrates have traditionally been seen as having little importance in natural resource management, with many NRM policies focusing on plants and vertebrates. Little attention has been paid to the contribution of insects to biodiversity and ecosystem function. The group is advocating for invertebrates to be included in future biological asset inventories and NRM studies in areas such as ecological restoration, optimising revegetation and developing new approaches to integrated pest and natural resource management.

The rehabilitation of mine sites is a significant opportunity. Mining and exploration companies require a range of environmental services to help limit and repair the effects of their work. Invertebrates could play a significant role both as indicators of disturbance to the environment and of the success of remediation work.

Bee and pollinator research is expected to become vital with wild bee populations in Australia under threat. About 80 per cent of crops are now served by wild pollinators such as honey bees, but in the USA and New Zealand, where the Varroa mite has taken over, wild bee populations have been decimated. If this were to happen in Australia, there would be the opportunity to develop protocols for commercial pollination services as well as new diagnostic management strategies.

Spotlight: Mites and thrips

Scientists at Entomology have developed a highly effective and benign control for onion thrips in stored red onions using a commercially-available predatory mite. An investment of \$6 per bin on protective mites saves up to \$279 per bin, leading to an annual saving of \$23 million for the Australian onion industry's 50,000 tonne red onion sector.

Western flower thrips is a major vegetable pest on the Northern Adelaide Plains, affecting more than 500 properties. Sustainable management of the thrips is a step closer through Entomology's project, *Revegetation at Property Scale*. The project has shown that native vegetation can increase the thrips' natural enemies, and an active extension campaign is underway.

The team has also demonstrated that using soil composts to nurture soil-dwelling predatory mites is an effective biological control for the citrus industry's key pest – Kelly's Citrus pest. An analysis found that every dollar spent on soil composts returned between \$2 to \$5 resulting from improved pest control and the production of more marketable fruit.

Plant and Soil Health

Science Leader: Dr Kathy Ophel-Keller

Focus

Plant and Soil Health is acknowledged as the national leader in plant pathology and molecular diagnostics. With its multi-disciplinary approach and reputation for sound on-farm research, it serves industries such as viticulture, horticulture and broad-acre farming. It develops innovative technologies and solutions for plant health and disease management that combine chemical and biological management, diagnostics and resistance breeding.

The program plays a vital role in helping to maintain the biosecurity of the state and country, protecting local food industries from exotic pests and diseases while also ensuring ongoing access to key export markets. This involves both cutting-edge research and emergency response, but also feeds back into wider biosecurity management by setting standards and creating protocols.

Opportunities and future directions

Biosecurity and quarantine play a vital role in protecting local food industries from exotic pests. There is a strong opportunity for the group to advance the detection of diseases and pests through new technologies such as remote sensing, DNA testing and emerging technologies including biosensors. Developing new strategies to manage the impact of attacks by exotic pests and diseases build on the group's core competencies in integrated disease management.

As consumers drive demand for natural food, reducing the use of pesticides offers significant opportunities for the future. Examples include reducing the use of fumigants on potatoes and other vegetables through the management of soil-borne diseases, and breeding disease-resistant crops. In the area of soil health, working to improve symbiotic relationships and understanding the impact of recycled organic material on soil health, both show strong promise.

Plant and Soil Health, brings together the diagnostic and plant pathology capabilities in disease management, soil health, composts and molecular diagnostics to enhance research and service delivery.

Spotlight – Spin-offs from crops to tuna from molecular tests

Soil and Plant Health's molecular diagnostics section is providing new technologies for a range of current issues from drought tolerance to environmental impacts. In the past 10 years, the technology has expanded rapidly from the initial suite of tests, delivered to industry as Predicta B for quantification of cereal root pathogens in soil. Spin-offs have included:

- » Tests to assist industry monitor the environmental impact of farming southern bluefin tuna, now adapted for environmental impact of yellow tail kingfish farming systems.
- » DNA assays used to study root architecture in the soil profile are now assisting breeders to develop drought tolerant wheat and barley.
- » Rapid and accurate assays to detect soil-borne diseases in potatoes have gone on to provide growers with new hope of sustainability through the development of improved management strategies.

The Predicta B package itself can now detect and quantify 12 strains of significant diseases spanning major cereal and pea crops from soil samples. The technology is delivered via partnerships with agribusiness and private consultants, including training in the interpretation of diagnostic tests to assist growers to better manage disease risk and take the guesswork out of crop selection.

Water Resources and Irrigated Crops

Science Leader: Dr Jim Cox

Focus

The availability of water is a well-known factor limiting South Australia's economic development. The Water Resources and Irrigated Crops science program is a national leader in research into the sustainable use of water in agriculture, and in soil science in irrigated environments. Irrigated agriculture in Australia is contending with huge challenges due to the extended drought and long-term climate change, at the same time as it sees unprecedented opportunities in global demand for both food and fuel.

With its expertise in managing water, salt and soil, modelling and environmental physics on irrigated land, Water Resources and Irrigated Crops is in an ideal position to take advantage of increased needs in water management, especially as water quality declines around the world. Its strengths include irrigation, salinity and drainage, crop nutrition, the reuse of waste water, saline horticulture, root zone salinity management, precision irrigation and low-water use horticulture. It is also involved in developing strategies for reducing the impact of agricultural land use on the quality of surface and groundwater resources.

Opportunities and future directions

With good quality water in short supply due to the drought and over-allocation of water from the Murray, the challenge lies in improving efficiency, drought-proofing permanent horticulture and smarter management.

A suite of research projects aimed at enhancing the resilience of permanent horticulture in citrus, almond and viticulture industries will be a major focus. The projects, initially established through the State Government Drought Response initiative, have recently attracted industry funding to continue until 2013 and will provide a valuable body of knowledge to prepare industries in dealing with declining water supplies in the long term.

Developing alternative water supplies will feature in forward programs. Examples include using waste water, reclaimed and brackish water for irrigation and developing salt-tolerant crops. The program also hopes to attract new collaborative opportunities through its combined expertise in water resources, soils, solute and nutrient transport associated with irrigation and agricultural land use, now emerging as a major field and warranting development.

Spotlight

SARDI Water Resources and Irrigated Crop researchers have developed a simple tool to help irrigators who are striving to achieve highly efficient water use to meet a new challenge – root zone salinity. The problem threatens irrigated horticultural crop losses of up to \$100 million along the Murray and occurs under highly efficient irrigation systems, which leave very little water to flush away salts in the root zone. The soil water extractor, when inserted into the soil near a plant's roots collects water from surrounding earth so it can be easily tested for salts and nutrients. The extractor is portable, easy-to-use and allows growers to measure the salinity of water anywhere on their property – and adjust watering regimes to alleviate the problem. The product retails at less than one-tenth the price of more expensive versions, which by comparison have to be permanently installed. Growers can also use the device to track nitrogen movement, and improve nutrient management to ensure their irrigation programs do not flush valuable nutrients away. Now effective salinity and nutrient management is within reach of all growers.

Viticulture Science

Science Leader: Dr Michael McCarthy

Focus

The SA wine and grape sector is valuable to SA, with gross wine revenue exceeding \$3 billion, and table grapes worth around \$765 million.

SARDI's viticulture program offers unique specialist skills to support profitable, sustainable production, on behalf of the South Australian government to meet national grape and wine industry objectives, also aligning with the Wine Innovation Cluster.

Taking a systems approach, the program draws together expertise in climate adaption, soil, water and nutrient management, and the control of pest and diseases that minimise environmental impacts, while ensuring maximum product safety.

Opportunities and Future Directions

The globalisation of the world wine market has increased cost pressures on Australian wine producers and growers. Economic survival will in part depend on maintaining sustainable production, yields and quality – all underlined by vineyard-focused research that SARDI will contribute.

Increasing the resilience of vineyards through drought will remain a priority (refer to Spotlight story). Root zone salinity has emerged under efficient irrigation, for which SARDI has pioneered monitoring tools and effective salt-leaching strategies. Future research efforts will explore novel ways to improve the physical condition of soil, using recycled organic materials to address the problem.

Although viticulture is sensitive and exposed to climate change, the grapevine is an adaptive plant. The climate applications team will continue to provide national leadership in exploring the adaptive capacity at the vine, vineyard and winery level. With the team close to establishing the impacts of climate on crops and product quality; future research efforts will investigate approaches to mitigate these impacts.

The sustainable management of diseases and pests aimed at improving yields and marketability, decreasing chemical inputs, and reducing carbon footprint will feature in viticulture pathology research, as will leadership on novel ways to eliminate incursions without destroying vineyards.

Spotlight – Drought response

Researchers, supported through the State Government's Drought Response initiative, are testing the limits under which grapevines can survive when faced with extreme water deficits. Trials have been established by SARDI at Yalumba Nurseries at Oxford Landing Estate and at an Orlando Wyndham vineyard in Langhorne Creek. The trials will gather information about the absolute minimum water needed to keep vines alive and grow commercial crops. They will also provide knowledge about how long it will take to restore yields so that vineyards are not lost as a critical asset, even if production has to be shut down. The trials will continue through to 2013 with the backing of the Grape and Wine Research and Development Corporation. Partners through the Wine Innovation Cluster will also access the field sites.

Appendix 1

Abbreviations Used in this Report

CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific & Industrial Research Organisation
DTED	Department of Trade & Economic Development
GM	Genetically modified
IMOS	Integrated Marine Observing System
MISA	Marine Innovation South Australia
NCRIS	National Collaborative Research Infrastructure Strategy
NRM	Natural Resource Management
PIRSA	Primary Industries & Resources South Australia
PISC	National Primary Industries Standing Committee
RDC	Research & Development Corporation
SAIMOS	Southern Australian Integrated Marine Observing System
SARDI	South Australian Research & Development Institute
SIS	Salt Interception Scheme
STI10	Science Technology and Innovation – 10 Year Strategy
WIC	Wine Innovation Cluster

