

Department of Agriculture, Fisheries and Forestry agricultural research, development and extension plan

Contributing to the 2040 vision to double
Queensland's agricultural production



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Ministers foreword



Feeding the world's growing population is a considerable and significant challenge. Increased food production is vital for our future. In recognition of the importance of agriculture to our state, the Queensland Government has established agriculture as one of its four economic pillars.

Queensland's agriculture, fisheries and forestry industries are estimated to have a production value of \$14.7 billion (2011–12), employ approximately 320 100 people across the food chain and generate export earnings of over \$6.3 billion.

These industries are confronted with significant challenges, such as global economic uncertainties, a high Australian dollar, increasing production costs, pest and disease risks, and climatic variability. I am confident, however, that there is still significant capacity to grow Queensland's agricultural sector.

The world's population is predicted to increase to 9.2 billion by 2050, requiring an increase in global food production of 70 per cent.¹ Meeting this demand presents unique scientific, economic and political challenges. Queensland is strategically placed to supply growing demand from our neighbouring countries and contribute to global food security. In response to increasing demand for food, the state government has set an ambitious target to double Queensland's agricultural production by 2040.

Research, development and extension (RD&E) contributes to a range of technological advances and provides expertise that leads to productivity growth. Funding RD&E to develop knowledge and new technologies is a fundamental component of the innovation process, and extension is critical to facilitate the adoption of these new innovations at the grassroots level.

Queensland is one of the few developed regions in the world with biodiverse tropical ecosystems. Queensland's proximity to future tropical markets in Asia and its strong RD&E base in subtropical and tropical agriculture makes it well placed to capitalise on the potential increases in demand for tropical agricultural products.

I believe that effective and targeted RD&E will steer the next wave of productivity growth in Queensland agriculture. RD&E funded by the Queensland Government will therefore be directed towards strategic areas where market failure is evident—in partnership with industry, universities and other research providers.

In a modern economy, the private and public sectors should take up the innovation challenge wherever possible.

The Honourable Dr John McVeigh MP
Minister for Agriculture, Fisheries and Forestry

¹ CropLife Australia 2012, *Submission in response to national food plan green paper*, CropLife Australia Limited, Canberra, < http://www.daff.gov.au/__data/assets/pdf_file/0009/2208348/CropLife_Australia.pdf.

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Preface

The Queensland Government has set a clear, ambitious target to double Queensland's agricultural production by 2040.

The purpose of this research, development and extension (RD&E) plan is to describe how the Queensland Department of Agriculture, Fisheries and Forestry's (DAFF) agricultural RD&E program will contribute to achieving this target.

This plan addresses the recommendations of an internal government audit of DAFF science, and is informed by the National Primary Industries Research, Development and Extension Framework.

Queensland plays a major role in establishing national priorities for RD&E in beef, sugar, summer cereals, tropical forests, tropical and subtropical horticulture, tropical and subtropical fisheries, and aquaculture. It also plays a support role in cotton, dairy, winter cereals, temperate horticulture, pulse grains, pork, poultry and new and emerging industries, and a link role in temperate forests, horticulture, fisheries and aquaculture, sheep meat, wine and wool. We are the lead proponent for the beef and sugar industries and develop strategies for these industries. In addition, Queensland plays an increasing role in RD&E that addresses biosecurity risks across all agricultural industries.

Introduction

Queensland's agricultural production has grown steadily over the past 30 years and Queensland continues to be a significant net exporter of agricultural products. Queensland's primary producers have a strong tradition of innovation and adoption of new farming practices and technologies. This has been central to the development of a competitive Queensland agricultural sector with a solid reputation as an efficient supplier in the international market.

RD&E leads to improvements in productivity through lowering the costs of production, increasing yields, improving sustainability, encouraging efficient resource allocation and providing opportunities to enter new markets. RD&E is also critical in preventing and responding to emergent pest and disease incursions that have the potential to harm agricultural production in Queensland. It is crucial that innovation occurs along supply chains as a key enabler of productivity growth.

Research and development (R&D) is an evolving process, increasingly drawing upon knowledge acquired through science and innovation both in Australia and overseas. Coupled with an effective extension network to facilitate the dissemination of that knowledge and encourage change and innovation for end users of that knowledge, R&D aims to improve the productivity, sustainability and competitiveness of the rural sector.²

For rural R&D to achieve the best results, research outcomes must be extended to, and adopted by, farmers and other end users. Traditionally, state and territory governments provided extension services. In recent years, extension services have broadened to include providers such as private consultants, agribusiness and input suppliers, local grower groups and public information networks. The result is a set of complex communication and delivery channels through which information, knowledge and ideas flow.³ This makes for an increasingly complex RD&E system, where effective communication and coordination is crucial.

The Queensland Government, in collaboration with a range of RD&E partners, will facilitate a funding environment and provide a concerted effort to encourage innovation in the agricultural sector. Queensland has the capability to be at the forefront of cutting-edge tropical and subtropical agricultural RD&E.

This plan describes how agricultural RD&E will contribute to the government's vision of an efficient, innovative, resilient and profitable sector that thrives for the long term. It seeks to provide clarity for stakeholders, researchers, investors and partners on how DAFF-funded RD&E will contribute to each of the four pathways to growth described in *Queensland's agriculture strategy*.

This plan also identifies the Queensland Government's commitment to the National Primary Industries Research, Development and Extension Framework and how the government works effectively with collaborators. The outcomes of the Productivity Commission review into rural research and development corporations⁴ and an internal Queensland government review of DAFF science have been incorporated into this plan.

² PISC RD&E Subcommittee, *Extension principles*, National Primary Industries Research, Development and Extension Framework, <http://www.npirdef.org/files/resourceLibrary/resource/25_ExtensionPrinciples.pdf>.

³ Department of Agriculture, Fisheries and Forestry 2013, *Rural research and development policy statement*, Australian Government, Canberra, p. 8, <http://www.daff.gov.au/_data/assets/pdf_file/0004/2176222/research-and-development-policy-statement.pdf>.

⁴ Australian Government Productivity Commission 2011, *Productivity Commission inquiry into rural research and development corporations*, no 52, 10 February 2011, Australian Government, Canberra.

Funding trends

Global

In 2008, global public spending on agricultural RD&E totalled approximately \$31.7 billion, with an average increase of 2.4% per year since 2000. Almost half of this growth can be attributed to accelerated RD&E spending by China and India. Other middle-income countries (particularly Argentina, Brazil, Iran, Nigeria and Russia) also significantly increased their spending on public agricultural R&D during this period. However, agricultural RD&E funding by high-income countries, including Australia, continued to decline during this period—a trend that has also been observed over the previous decade.⁵

Domestic

Australia has a long history of investing in agricultural RD&E to improve productivity in rural industries. However, this investment has declined over the last 20 years. The funding profile in RD&E across Australia is also complex. There are multiple investors and research providers, reflecting the diversity of Australia's agricultural industries and the breadth of RD&E conducted, and spanning on-farm and off-farm RD&E and commercialisation of research outcomes.

Private and public sector funding of agricultural research is driven by different goals, with private funding more likely in areas where there is clear, direct commercial benefit to a particular enterprise and opportunities for quick returns. Meanwhile, traditional on-farm RD&E has been funded predominantly through the public sector. However, there has been an increasing trend over the last two decades towards industry, private and public sector co-funding.

The amount of funds invested each year in rural RD&E in Australia has been estimated to be \$2.9 billion by the Rural Research and Development Council, defining the rural sector broadly to include rural industries along the supply chain and other rural-related R&D. This includes areas of environmental sciences, such as ecosystem management of land and marine resources, and control of pests and diseases.⁶

Primary producers provide significant funds for RD&E through national levies that are managed by the commodity-based Research and Development Corporations. These levies attract matched funding from the federal government. In 2008–09, the total expenditure by Research and Development Corporations on R&D was around \$470 million.⁷ Research and Development Corporations are an integral component of the rural RD&E structure, alongside the federal, state and territory governments, CSIRO and universities.

Evaluations of rural R&D have shown that \$1 invested returned \$10.51 over the course of 25 years.⁸

5 Beintema, N, Stads, G, Fuglie, K & Heisey, P 2012, *ASTI global assessment of agricultural R&D spending: developing countries accelerate investment*, Agricultural Science and Technology Indicators, Rome, <<http://www.ifpri.org/sites/default/files/publications/astiglobalassessment.pdf>>.

6 Department of Agriculture, Fisheries and Forestry 2013, *Rural research and development policy statement*, Australian Government, Canberra, <http://www.daff.gov.au/__data/assets/pdf_file/0004/2176222/research-and-development-policy-statement.pdf>.

7 Department of Agriculture 2012, 'Research and innovation', Australian Government, Canberra, viewed April 2013, <<http://www.daff.gov.au/agriculture-food/innovation>>.

8 The Prime Minister's Science, Engineering and Innovation Council 2010, *Australia and food security in a changing world*, Australian Government, Canberra, p. 16, <http://www.chiefscientist.gov.au/wp-content/uploads/FoodSecurity_web.pdf>.

Investment in agricultural R&D reached a peak of 5% in the late 1970s as a proportion of agricultural gross value of production, but this has steadily declined to just over 3% in 2007.⁹ The slowing in real investment in agricultural R&D has been linked to a slowing of growth in agricultural productivity.¹⁰ This might be due to the significant lag between R&D investment being made and a productivity gain (or benefit) being seen. The investment in agricultural R&D and how the investment is focused will be critical to achieving necessary productivity gains.

The decline in Australian agricultural RD&E funding and the need to maintain critical agricultural RD&E capability and infrastructure led to the development of the National Primary Industries Research, Development and Extension Framework. The National Primary Industries Research, Development and Extension Framework seeks to improve collaboration between jurisdictions and concentrate RD&E effort nationally to avoid duplication and maximise the return on investment. Queensland is committed to being an active partner in this framework.

Agricultural science is the only area in which Australia has a research organisation ranked in the world's top 10 (CSIRO). In plant and animal sciences we have six organisations ranked in the world's top 10%.¹¹

In 2010, Australia produced 743 agricultural science graduates, and in the same year approximately 4500 agricultural science jobs were advertised.¹² China produces more than 100 000 agricultural graduates a year. This, coupled with declining student participation in agricultural science subjects (down 31% between 2002 and 2010), presents a challenge to ensure we have the ongoing capability to support producers and the economy.

RD&E funding in Queensland is provided through public organisations—such as government, Research and Development Corporations, universities and CSIRO—and is directed by industry priorities. The overall investment in Queensland agricultural RD&E has also declined significantly over the last 20 years.

9 Nossal, K & Sheng, Y 2010, 'Productivity growth: trends, drivers and opportunities for broadacre and dairy industries', *Australian Commodities*, vol. 17, no. 1, ABARE, Canberra.

10 Sheng, Y, Mullen, JD & Zhao, S 2010, 'Has growth in productivity in Australian broadacre agriculture slowed?', paper presented to the Australian Agriculture and Resource Economics Society Conference, Adelaide, 10–12 February 2010.

11 The Prime Minister's Science, Engineering and Innovation Council 2010, *Australia and food security in a changing world*, Australian Government, Canberra, p. 52 (based on Thompson Reuters Web of Knowledge, 2010).

12 Office of the Chief Scientist 2012, Australia's Chief Scientist submission to the Senate inquiry into agriculture, Australian Government, Canberra, <<http://www.chiefscientist.gov.au/2012/02/senate-enquiry-submission-agriculture/>>.

The way forward

RD&E is one of the key strategies underpinning the implementation of *Queensland's agriculture strategy*. The Queensland Government's investment in RD&E will focus on areas where Queensland has a competitive advantage, particularly in the areas of beef production, sugarcane, tropical forest plantations, summer cereal grains, tropical aquaculture and tropical and subtropical horticulture.

Funding for Queensland agricultural RD&E will continue to target areas that will provide clear benefits for these industries and stimulate economic growth. Leveraging capability and capacity through effective partnerships, collaborations and outsourcing will provide flexibility in approaches to accessing cost-effective and targeted RD&E.

Pathways to growth

Queensland's agriculture strategy identifies four key pathways to grow Queensland's agricultural sector¹³, which are underpinned by the following RD&E strategies.

1. Resource availability

RD&E strategies will secure and increase resource availability by:

- developing new whole-farm production systems for new agricultural areas
- developing cost-effective ways to build resilience to seasonal changes and foster adaptation opportunities
- developing and promoting best management practices such as soil conservation, integrated pest and disease management, and water-use, nutrient-use and energy-use efficiency
- minimising nutrient and sediment transfer into waterways and reef systems.

2. Productivity

RD&E strategies will drive productivity growth across the supply chain by:

- increasing the uptake of best practice, including measures such as conservation cropping techniques, irrigation efficiency, machinery adaption and sustainable grazing land use
- increasing the value of harvested product through improved varietal attributes and/or post-harvest processing and packaging
- developing integrated pest management systems to improve plant health, animal health, welfare and productivity
- enhancing science and technology capability, including partnerships with universities, to provide practical research that boosts productivity.

¹³ Department of Agriculture, Fisheries and Forestry 2013, *Queensland's agriculture strategy*, Queensland Government, Brisbane, <http://www.daff.qld.gov.au/__data/assets/pdf_file/0016/81070/2320-qld-ag-strategy-v15.pdf>.

3. Markets

RD&E strategies will focus on securing and increasing market access by:

- identifying new market opportunities and processes to refine raw produce to a stage suitable for new and established uses and markets
- supporting exotic pest and disease preparedness
- improving food quality and delivering fresh, safe products with minimal pesticide residues through efficient supply chains to consumers
- getting rid of fruit fly and other pests to gain domestic and international market access.

4. Production costs

RD&E strategies will minimise the costs of production by:

- improving genetics, resulting in new varieties and breeds with increased yield and resilience to biotic and abiotic stresses
- developing enhanced capabilities, diagnostics and tools for surveillance, detection and control of plant, animal and environmental pests and diseases
- improving systems for integrating new technologies, focusing on people, enterprises and business management to support adoption and uptake of new innovations.

Principles for investment

The Queensland Government is committed to working with agribusiness and industry to create the conditions to build a resilient, innovative, efficient, profitable and productive agricultural sector.

The following principles outline how the Queensland Government will fund and collaborate on RD&E projects and programs with industry, private enterprise, universities and other research investors and providers.

Public benefits

The Queensland Government will invest in agricultural RD&E where there are clear benefits to Queensland—including economic, environmental and social benefits. This includes the provision of higher quality and affordable food and fibre products to consumers.

Consistency with Queensland Government policy

The Queensland Government is committed to the delivery of agricultural RD&E and values its role as an enabler of sustainable economic growth. *Queensland's agriculture strategy* (as well as an internal government audit of DAFF science undertaken in 2012) highlights the importance of science and extension to increasing the productivity and resilience of the agribusiness sector.

Building skills and capacity

The availability and continuity of skilled scientific expertise will be crucial to meeting the challenge of doubling agricultural production in a sustained and efficient way for the long term. Therefore, training and skilling in agricultural science and promoting agriculture as a desirable career are imperative to achieve this critical capability.

The Queensland Government aims to improve agricultural skills and career pathways by working with industry, government agencies and educational institutions to increase the uptake of relevant skills and professional qualifications. This includes building a critical mass of experienced agriculture scientists, extension specialists and business improvement specialists where appropriate to increase the productivity of producers and their supply chain.

In addition to building this critical mass of experienced scientists and extension specialists, there is also a need to link this capacity to:

- effective succession planning
- mentoring programs within industry
- a philosophy of continual improvement so that the quality of research output increases.

The government will discuss the best ways to facilitate this outcome with industry bodies.

Market failure

Market failure in rural RD&E is generally more prevalent when compared to other industries, based on the large numbers of small producers with limited capacity to undertake RD&E. The benefits of rural RD&E accrue over long periods and are less appropriable to individual producers, as others can obtain cost-free benefits. Conversely, the benefits of R&D in the manufacturing sector are largely appropriable through patents and non-disclosurable intellectual property, and can be hidden from competitors through industrial processes.

RD&E can be funded by the public sector, the private sector or a mix of both. RD&E funding is informed by the distribution of the benefits from cost-benefit analysis and the nature of the market failure.

The Queensland Government encourages the development of private sector agricultural RD&E services and will assist where there are gaps in the RD&E continuum. The government will consider its role in extension where there is market failure (i.e. the market does not deliver the optimal amount of RD&E to address industry-wide or cross-sectoral issues).

Co-funding and strategic leveraging

Significant RD&E capability exists across numerous public and private organisations. DAFF's research and extension capability is trending towards the development of collaborative partnership models, resulting in more integrated, interdependent and specialised capacities. The outcome of this is a larger critical mass with less fragmentation, greater efficiencies and reduced duplication. Additionally, partnering creates new attractive opportunities for scientists and extension specialists, and provides rewarding career pathways.

The Queensland Government has had a long, beneficial collaborative relationship with the university sector and other research providers. One major alliance is with The University of Queensland through the Queensland Alliance for Agriculture and Food Innovation, where research is provided to DAFF under a five-year agreement from the university.

To maximise returns on funding and expenditure, the Queensland Government will increasingly encourage partnerships and collaborative opportunities with other RD&E providers (including other universities) to leverage co-investment and capabilities from local, national and international sources.

Domestic and export opportunities

Expanding the penetration of Queensland production into new markets is a critical component of the Queensland Government's goal to double agricultural production by 2040—it is one of the key determinants of future growth. Securing current markets and accessing new export markets—such as India, China and other near-neighbour markets in Asia—will be vital to the sector's ongoing performance.

This will be achieved by working with enterprises to extend scientific and technical expertise and knowledge to producers who are keen and able to enter or expand into new markets. In many instances, this involves working along the whole value chain to improve production and management practices, improve post-harvest handling techniques, enhance product shelf-life innovations and provide timely market intelligence and in-market assistance (including the purchasing habits and decisions of consumers).

With the various issues facing the agricultural sector (e.g. drought, lower domestic prices for their produce and competing against cheaper imports), it is important that this industry grows its customer base. DAFF will assist by working closely with Trade and Investment Queensland (part of Queensland Treasury and Trade).

Through local and international client service networks, Trade and Investment Queensland delivers a suite of export services to assist the agricultural sector expand markets and become more competitive. Trade and Investment Queensland works closely with potential, new and existing Queensland exporters (primarily small to medium enterprises/producers), as well as international buyers, investors and officials involved in purchasing decisions in overseas markets.

Trade and Investment Queensland also works with partner agencies, organisations and trade allies to promote better access to overseas markets and decision-makers. DAFF will be the conduit through which issues relating to overseas market access are identified by Trade and Investment Queensland. Better communication between DAFF and relevant industry bodies on export services will also be investigated.

Investment profile

To achieve optimal returns on investment, the Queensland Government will target a funding and expenditure profile (as outlined in the *National strategic rural research and development investment plan*¹⁴), covering the areas of transformational RD&E, industry development, sustainable production, capacity and international linkages. While these areas are not necessarily mutually exclusive, the Queensland Government proposes to align expenditure in the following proportions:

- transformational RD&E: 10–20%
- industry development and sustainable production: 60–80%
- capacity: 10–20%
- international linkages: <10%.

These proportions were developed based on identified RD&E needs and the anticipated nature of RD&E required by DAFF to fulfil these needs going forward.

The Queensland Government will continue to invest in agriculture by ensuring government activities lead to more efficient use of existing funds, and therefore increase the capability of public agricultural RD&E. DAFF has an internal evaluation system that looks at how it spends existing funds. This is an ongoing evaluation to ensure Queensland is getting the right returns on its investment. This evaluation has led to the development of this RD&E plan to further refine the system and ensure the best value is received on the public dollar when used for RD&E for this sector.

National framework

The Queensland Government is a supporter of the National Primary Industries Research, Development and Extension Framework.¹⁵ The National Primary Industries Research, Development and Extension Framework aims to improve the coordination of RD&E nationally, maximising the impact of the nation's resource investments and minimising fragmentation and duplication of these resources throughout Australia.

The premise of the National Primary Industries Research, Development and Extension Framework recognises that basic and strategic research can be provided from a distance, with regional adaptive development and local extension required to assist the uptake of innovation by industry.

Queensland is committed to supporting the national framework and a nationally coordinated RD&E system, particularly in areas of greatest interest to the state's agriculture sector.

DAFF values the intent of the federal government to provide guidelines and direction to facilitate and strengthen a national rural RD&E system with increased efficiencies and positive returns on investment.

¹⁴ Rural Research and Development Council 2011, *National strategic rural research and development investment plan*, Department of Agriculture, Fisheries and Forestry, Canberra, <<http://www.daff.gov.au/agriculture-food/innovation/national-strategic-rural-research-and-development-investment-plan>>.

¹⁵ National Primary Industries Research, Development and Extension Framework, Primary Industries Standing Committee, <www.npirdef.org>.

The way forward for key industries

The following section outlines the way forward for key Queensland agricultural industries. Detailed operational RD&E plans and funding will be guided by industry action plans that will be developed by the Queensland Government in collaboration with industry.

Note: Figures used for gross value in key industries include figures for farm gate and first-stage processing.¹⁶

Beef

The beef industry is Queensland's largest agricultural industry, with the gross value of cattle sales and meat processing worth \$4.8 billion in 2011–12. Beef production occurs across 85% of the state and the industry employs approximately 52 000 Queenslanders. The majority of beef produced by the state is exported (60%)—this totals 1 million tonnes and is destined mainly for Japan, Korea and the United States.

Through the North Australian Ministerial Forum, Queensland leads implementation of the North Australian Beef Industry Action Agenda and collaborates with the Northern Territory, Western Australia and federal governments and key industry stakeholders to promote industry development. In particular, the action agenda highlighted the need for R&D that supports industry growth, and research has recently been completed (in partnership with CSIRO) to evaluate transport and logistical impediments to beef supply chains and where investment could improve the transport of cattle from property to export.

Under the National Primary Industries Research, Development and Extension Framework, Queensland plays a major role in implementation of the National Beef Production RD&E Strategy in partnership with Meat & Livestock Australia.

Science capability within DAFF and of its main collaborators (The University of Queensland and CSIRO) delivers most of the on-farm RD&E needs of the beef industry.

Major focus

The major focus of beef RD&E will be on improving cattle productivity and welfare to increase profitability and market access, while minimising environmental impacts.

DAFF-funded beef RD&E projects will focus on the four key pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Minimise nutrient, pesticide and sediment transfer from grazing lands into waterways and reef systems, reduce the impact of environmental and greenhouse gas issues, and derive carbon offsets from use of waste materials as high-value fertilisers to decrease greenhouse gas emissions.

2. Productivity

- Improve the reproductive performance of cattle through improved genetics, genetic tools, nutrition and management of reproductive diseases.

¹⁶ Department of Agriculture, Fisheries and Forestry 2012, *Queensland AgTrends 2012–13: forecasts and trends in Queensland agricultural, fisheries and forestry production*, Queensland Government, Brisbane, <http://www.daff.qld.gov.au/__data/assets/pdf_file/0004/58144/1882-agtrends-oct-12_v5.pdf>.

- Improve sustainable growth pathways through optimised nutritional inputs.
- Reduce the impact of pest and disease through epidemiology and the development of diagnostic and integrated systems for the control of endemic and exotic diseases and pests in intensive and extensive beef production systems. This work will be undertaken in collaboration with experts from Biosecurity Queensland and elsewhere.
- Improve the feed base through new and improved forages and forage systems, and improve grazing land management.

3. Markets

- Support exotic pest and disease preparedness.
- Develop applications to detect and manage zoonotic diseases and toxins in livestock populations and products for improved food safety.
- Develop technologies to support improved welfare and husbandry practices.

4. Production costs

- Improve systems for integrating new technologies, focusing on people, enterprises, logistics and business management.

Challenges

Despite the strong economic position of Queensland's beef industry, it faces a number of challenges to on-farm productivity growth and profitability due to the high value of the Australian dollar. The northern production cycle is constrained by poor forage quality, with seasonally low levels of protein and dry matter digestibility. This leads to weight loss during the dry season and low conception and weaning rates.

Other challenges include high land values, rising energy costs, changing consumer demand and expectations regarding animal welfare, pests and diseases, converting low-value waste streams to higher value fertiliser products and minimising off-site impacts from extensive and intensive beef production systems (sediments, nutrients, noise, dust, odours and pathogens).

Opportunities

Opportunities exist to increase the rate of productivity growth, profitability, sustainability and social resilience of the beef sector through increased uptake of known and new technologies. Segments of the industry have shown productivity growth and favourable rates of return despite variable climatic conditions and a high Australian dollar. Significant opportunities exist to work in new ways with the next generation of beef industry managers.

Intensive livestock

Intensive livestock industries (dairy cattle, pigs, poultry and aquaculture) in Queensland account for more than \$1 billion in gross value of production. Fisheries and aquaculture are addressed separately.

Under the National Primary Industries Research, Development and Extension Framework, Queensland plays a support role in implementation of the National Pork RD&E Strategy, National Poultry RD&E Strategy and National Dairy RD&E Strategy.

Science capability within DAFF is primarily focused on managing pests and diseases, improving productivity and profitability, and managing environmental impacts in intensive livestock production systems.

Major focus

The major focus of intensive livestock RD&E will be on improving tropical livestock health, productivity and welfare to increase profitability and market access while minimising environmental impacts.

DAFF-funded intensive livestock RD&E projects will focus on the four key pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Develop technologies and systems to enable the dairy, poultry and pork industries to reduce their impact on the environment and minimise pesticide nutrient and sediment transfer into waterways and reef systems.

2. Productivity

- Undertake epidemiology and development of diagnostic and vaccine applications for control of endemic and exotic diseases and pests in poultry and pork production systems. This work will be undertaken in collaboration with experts from Biosecurity Queensland and elsewhere.

3. Markets

- Monitor and assess environmental resources to maintain market access.

4. Production costs

- Optimise tropical and subtropical feeding systems to enable dairy businesses to compete competitively and meet fresh milk market demand.

Challenges

Intensive livestock industries need to respond to a number of changes and challenges, including competition (domestic and international), declining terms of trade, rising energy costs, changing consumer demand and expectations regarding animal welfare, water restrictions, pests and diseases, and minimising off-site impacts from livestock production systems (waste and nutrient management, noise, dust, greenhouse gas and pathogens).

Opportunities

Opportunities exist to meet rapidly increasing consumer demand for poultry products, and increase the rate of productivity growth, profitability, sustainability and social resilience of the intensive livestock sector through increased uptake of known and new technologies. Significant opportunities exist to work in new ways with the next generation of managers.

These industries are significant employers and major contributors to the economy and viability of a number of rural and regional areas throughout Queensland. They are reliant on sustainable, environmentally friendly production systems to increase the footprint of these industries (especially the poultry industry) in these regions.

Sugarcane

The Queensland sugarcane industry is anticipated to represent \$1.2 billion of gross value of production for Queensland in 2012–13 and \$0.68 billion for first-stage processing.¹⁷ Over 80% of the sugar is exported.

In 2013–14, the Queensland Government will invest \$3.95 million in Sugar Research Australia, the principal provider of RD&E to the Australian sugarcane industry.

The Queensland Government is keeping its promise to the sugarcane industry to increase its R&D funding to \$16 million over four years. This funding will complement the industry's annual investment and will deliver valuable growth for the sugar industry through a variety of projects.

The funded program of projects aims to increase yield and achieve improvements in productivity and profitability, improve efficiency along the supply chain, maintain environmental sustainability and investigate diversification opportunities. In addition, DAFF investment considers the agricultural science skilling needs and capabilities of the industry.

Major focus

DAFF-funded sugarcane RD&E projects will focus on three of the four key pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Develop nutrient, pest, disease and weed management technologies that can be integrated into farming systems to deliver productive, profitable and sustainable agribusiness.
- Accelerate growth and resilience in field crop productivity via the design, development and delivery of effective and better integrated whole-farm production systems that remain productive, profitable and sustainable in a environment with plant pest and disease and soil-health pressures.

2. Productivity

- Develop systems to ensure the best parents are selected to improve sugarcane genetics.
- Investigate in-field sucrose losses and determine possible systems to minimise harvesting loss for increased profitability.
- Explore the impacts of nutrient and farm management systems on biomass production.

3. Markets

- Develop system protection technologies to protect crops from insects and diseases, and ensure a sustainable, productive and safe sugarcane industry in Queensland.

¹⁷ Department of Agriculture, Fisheries and Forestry 2012, *Queensland AgTrends 2012–13: forecasts and trends in Queensland agricultural, fisheries and forestry production*, Queensland Government. Brisbane, <http://www.daff.qld.gov.au/__data/assets/pdf_file/0004/58144/1882-agtrends-oct-12_v5.pdf>.

DAFF sugar RD&E investments in Queensland are strongly aligned to the National Sugarcane Industry RD&E Strategy. RD&E funding is based upon ongoing industry collaboration, as well as vital partnerships with organisations such as Sugar Research Australia, CSIRO and universities.

Challenges

The sugarcane industry faces several challenges, including stagnating productivity growth, environmental impacts (water use and quality), continued investment in the development of genetically modified sugarcane varieties, preparedness for disease outbreaks, seasonal variability, declining numbers of researchers committed to sugar industry R&D, socio-economic factors (grower age, succession planning and small farm size) and market competition from industries with lower production costs.

Opportunities

Opportunities in the sugarcane industry include the development of second-generation biofuels and other products from sugarcane that do not compete with sugar production. Diversification brings options for exploring new markets and products. The R&D to underpin these opportunities is likely to take many years to develop and implement.

Broadacre cropping

Broadacre cropping in Queensland is valued at \$2.2 billion and includes production of feed grains and fodder, cereals, pulses and cotton in a sustainable manner. The major production areas are the Darling Downs and Central Queensland. The high value of the Australian dollar directly affects the competitiveness of exports from this sector.

Major focus

DAFF-funded broadacre cropping RD&E projects will focus on the four key pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Develop technologies and systems that support profitable broadacre cropping by addressing issues of soil nutrient decline, pasture run-down, irrigation water-use efficiency and soil health.
- Develop a best management practice framework to boost profitability while improving water quality in the reef catchments. The sector needs to ensure its farming practices meet community expectations of sustainability and do not impact on the natural environment (e.g. Great Barrier Reef).

2. Productivity

- Develop and deliver enhanced genetics for field crops in Queensland to provide a reliable and increased supply of market-focused food, feed grains and fodder despite seasonal variability, scarce resources, high input costs and agronomic threats.
- Develop and deliver improved integrated farm production systems, including best management packages that address issues such as crop rotations to increase soil health and nutrition, and reduce disease and insect pressures, herbicide-resistant weeds and biosecurity risks.

3. Markets

- Develop cropping and harvested product management systems and technologies and genetic solutions to protect crops from pests and diseases to ensure sustainable, productive and safe field crop industries in Queensland.
- Develop market access protocols to gain access to a broader range of markets for Queensland's broadacre crops, and search out new crop options that fulfill consumer needs and lead to new market segments.

4. Production costs

- Develop and deliver more efficient production systems that have reduced input costs or greater harvested value to enhance enterprise profitability.
- Develop the skills and human capacity in Queensland's broadacre cropping sector to drive enterprise production efficiencies and capture cost savings through the supply chain.

DAFF grains and cotton RD&E investments in Queensland are strongly aligned to the National Primary Industries Research, Development and Extension Framework strategies for these industries. Activity is centered on the priorities for Queensland industries. RD&E investment is based upon ongoing industry collaboration as well as vital partnerships with organisations such as the Grains Research and Development Corporation, Cotton Research and Development Corporation, universities (including the Queensland Alliance for Agriculture and Food Innovation), other state-based research agencies, CSIRO, private enterprise and cooperative research centres.

Under the Grains Industry National Primary Industries RD&E Strategy, Queensland has major focus on summer crop genetic improvement, winter cereal pre-breeding for biotic stress resistance, tropical pulses, crop protection (weeds, pathology and entomology), agronomy and farming systems including bio-economic modelling, soil biology and nutrition, grain quality assurance, functionality and product development, and biometry and bioinformatics.

Under the Cotton Industry National Primary Industries RD&E Strategy, Queensland has a major focus on improving farming systems including water-use efficiency, crop production stewardship, sustainable natural resource management and system integration.

Challenges

The broadacre cropping industries face several challenges, including stagnating productivity growth, seasonal variability, increasing risks to production, skills and labour shortages, food security and safety, and declining availability of inputs such as land and water.

DAFF broadacre RD&E activities play a key role in delivering the scientific foundations to manage biosecurity threats and responses. RD&E supports the science-based risk analysis and decision-making that underpins threat identification and prioritisation, prevention, preparedness, detection and hazard reduction or management. The plant diagnostic service and industry co-funded RD&E projects (that include surveillance and industry alerts) form part of the complex network of collaborations to deliver biosecurity capacity and capability.

Opportunities

The broadacre cropping industry has opportunities to raise productivity and profitability through the adoption of innovative biotechnology, farming systems technologies, genetic solutions, expanded market access and innovative pest and disease management systems.

Additionally, RD&E that assists dryland crop growers with increased options to manage seasonal variability and drought more effectively is seen as an increasing focus that can deliver gains in productivity.

Case study 1: Barley pre-breeding

On 5 September 2012, the Queensland Government and the Grains Research and Development Corporation announced that the government would maintain a barley breeding capability in Queensland and enhance the program through a focus on genetics and pre-breeding.

Both parties recognised that greater private sector investment in barley breeding for the northern region was vital for the future delivery of improved varieties to growers and industry.

DAFF will concentrate on the early stages of breeding and InterGrain Pty Ltd will breed finished varieties for growers (InterGrain is one of the largest barley breeding companies in Australia).

DAFF will also develop capacity in other key RD&E areas such as regional agronomy, entomology and plant pathology.

Case study 2: Robotics

This project will develop small cooperative agricultural robots to increase broadacre crop production and reduce environmental impacts. The growth in size of agricultural equipment has increased soil compaction damage and operational disruptions due to single machine failures. This project will create a new class of machines to perform weeding, which is the key element of zero-tillage agriculture.

These robots will have an advanced navigation capability using low-cost sensors—unlike current agricultural precision guidance—while also supporting local navigation with respect to weeds and other robots. They will cause less soil damage, apply herbicide more intelligently and operate as a robust system that can withstand individual machine failures.

Fisheries and aquaculture

The Queensland Government's aim is to not only protect the fisheries resource but balance its use to ensure fair and managed access for Queenslanders. Further, the government aims to sustainably manage the resource utilising the best available science, while minimising regulatory burden and intrusion in daily activities. The government's approach to fisheries management will be based on the best available science, taking into account environmental, economic, social and cultural impacts.

By its very nature, in comparison to terrestrial activities, knowledge of the marine ecosystem, fisheries and the impacts of the industry on the resource is relatively limited. Continuing research and monitoring is a vital part of improving this knowledge, which will lead to better decision-making.

The government supports the need for some public funding of fisheries research. This research must target priority issues that deliver optimum outcomes for the community's investment. Priorities need to be determined in conjunction with stakeholders. Where the government contributes to bodies such as the Fisheries Research and Development Corporation, it expects its priorities to be addressed in subsequent project approvals.

Fisheries and aquaculture make a modest contribution to the gross value of production in Queensland. Federal and state-managed commercial fisheries account for \$260 million, the recreational fishing sector accounts for \$73 million and aquaculture accounts for \$103 million. However, aquaculture is one of the fastest growing agricultural sectors—production has doubled over the past 10 years to meet growing demand for seafood.

Under the National Primary Industries Research, Development and Extension Framework, Queensland plays a major role in implementation of the tropical component of the National Primary Industries Fisheries and Aquaculture RD&E Strategy (in partnership with Western Australia and the Northern Territory in a northern tropical alliance).

DAFF's science capability and that of its main collaborators (CSIRO, The University of Queensland, James Cook University and the University of the Sunshine Coast) is able to deliver most of the RD&E needs of the fisheries and aquaculture industries.

Major focus

The major focus of fisheries RD&E is to sustain production through preventing a decline in fishery health—as opposed to increasing productivity. Fisheries research also contributes fishery management advice for improving the profitability of fishing.

DAFF-funded fisheries RD&E projects will focus on two of the four key pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Undertake stock assessments and management strategy evaluations of the major fisheries.
- Conduct fishery-independent surveys and evaluate the effects of fishing.
- Assess the impacts of seasonal variability and adaptation needs for east coast fisheries.

2. Productivity

- Enhance freshwater fishery production through riverine habitat rehabilitation.
- Determine optimal harvest rates to maximise economic yields.

The major focus of aquaculture RD&E is to increase productivity through genetic improvement, nutrition and broodstock husbandry, and to minimise off-site impacts through effluent reduction.

DAFF-funded aquaculture RD&E projects will focus on three of the four key production pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Encourage uptake and extension of effluent-reduction technology.

2. Productivity

- Extend the breeding season of farmed finfish species by photothermal control.
- Develop nutritional improvements to growth and survival during the fingerling stage.
- Undertake prawn husbandry broodstock management, including infertility.

3. Production costs

- Develop technical solutions to reduce the cost of aquaculture (energy costs in particular).

Challenges

Fisheries

A federal government commitment to expand the footprint of marine reserves will diminish the area available to fishing. This will lead to either a concentration of fishing effort and consequent increased risk of overfishing in the reduced area, or a reduction of fishing effort or catches to prevent this happening. Like other industries, wild-capture fisheries are exposed to increasing costs, particularly fuel and price competition with cheaper imports. Unlike other agricultural sectors, the purpose of most fisheries RD&E is to maintain fishery production at or near maximum sustainable levels. There is less capacity to increase harvests except through habitat improvement (especially freshwater systems), which leads to increased fish production. Fisheries RD&E therefore contributes to fishery production by preventing its decline rather than increasing it.

Aquaculture

A major and unique challenge to aquaculture expansion in Queensland is the need to minimise the discharge of nutrients into the environment from new farms. Minimising discharge is technically feasible in pond-based aquaculture (prawns, barramundi), but generally not economically feasible. An additional challenge is the ability to attract commercial investment into a relatively new industry in Queensland where competition from imports is strong.

Opportunities

Fisheries

There is an opportunity to strengthen science partnerships that deliver fishery forecasts from large national initiatives, such as QIMOS (Integrated Marine Observation System—Queensland node). There is also an opportunity to strengthen fishery assessment capability through a strong alliance between DAFF and the Centre for Applications in Natural Resource Mathematics (The University of Queensland), and between DAFF and the Centre for Sustainable Tropical Fisheries and Aquaculture (James Cook University).

Aquaculture

Commercial partnerships in Queensland finfish aquaculture using recirculation technology could lead to a major expansion of this industry over the next few years, particularly as it addresses the requirement for minimal discharge of nutrients from new farms. Global demand for fish is driving strong growth of the aquaculture sector (production has doubled over the past 10 years). There is strong potential in Queensland and South-East Asia for application of effluent-reduction RD&E (notably polychaete-assisted sand filters or worm beds) to substantially reduce the nutrient content of waste streams. The application of novel breeding designs to finfish aquaculture could greatly accelerate genetic improvements in growth or other desired traits.

Horticulture

Queensland is a major production state for Australian horticulture. DAFF is looking at opportunities in North Queensland for industry expansion. The total value of horticultural crop production in Queensland, including first-stage processing, is \$3.8 billion.

Under the National Primary Industries Research, Development and Extension Framework, Queensland has major responsibilities for tropical and subtropical horticulture crops—avocado, banana, capsicum, macadamia (shared with New South Wales), pineapple, strawberry, sweet corn, sweet potato, tomato and other tropical fruit. This imposes an obligation on Queensland to coordinate national RD&E for these crops between the state agencies, universities and industry. In addition, Queensland is required to support certain aspects of the national RD&E effort for apple, bean, brassica, citrus, cucurbit, leafy greens, pea, persimmon, pome fruit, stone fruit and table grape, with lead responsibility for these crops vested in other state agencies.

Queensland is able to deliver most of the RD&E needs of these industries. Specialist scientists from a range of relevant disciplines (entomology, microbiology, nematology, physiology, chemistry and genetics) work with applied scientists in crop protection, agronomic systems and supply chain and market access improvement. Some more specialist skills are accessed through university collaborations, including strategic arrangements and alliances. These include five horticulture-related researchers aligned with The University of Queensland through the Queensland Alliance for Agriculture and Food Innovation, and a professorial position part-funded by DAFF at Central Queensland University (Bundaberg), establishing a vegetable research focus and providing valuable expertise to the rapidly growing horticulture industries of that region.

Major focus

DAFF-funded horticulture RD&E projects will focus on the four key pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Foster good stewardship of resources through research to underpin the development of best management practices, responsible water use and minimisation of off-site effects of horticultural practices.

2. Productivity

- Improve productivity and growth of horticultural sectors of significant economic importance and growth potential for Queensland, where RD&E is clearly making a difference. These include each of the crops for which Queensland has major responsibilities under the national framework, as well as mango, apple and stone fruit (low chill).
- Develop active breeding programs and more productive varieties for a range of crops, including capsicum, mandarin, macadamia, mango, pineapple, stone fruit (low chill), strawberry, sweet corn and tomato. Other varietal improvements currently underway without full ongoing breeding programs include apple (commercialising from an earlier breeding program), banana (on imported germplasm), custard apple and papaya.
- Develop diagnostic tools, early detection and management options, and resistant varieties to help industry avoid or at least reduce the effects of future exotic pest and disease incursions on productivity and markets. This work will be undertaken in collaboration with experts in Biosecurity Queensland and elsewhere.

3. Markets

- Improve market access (disinfestation research, mainly focused on fruit fly).
- Undertake supply chain optimisation (product quality maintenance increasingly supporting export growth into overseas markets).
- There is also a market growth component to the breeding programs mentioned above, modifying products to better suit market and consumer preferences.

4. Production costs

- Research to reduce production costs is vital to increase total factor productivity and grower profitability, and to enable products to compete in both domestic and international markets. We will work with engineers in collaborating organisations to develop mechanisation, automation, robotics and remote-sensing technologies to benefit a range of horticulture crops and co-adjust crop agronomy for optimal outcomes.

Challenges

The horticultural industry faces a number of changes and challenges, including domestic and international competition, changing consumer demand, preferences and expectations, seasonal variability, pests and diseases, maintaining product quality along the supply chain, and access to interstate and international markets.

Opportunities

While import/export data is scarce for individual states, Australia exports 13% of fruit and 9% of vegetables produced but imports 34% of fruit and 19% of vegetables consumed—probably mainly processed. With increasing affluence in Asia, and particularly if the world population grows as predicted, the opportunity for increased Australian horticultural exports may be greater than the opportunity/need for import substitution.

Case study 3: 'Small Tree – High Productivity' initiative

Over the last 35 years there has been a dramatic improvement in our understanding of 'old world' horticultural tree crops such as apple, with R&D spectacularly improving their productivity.

A new 'Small Tree – High Productivity' initiative aims to do for subtropical and tropical Queensland fruit and nut tree crops what has already been done for apples. Work will be undertaken on many aspects of the orchard system that are known to influence yields and the ability to automate tending and harvesting. This includes development of dwarfing rootstocks, optimising flowering, fruit set, light interception and tree architecture.

The initiative will reduce production costs and increase yields, quality, profitability and the ability of Queensland growers to export and compete internationally.

Forestry and timber

The total value of the forestry and timber industries in Queensland, including first-stage processing, is \$536 million.

Under the *Queensland forest and timber industry plan*¹⁸, an industry-led panel is being established to advise on R&D investment priorities. While capacity to meet most expected industry needs already exists within Agri-Science Queensland (part of DAFF), a small but growing partnership with the University of the Sunshine Coast will also play a key future role.

Of particular significance is the DAFF forest products research capacity and equipment located at Salisbury in Brisbane—Australia's only remaining site dedicated to timber processing and product development, and increasingly viewed and used as a strategic national resource.

Under the National Primary Industries Research, Development and Extension Framework, Queensland has major responsibilities for tropical and subtropical production forestry and timber R&D, obligating Agri-Science Queensland to coordinate national RD&E in these fields between the state agencies, universities and industry.

Major focus

The major focus of recent DAFF-funded forestry and timber research projects has been aligned to the four key pathways in *Queensland's agriculture strategy*, but priorities are expected to be adjusted after the industry-led advisory panel is established:

1. Resource availability

- After decades of genetic improvement to the subtropical exotic pines that are now the state's primary timber resource, recent focus has been on expansion of resources with hardwood plantations. As with the former softwood breeding work, this takes a long-term view, producing reliable germplasm and deployment knowledge in readiness for future rounds of plantation investment and expansion.

¹⁸ Forest and Timber Industry Plan Working Group 2012, *Queensland forest and timber industry plan*, Queensland Government, Brisbane, <<http://www.timberqueensland.com.au/Docs/Growing-Processing/Processing/Queensland-Forest-Timber-Industry-Plan-December-2012-sml.pdf>>.

2. Productivity

- Develop elite germplasm for deployment in new or second/third rotation plantations to increase wood yield and quality.
- Quantify carbon sequestration rates for future potential carbon market trading.
- Develop systems to reduce losses and risks from pests, diseases and fire, with particular attention currently being paid to recently introduced myrtle rust.
- Improve post-harvest processing to increase the value of harvested wood.

3. Markets

- Identify new market opportunities for timber-based products and building systems, develop these products and processing technologies, and reclaim market segments previously lost to alternative building materials.

4. Production costs

- Develop cost-effective pest and disease strategies using semiochemistry-based science.
- Develop less energy-intensive processing technologies.

Challenges

Low housing starts and sales volumes, profitability and return on investment across the industry are constraining new investment, particularly in the forest-growing (plantation) and primary processing sectors. Substitute non-renewable building products (steel, concrete, aluminum etc.) have displaced timber in some traditional market segments. Poor understanding of the industry and the environmental benefits of wood products has reduced community support for the industry.

Opportunities

There is significant potential for growth of timber-based products and building systems in commercial and multi-story residential construction. While the adoption in Australia of trends and innovations already firmly established overseas has been very slow, it is now starting to occur. It is widely expected that this will see timber-based products regain significant market share from concrete in these sectors in Australia, but growth could quite quickly become constrained by domestic log supply. There is export potential into new and existing markets, particularly as the Australian dollar value returns to long-term values.

The way forward for key cross-sector services

Biosecurity

Biosecurity RD&E is essential to the future prosperity of Queensland's agricultural, fisheries and forestry industries, for maintaining our diverse environment and for continued social amenity. Exotic pest animals, weeds and diseases (if not prevented or rapidly addressed) can result in large direct and indirect costs to industry profitability. Impacts of a biosecurity event can also go beyond the industry involved, with flow-on effects to the rest of the economy. An incursion or outbreak of a pest or disease can have a range of significant direct and indirect costs to affected producers, industry, the economy and the community in general.

Outbreaks (or suspected outbreaks) of diseases such as foot-and-mouth disease, 'mad cow disease'/BSE (Bovine Spongiform Encephalopathy), avian influenza in poultry, classical swine fever in pigs and equine influenza in horses all have major impacts on production and trade.

For example:

- a foot-and-mouth disease outbreak alone could cost the Queensland economy \$9 billion and have an impact for many years as lost market share is regained
- red imported fire ants could cost the Australian economy \$8.9 billion (it currently costs Texas \$1.2 billion a year to manage) and have major impacts on productivity and social amenity
- varroa mite, a parasitic mite of European honey bees and other bees, has the potential to kill European honey bee colonies, resulting in reduced productivity of crops that rely on bee pollination and commercial honey production
- papaya fruit fly and citrus canker infestations affected both the trade and productive capacity of many fresh fruit and vegetable crops—although papaya fruit fly and citrus canker entered Australia, a rigorous response has resulted in eradication of both pests
- established weeds and pest animals cost Queensland in excess of \$700 million annually—investment in weed and pest animal research can provide a cost-benefit ratio of 1:80 (notable successes include biological control of some of our worst weeds such as prickly pear, rubber vine, harrisia cactus, parthenium and groundsel bush by using natural enemies like insects and pathogens from the weeds' native range).

Biosecurity services are heavily reliant on sound, multidisciplinary science. This science is achieved via collaboration and alliances with DAFF RD&E programs, other research providers (including the CSIRO Biosecurity Flagship), cooperative research centres, aligned agencies, industry, natural resource management groups, business sectors and the community. Effective biosecurity systems need scientific information for risk assessment and decision-making, and to provide the necessary tools and policies for biosecurity responses.

Biosecurity Queensland (part of DAFF) has a strong internal science capability, particularly related to the diagnosis and identification of pests and diseases, and research associated with weeds and pest animals. However, the group works very closely with R&D staff within Agri-Science Queensland, who have specialist skills and expertise in a number of areas not found in Biosecurity Queensland. This combination of skills across Biosecurity Queensland and Agri-Science Queensland ensures DAFF remains a national leader in biosecurity science.

Major focus

DAFF-funded biosecurity RD&E projects will be aligned with the four key pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Understand characteristics and impacts of known damaging weeds, pests and diseases.
- Develop an ongoing prioritisation process to identify and agree research priorities across the system.

2. Productivity

- Identify innovative approaches to help manage existing biosecurity problems.
- Analyse risk pathways and vectors for entry and dispersal of weeds, pests and diseases.
- Develop methods for managing risks offshore.
- Develop innovative data mining and intelligence methodologies that aid the capacity to forecast and respond to emerging biosecurity risks.

3. Markets

- Understand the impacts on plant and animal physiology of chemical residues and contaminants.
- Develop an understanding of human behaviour in creating, managing and communicating biosecurity risks.
- Investigate ways to promote animal welfare, including the humane treatment of animals in the control and treatment of pests and diseases.
- Develop systems and treatments that facilitate trade while managing biosecurity risk.

4. Production costs

- Improve systems and infrastructure for delivery of specialised diagnostic services.
- Develop cost-effective surveillance tools and treatment technologies.
- Develop innovative control mechanisms for weeds and plant diseases, including smarter chemical and biological controls.
- Develop enhanced capabilities, diagnostics and tools for surveillance and detection of pests and diseases, including aquatic invasive pests.

Challenges

Biosecurity RD&E operates within an uncertain and unpredictable environment, with priorities set using a risk management framework. The ability to predict new and emerging incursions and to target scarce biosecurity resources presents a major challenge.

Biosecurity science is broad in scope. The focus includes pre-border, border and post-border issues, as well as a range of environments including terrestrial, freshwater and marine systems. The extensive science needs of Biosecurity Queensland pose a challenge to ensure the organisation can influence the development of national and state biosecurity RD&E priorities.

Major biosecurity incidents are expected to become more frequent as the movement of products and people around the world increases, climates and environments change, free trade agreements become more common and market requirements intensify. Additionally, the greater focus on decreasing chemical use presents a challenge to develop new approaches and tools to control new and established pests.

Biosecurity incidents occur frequently and often more than once for some pests and diseases. Having information and knowledge management systems in place to draw upon and learning from past events is important to effectively predict and respond to emerging and repeated biosecurity events.

Opportunities

Biosecurity RD&E aims to provide scientific information, tools and solutions to better manage biosecurity risks in Queensland.

Case study 4: Foot-and-mouth disease

To be ready for foot-and-mouth disease, Queensland requires RD&E designed as part of surveillance, preparedness, prevention and response planning to support actions in the event of a foot-and-mouth emergency. Activities will include:

- risk assessments of potential pathways of foot-and-mouth introduction, establishment and spread, and the likely consequences of an incursion for government, industry and the community
- identification of preventative measures to minimise the risk of introduction, establishment and spread of foot-and-mouth in Queensland and Australia
- extension activities such as disease recognition, clinical signs, reporting mechanisms and use of personal protective equipment and personal decontamination.

This work will deliver greater veterinary, government and community awareness, and the ability to detect and respond to a foot-and-mouth incursion.

Value-added foods

Queensland's food value chain in 2010–11 was worth at least \$18.7 billion to the state's economy and supported 267 000 Queensland jobs.¹⁹ Of the food value chain, \$9.4 billion and 186 000 jobs are situated post–farm gate within the food processing, value-adding, wholesale/retail and service industry sectors. Production capabilities range from fresh fruit and vegetables, seafood, grains, sugar and meat to value-added foods including fresh ready-to-use horticultural products, processed foods and food ingredients. The industry is spread across 1030 food processing business in Queensland, of which 95% are small (employ less than 20 staff) or medium-sized (employ less than 200 staff) companies.

Under the draft national food and nutrition RD&E strategy, Queensland has a major focus on providing the linkage between research and the commercial application of new products and technologies, and researching and promoting the human health components of food and their impacts.

The government, through its Value-Added Foods RD&E Program, invests in developing and delivering products and services that underpin the ability of Queensland primary producers, food processors, retailers and service industries to better meet consumer needs in the areas of food choices, safety, quality, health and convenience.

Major focus

The value-added food RD&E capability of the Queensland Government will be aligned with the four key pathways in *Queensland's agriculture strategy*.

1. Resource availability

- Contribute to improving food security and minimising environmental impact through maximising commodity use, improving processing efficiency and reducing resource wastage.

2. Productivity

- Increase the value of harvested products, either through improved varietal attributes and/or post-harvest processing and packaging.

3. Markets

- Research and define consumer needs/attributes to identify and inform market opportunities.
- Produce new value-added products that improve competitive position in target markets, including export markets.
- Utilise innovative pilot plant manufacturing research to test and refine product concepts.

4. Production costs

- Increase skills and capacity to engage in food product innovation and world's best practice.
- Raise competitiveness to manage import substitutions.

¹⁹ Department of Employment, Economic Development and Innovation 2011, *Food for a growing economy—an economic development framework for the Queensland food industry*, page II, Queensland Government, Brisbane.

Challenges

The major challenge to undertaking broad impact, value-added food RD&E is the perceived lack of a peak industry body to provide strategic direction and co-investment, along with government and other RD&E providers. As a result, much of the current RD&E is for private benefit and application of new knowledge across a broad cross-section of industry is constrained. The Queensland Government has invested heavily in value-added food research infrastructure recently in an attempt to facilitate collaborative research efforts in this area.

Opportunities

The major opportunity for value-added food products is the ability to improve food quality and functionality as perceived by consumers. This will allow the state's agricultural industries to compete on premium product strengths rather than a low-cost commodity basis. This approach is critical to driving increased production (through demand) and economic impact (through value-adding and preferential consumer purchasing). DAFF food science and technology facilities provide Queensland with an outstanding opportunity to develop and take advantage of strong collaborative research relationships with other leading food RD&E agencies. Collaborative partners include The University of Queensland (Queensland Alliance for Agriculture and Food Innovation), CSIRO, James Cook University and Queensland Health.

Environmental sustainability

Long-term agricultural productivity is dependent on appropriate conservation and custodianship of natural resources and protection of land, resources and the environment. DAFF will work with other Queensland Government departments to promote and encourage best management practices such as soil conservation, water- and nutrient-use efficiency, and integrated pest and disease management. Appropriate agronomic practices will assist industry to achieve productivity improvements for the long term.

DAFF is also currently working with the grazing industry to help producers transition from a regulatory system to an industry-led system underpinned by profitability, productivity and land stewardship. The government is supporting graziers as they develop best management practice programs and identify the most profitable and sustainable management practices for their own businesses.

The best management practice framework, developed through productive negotiations with other stakeholders, places the grazing industry in a strong position to boost profitability while improving water quality in the reef catchments. The sector needs to ensure its farming practices meet community expectations of sustainability and do not impact on the natural environment (e.g. the Great Barrier Reef).

To assist with the development of best management practice programs regionally, the agricultural sector works with and within regional Natural Resource Management Bodies. These bodies are responsible for protecting and managing Queensland's natural resources and to ensure a win-win situation for all involved. The focus of these bodies is on sustainable management of the regions natural resources, including land, water, biodiversity, coasts and marine assets.

The Queensland agricultural sector's 'clean and green' image is important to retaining export markets.

Extension

Extension is the facilitation of change and innovation aimed at improving the productivity, sustainability and competitiveness of Australia's (and Queensland's) primary industries.

Public RD&E accounts for two-thirds of Australian agricultural productivity growth.²⁰ While R&D contributes to long-term productivity gains, extension can generate higher short-run productivity gains by ensuring a higher proportion of farmers become early adopters of R&D outcomes.²¹ The adoption of research outcomes should be treated as an integral part of the R&D planning and delivery process.

In conjunction with its stakeholders, the Queensland Government will ensure that extension remains an integrated component of the RD&E continuum. Further to this, the government will work with all parties associated with the National Primary Industries Research, Development and Extension Framework to ensure extension priorities are clearly understood and addressed in the implementation of the framework's sectoral and cross-sectoral strategies.

The Queensland Government is considering a number of principles to inform its prioritisation of extension delivery:

- DAFF will support the private sector's expansion of extension delivery into areas where there are market opportunities, and it will continue to invest in extension where market failure is evident.
- Extension will form a critical component of DAFF's customer-centred service delivery.
- DAFF extension effort will deliver economic development outcomes for Queensland's agriculture, fisheries and forestry industries.
- Extension will be delivered using different approaches and DAFF will work to optimise the benefits for industry.
- DAFF's efforts will aim to optimise the customer's access to the best available service, which in many cases will be DAFF.
- DAFF will work better with the private sector and RD&E partners to facilitate and broker information and extension services.
- DAFF will have the resources and skills to deliver extension services.
- DAFF extension effort will extend from behind the farm gate, as well as along the supply chain.
- DAFF is committed to extension as an important means of contributing to doubling Queensland's agricultural production by 2040.

These principles form the basis of a plan to ensure the Queensland Government is delivering the type of information and advice required by each sector in a way that will make enterprises more resilient, innovative, efficient and profitable.

The digital economy may be the biggest singular challenge and opportunity facing extension in the agricultural sector today. Discussion should focus on the need to 'get it right' in terms of delivering information and achieving maximum extension impact. It is not a case of 'one size fits all'. Enhanced connectivity via digital technology is considered

²⁰ Department of Agriculture, Fisheries and Forestry 2013, *Rural research and development policy statement*, Australian Government, Canberra, p. 22, <http://www.daff.gov.au/__data/assets/pdf_file/0004/2176222/research-and-development-policy-statement.pdf>.

²¹ As above

a major opportunity—the major challenge is how to best harness this connectivity and reach the right stakeholders and industry players.

DAFF will work with major stakeholders to ensure that the information trail is adequate and appropriate so Queensland's agricultural sector has the ability to improve its profitability and productivity and is able to make use of the R&D being undertaken. More money for extension is not the primary solution for improving extension delivery in Queensland, but rather it is better clarity, coordination and integration of extension roles, functions and service provision.

Research facilities

It is DAFF's intention that the efforts made to focus and revitalise Queensland's R&D infrastructure will lead to its use by all R&D providers.

DAFF manages a statewide portfolio of 35 world-class research-ready facilities, ensuring producers have access to the best possible agricultural RD&E services.

State-owned research facilities provide sites for all agri-science research capacity, including access for relevant Queensland and federal government agencies, R&D corporations, industry providers and the university sector.

These facilities cover a range of plant and animal commodities and operations, and are both intensive and extensive research sites. Each research facility comprises various unique combinations of built infrastructure, such as offices, laboratories, glasshouses and specialist plant and equipment to undertake the required range of RD&E operations specific to each location.

Agricultural research on soils, plants and animals is conducted at DAFF research facilities under controlled conditions when the nature of the experimental treatments and/or measurements are such that they cannot be conducted on cooperating producer properties or leased land.

The Queensland Government is continuing the process of rationalising and revitalising its research facilities. This will change the way that it operates, providing world-class research infrastructure that underpins science delivery. Up to \$40 million in infrastructure reinvestment has been spent in the beef, dairy, crop, food and horticulture industries throughout Queensland.

A portfolio management approach ensures consistent methodologies across all research sites. Co-funding of infrastructure and co-location with other research providers (including private) will maximise efficiencies. This will reduce overheads and operating costs, and modernise research infrastructure by replacing ageing and/or outdated facilities. Underpinning the rationalisation of facilities is the recognition that it is financially unsustainable to continue to hold onto properties that are no longer required for research.

There is an unprecedented partnership between industry and government to bring about change. The willingness of industry to work with government on the challenges faced by the agriculture sector has refocused the way government works, and will help achieve the vision to double Queensland's agricultural production by 2040.

Capturing and harnessing RD&E resources (skills, infrastructure and finance) across states, industries and research agencies provides the most cost-effective and efficient way to maximise RD&E funding outcomes for primary industries and the food sectors for the long term.

Intellectual property and commercialisation

Intellectual property and commercialisation is the development of new or original knowledge that is applied to the development of a product or service in the marketplace.

It is essential to enable collaboration with commercial partners in the development and adoption phase of a project. Without protection of intellectual property, commercial partners would not be prepared to provide the considerable funding required to deliver improved products to markets. In addition, the commercialisation process provides an income stream for future funding of RD&E. Benefits of past funding in R&D accrue to present users of improved technologies and practices.

The protection of intellectual property (where appropriate for commercialisation) provides an avenue for leveraging additional funding and attracting linkages, partnerships and collaborations. Appropriate models are in place to ensure flexibility and enable access to necessary information, goods and services, while still ensuring maximum return on funding for individual co-investors.

The Queensland Government will develop intellectual property or undertake commercialisation focused on public benefit and not for the primary purpose of revenue generation. Any intellectual property generated will be effectively managed to enable the maximum uptake of R&D outcomes and provide maximum benefit to the Queensland economy.

Royalty returns are encouraged, where appropriate, to encourage the commercialisation process.

Implementation

The DAFF agricultural RD&E plan will be implemented over five years, using existing resources. The plan will be reviewed after five years or if unforeseen circumstances and/or opportunities arise.

The government will implement RD&E jointly with industry and research providers. RD&E will be informed by industry development plans developed by DAFF with industry, and will complement the strategies of the National Primary Industries Research Development and Extension Framework.

The research capabilities of Queensland universities will be mapped and enhanced to enable a better fit with state government's objectives, communication with stakeholders about rural RD&E requirements will be improved and targets for transformational research will be established and monitored.

In addition, the government will monitor and report on the various components of the RD&E continuum.

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