Animal Welfare Research, Development and Extension Capability and Infrastructure Inventory for the Australian Livestock Sector

Volume 1: Final Report

Prepared for the National Animal Welfare R,D&E Strategy Steering Committee

January 2017

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Executive Summary

With the review and update of the *National Primary Industries Animal Welfare R,D&E Strategy (2017)*, the NAWRDE Strategy Steering Committee commissioned an assessment of the animal welfare R,D&E capability and infrastructure needs of the livestock industries. This will be used to ensure that effective plans are in place to retain and build the capability and infrastructure for the future.

The project only considered Australian R,D&E that is primarily undertaken to understand and/or improve the welfare of livestock species. R,D&E which is undertaken primarily to improve the health and/or production of livestock species, and which improves animal welfare as a 'by product', was not considered. R,D&E addressing issues of companion animals (such as cats and dogs), zoo animals, wild animals (including vertebrate pest animals), fish and animals used for experimentation or recreation were not considered as part of the project.

The analysis of extension capability analysis focused on the skills available for development of animal welfare extension strategies and preparation of resources and coursework materials rather than on generic extension delivery.

2016 R,D&E Capability Survey

Capability surveys provide a point-in-time assessment of parameters such as scale, type, location and quality of expertise. Such surveys contain a mixture of quantitative and qualitative data and while they are a 'snap-shot' in time, they enable comparisons in trends against past surveys, as well as an assessment of the current capability prospectively available to meet the forward R,D&E needs over the next 5- 10 years.

The project used an on-line survey, the AgInsight Survey Tool ©, which is a searchable database (that can be extensively interrogated and readily applied in future to update information). The survey utilised the Australian and New Zealand Standard Research Classification (ANZSRC, 2008) Fields of Research (FoR) codes as the underpinning basis. The survey was constructed to enable trend analysis against the prior survey. It was also necessary to ensure both the collection and use of data complied with the Australian Privacy Act 1988 (Privacy Act), updated 2014. Consequently the survey was given to individuals to complete, not managers on behalf of team members. The mailing list for the survey comprised 52 organisations.

Following completion of the on-line survey, the R,D&E capability data were analysed in a manner to allow assessment against the NAWRDE Strategy (2017) Priority Themes, trends identified in the previous capability assessment and other priorities identified by the Project Management Team. The approach included examining four Science Discipline Groups (Animal and Veterinary Sciences, Sociology and Ethics, Economics and Education and Industry Extension Development) and a number of Fields of Research within a Discipline Group (e.g. Animal behaviour (Ethology)). The Fields of Research were chosen from the ANZARC Fields of Research Codes.

Following analysis of the capability data and identification of trends and gaps, prospective sources of capability nationally were identified from a combination of the Study Teams' knowledge, desk top reviews, and discussions with science leaders and with the project Steering Committee.

Assessment of current animal welfare R,D&E capability

From invitations sent to 52 R,D&E organisations, responses were received from 32 organisations, a response rate of 62%. All major R,D&E providers responded to the survey.

The focus of the capability survey was to identify the scale and focus of people currently undertaking animal welfare R,D&E. Responses were received from 95 individuals including 12 postgraduate students. Of these 95 respondents (72.9 FTE), 68 people (54.35 FTE) identified as Researchers, 13 people (11.70 FTE) as Research Support, and 14 people (5.95 FTE) as Education and Industry Extension Package Developers. Follow-on interviews with group leaders in those organisations with more than 3 FTEs highlighted a very high response rate (>90%) to the survey by individuals in these organisations. These numbers compare very favourably with those reported by Kroker & Edge (2009).

Overall, the Project Team considers that the livestock industries are well placed with access to the majority of R,D&E capabilities it requires to address industry priorities over the next 5-10 years.

R and D discipline capability assessment

Animal and Veterinary Science disciplines

The Animal and Veterinary Sciences covers all major Fields of Research with a focus on the physical, biological and engineering sciences associated with animal welfare research. Sixty six people identified as undertaking Animal and Veterinary Sciences research, with a combined capability of 50.35 FTE, thus representing the majority of all Animal Welfare Researchers. The major research capability is associated with the fields of Animal Behaviour and Animal Management. Current capability in these fields is assessed as strong with a large complement of researchers located within a number of major research organisations and with wide industry linkages. Senior leadership is available with a solid group of scientists building experience, supported by new postgraduate students offering succession development.

The fields of Animal Breeding, Animal Nutrition, Animal Growth and Development, Animal Production are generally well placed for the immediate term requirements of the NAWRDE Strategy. Age and research experience distributions generally show a developing group of researchers, but only a small number of new postgraduates to support future growth in capability. In addition, capability in these fields is also strong in the agriculture production sector, suggesting that if capability gaps emerge in the short term, capability can be accessed from elsewhere, particularly from areas in animal production sciences.

Humane Animal Treatment and Animal Neurobiology are also generally well placed but are key contributors to the NAWRDE Strategy priorities, particularly the themes of 'Pain Assessment and Management', Management, Housing and Husbandry' and 'Transport, Euthanasia and Slaughter'. Growing market and community concerns are likely to necessitate increasing demand for this capability. Current capability is generally well placed for current requirements, but likely to be a concern for adequacy for intermediate and longer term needs. Increasing the scale of capability,

research leadership skills, and postgraduates, and opportunities to participate in development of industry codes and regulatory committees should be priorities. Capability is unlikely to exist widely in other sectors, and consequently, developing additional capability in these fields should be a priority for the NAWRDE Strategy.

The fields of Engineering Instrumentation (including automated welfare monitoring systems), Agriculture Engineering (including animal housing), Agricultural Biotechnology Diagnostics (including biosensors) and Veterinary Anatomy & Physiology recorded limited current capability (including only 1 postgraduate), yet all four could be increasingly valuable contributors to research for the NAWRDE Strategy themes of 'Animal Welfare Assessment'; 'Management, Housing and Husbandry' and 'Transport, Euthanasia and Slaughter'. For each of these Fields of Research, the limited current capability could be considered a concern, however, capability in each of these fields does exist widely in the non-agriculture sectors and in many agricultural production research fields. Consequently, building linkages with these other sectors should enable access to the necessary research capability.

The Fields of Research Veterinary Anaesthesiology and Intensive Care and Veterinary Pharmacology can be valuable contributors to research for the NAWRDE Strategy themes of 'Pain Assessment & Management' and 'Transport, Euthanasia and Slaughter'. No researchers identified with Veterinary Anaesthesiology, whilst only 3 people identified with Veterinary Pharmacology. In both of these fields, strong capability exists within most university veterinary faculties. Building linkages and raising awareness of the research needs and priorities for the agriculture animal welfare sector will provide opportunities for accessing the required capability.

Sociology and Ethics disciplines

An understanding of, and utilisation of, expertise in Sociology to assist the identification, prioritisation, conduct and delivery of research is increasing across most agricultural industry sectors (for all research interests, including productivity, sustainability and market access issues). Animal welfare R,D&E priorities are heavily driven by market and community perceptions, views and values. Sociology and Ethics capability is thus a key contributor now and increasingly into the future. This is recognised in the NAWRDE Strategy priorities, particularly 'Attitudinal effects on animal welfare'.

The current capability assessment indicates that Sociology and Ethics capability is a concern. A capability of only 2.40 FTE, with no postgraduates in training, an ageing team (60% over 50 years of age) and fragmented across many people and locations is unlikely to be adequate for addressing current and future NAWRDE Strategy priorities. Although Sociology research capability does exist In Australia supporting agricultural sector productivity issues and non-agricultural sectors, the capability is in high demand and building linkages with these groups together with developing new animal welfare focussed capability including postgraduate training will be of high importance.

Agriculture Economics

There was only a very small capability in agricultural economics associated with animal welfare and this could be seen as a significant capability gap. Such economics research is a key input in understanding issues such as the costs and benefits associated with new practices or community expectations on farm profitability and sustainability. However, it should be noted that a capability survey is a snapshot in time and economics research input may be relatively transient in comparison

with the more fundamental capabilities associated with the Animal and Veterinary Sciences. Across the major universities involved in animal welfare research, as well as CSIRO, there are considerable resources in agricultural economics that can be drawn upon to assist with animal welfare R,D&E. The current capability assessment does indicate a potential gap in the application of economics research and should at least flag the need for careful assessment of the extent of its inclusion in future animal welfare R,D&E projects.

Education and Extension Package development disciplines

The development of education and extension packages covering key animal welfare issues will be an increasingly important mechanism for securing changes in practices by industry and securing broader community support for the agricultural sector. Recognising that the capability available is applied to addressing both specific industry sector and cross-sectoral animal welfare education and extension package development, the total capability is of concern. Future Researchers are well placed to have a detailed knowledge and understanding of current research outputs and their prospective application by industry. Consequently, researchers can, and arguably should, be more involved in the preparation of Education and Industry Extension Development packages. A cross sectoral approach to defining the scale of required future capability together with developing a panel of interested and available organisations and individuals containing the necessary capability could be advantageous.

In the capability survey, 22% of Researchers identified themselves as 'Industry Recognised Experts' for their ability to effectively interface with Industry Advisory Intermediaries (such as Farm Management Consultants, Industry staff) and provide information on their research activities, outputs and the potential impacts on farm activities. These people were primarily those who are the most experienced researchers. As new extension models evolve, it is highly likely that there will be a growing need for researchers who can effectively interface with Industry Advisory staff. The qualitative results from the present study suggest there is a small number of such people available from amongst the senior researchers, with an even smaller number of mid-career researchers with these skills. To expand the number of suitable researchers, particularly in the short to medium term, emphasis could be placed on the cohort of mid-career researchers but this would require a planned and structured approach.

Postgraduates

Twelve postgraduates were identified in the current capability assessment and all were associated with the Animal and Veterinary Sciences, predominantly occurring in the Fields of Research of Animal Behaviour and Animal Management, two fields that are comparatively well resourced by existing researchers. There is a lack or shortage of postgraduates in a number of identified key capabilities of concern, such as Animal Neurobiology, Engineering Instrumentation, Agriculture Biotech Diagnostics, Animal Breeding (breed more welfare resilient animals) and Sociology.

In the capability assessment conducted at the time of the original Animal Welfare R,D&E Strategy, it was reported that there were 23 postgraduate students. Results from the current capability assessment would indicate a decline in postgraduate training.

Overall, it is questionable if the current level of postgraduate training is sufficient to meet the growing and future demand for animal welfare R,D&E. Additionally, indications are that the current Fields of Research focus of postgraduates will not adequately address current and emerging capability gaps.

Capability assessment to deliver against the Priority Themes in the NAWRDE Strategy 2017.

An assessment of individual R,D&E capabilities also enabled an aggregated assessment of the current capability to deliver against the planned priority themes of the NAWRDE Strategy (2017). The comments above for Education and Extension Package Development capability apply equally across all priority themes, so the following assessment just refers to the R&D capability to deliver against the relevant Priority Themes.

Animal Welfare Assessment theme:

Existing capability, primarily through Animal Behaviour expertise is strong however, increased access to capability associated with fields such as automated welfare monitoring systems and biosensors will be necessary to meet the objectives of this theme. This additional capability exists in other RD&E sectors (both agriculture and non-agriculture) and should be accessible.

Pain Assessment & Management theme:

Existing capability is generally well placed, although there are multiple, relevant Fields of Research capability (for example Veterinary Anaesthesiology, Pharmacology, Neurobiology) that will need to be accessed from other RD&E sectors to meet the likely capability requirements to achieve the themes' objectives.

Management, Housing & Husbandry theme:

Of all the NAWRDE Strategy priority themes, the 'Management, Housing & Husbandry theme' is best placed to achieve its objectives based upon current animal welfare researcher capability. Most of the key relevant Fields of Research are strong or well-placed and readily available.

Transport, Euthanasia & Slaughter theme:

This theme shares key relevant capability requirements with several other themes, particularly 'Animal Welfare Assessment', 'Pain Assessment & Management' and 'Management Housing & Husbandry'. Consequently, is has strong capability in a number of key fields, such as Animal Behaviour, Animal Management and Animal Nutrition. However, meeting the objectives of this theme will, in concert with other priority themes, require accessing several key capabilities from other R,D&E sectors, such as for animal welfare monitoring and engineering/housing.

Attitudinal Effects on the Welfare of Livestock throughout the Value Chain theme:

There are indications that this priority theme is of increasing importance for the NAWRDE Strategy. It is also noteworthy that this theme will be highly interactive and contributory to all other priority themes in the strategy. The results from the capability survey would suggest that this theme warrants greatest consideration for the adequacy of capability to meet the immediate and near term priorities of the NAWRDE Strategy. The key capabilities required for this theme are all contained within the 'Sociology and Ethics' discipline group. Total current capability is limited and increased capacity will be required. There is potential capacity in the social sciences in several government departments and universities, however, social science capability is increasingly being sought by the agricultural production sector (particularly in the design and development of new extension delivery models and for research design and prioritisation). Consequently, the ease and assuredness of being able to access the necessary capability from other RD&E sectors needs further investigation.

Education, Training & Extension theme:

This theme is of comparatively lower priority with respect to researcher capability, with the key capability being provided by non-researchers. However, researchers can provide a valuable degree of supporting capability. The results from the capability survey indicate that a small percentage of current animal welfare researchers directly participate in this theme and thus opportunities exist for broadening researchers' engagement and skills to support the theme.

Recommendation 1. *That the NAWRDE Strategy Steering Committee commit to an annual meeting of animal welfare R,D&E investors and providers to assess progress in securing and sustaining key capabilities within each of in the six priority themes in the NAWRDE Strategy.*

Recommendation 2. *That the NAWRDE Strategy Steering Committee support a review, involving investors and providers, to determine the future scale and requirements for Sociology and Ethics capability and explore options to strengthen capability by:*

   a. *Establishing a database of interested and available organisations and individuals containing the necessary capability;*
   b. *Examining the prospect of investing in additional postgraduate student training in Sociology and Ethics capability; and*
   c. *As Sociology and Ethics is a cross–sectoral issue, consider a strategic appointment in animal welfare Sociology and Ethics within an R,D&E provider organisation with strong critical mass to provide national leadership and to build linkages and partnerships.*

Recommendation 3. *That the NAWRDE Strategy Steering Committee supports a review by investors and providers to determine the future scale and priority information targets for Education and Extension Information Package Development capability and explore options to strengthen capability in the private sector and utilising experienced researchers, together with establishing a database of interested and available organisations and individuals containing the necessary capability.*

Recommendation 4. *That the NAWRDE Strategy Steering Committee support a cross-sectoral approach to building capability through postgraduate student training in key disciplines for animal welfare R,D&E that have low and dispersed capability (for example, Engineering Instrumentation, Humane Animal Treatment, and Animal Neurobiology) and that are reliant on accessing capabilities from the production sector or non-agriculture sector.*

Strategic partnerships to address capability gaps

Many RDCs and research providers are establishing large-scale strategic partnerships as a means of addressing important capability issues and ensuring research is focussed on priority industry issues. The rationale is to bring research agencies, funding bodies and sometimes regulatory organisations together, in either bilateral or multilateral agreements, to combine skills and resources to either deliver an integrated outcome or fill a capability gap.

There are a number of different partnership models that exist currently across a number of different agriculture sectors. Some of these have been developed to address a large issue that one organisation could not address on its own (e.g. The CRCs for dairy, beef, pork, poultry and sheep) while others have been specifically developed in response to a particular need, such as low levels of capability and capacity in a particular area (e.g. AWSC for animal welfare).

The Animal Welfare Science Centre (AWSC) is one of a small number of multi-agency R,D&E centres addressing animal welfare priorities in Australia, and provides a mechanism to coordinate R,D&E capability development in most priority areas. The AWSC has considerable R,D&E capability to address four of the six priority themes in the NAWRDE Strategy (2017), including Animal Welfare Assessment; Management, Housing and Husbandry; Attitudinal Effects on the Welfare of Livestock; and Education, Training and extension. Capability to address the other two Priority Themes (Pain Assessment and Management; Transport, Euthanasia and Slaughter) is low in the AWSC and spread across a number of R,D&E organisations. Capability to address the priority theme "pain assessment" is available in most university Veterinary faculties. The new Animal Welfare Strategic Partnership for the Red Meat industries, currently being established by Meat and Livestock Australia to address animal welfare priorities identified in the Meat Industry Strategic Plan provides a new opportunity for building and coordinating capability.

Recommendation 5. *That the NAWRDE Strategy Steering Committee:*

a. *Recognises the value and importance of multi-organisational strategic partnerships, such as the AWSC, in building capability and maintaining a critical mass to address animal welfare RD&E priorities;*
b. *Actively supports existing strategic partnerships through co-investment arrangements and long term funding agreements that provide R,D&E organisations with the funding certainty required to maintain and build capability; and*
c. *Identifies and promotes opportunities to establish new collaborative arrangements to help maintain existing capability and to fill capability gaps.*

Future trends of Research and Development Corporations

Animal welfare R,D&E is a high priority for all livestock industry RDCs and all are planning to either increase or maintain their current levels of investment in this area.

Formal and structured evaluation can be used to demonstrate effective pathways to market. However, there is little evidence that evaluation findings are being shared and used to maximum benefit. The study documented three case studies as examples of effective pathways to market demonstrating the impact of research outcomes. Evaluations can be used to identify industry outcomes and benefits and demonstrate progress towards achieving higher standards of animal welfare.

Recommendation 6. That the NAWRDE Strategy Steering Committee advocate for and support formal, independent evaluations of investments in animal welfare R,D&E, broadening the scope to include social and environmental, as well as economic, benefits and sharing the findings with all stakeholders, with a particular focus on providing guidance to Education and Extension capability and improving service delivery.

Assessment of Infrastructure and Facilities

Infrastructure and facilities available for animal welfare R,D&E appear to be adequate for virtually all of the major R,D&E organisations contacted. Whilst some organisations identified that a lack of suitable infrastructure and facilities in some areas was a concern, (for example, animal environmental chambers to measure heat stress), collaboration with other organisations to access infrastructure and facilities will likely overcome these concerns.

Recommendation 7. That the NAWRDE Strategy Steering Committee note that infrastructure and facilities were generally adequate for R,D&E, and where localised concerns arise, organisations requiring specialised facilities should be encouraged to collaborate with other organisations with those facilities.

Summary Assessment of 2017 Animal Welfare R,D&E Capability

Discipline Group	Fields Of Research	No. Researchers with some % effort directed to the Field of Research.	Total Researcher FTE	Summary capability assessment	Key needs/opportunities
Animal and Veterinary Sciences	060801 Animal Behaviour (Ethology)	33	15.55	(green)	
	099902 Engineering Instrumentation (incl. automated welfare monitoring systems)	3	0.75	(orange)	Capability available in other sectors. Build linkages
	099901 Agricultural Engineering (incl. animal housing)	0	0	(orange)	Capability available in other sectors but must incorporate knowledge of Animal Behaviour
	070201 Animal Breeding	13	4.25	(green)	
	070203 Animal Management	28	7.80	(green)	
	070299 Animal Production not elsewhere classified	12	2.65	(green)	
	070204 Animal Nutrition	13	4.20	(green)	Capability can be accessed elsewhere
	070207 Humane Animal Treatment	10	4.00	(orange)	
	070202 Animal Growth and Development	14	3.05	(green)	Capability can be accessed elsewhere
	070799 Veterinary Sciences not elsewhere classified	6	2.05	(green)	
	070701 Veterinary Anaesthesiology & Intensive Care	0	0	(orange)	No current capability. Potential for capability to be accessed elsewhere
	100101 Agricultural Biotechnology Diagnostics (incl. Biosensors)	3	0.60	(orange)	Capability available in other sectors. Build linkages
	070710 Veterinary Pharmacology	3	1.00	(orange)	Capability could be accessed in University Vet Schools.
	060805 Animal Neurobiology	6	2.45	(orange)	Capability available in other sectors. Build linkages
	070702 Veterinary Anatomy and Physiology	3	1.40	(orange)	Capability can be accessed elsewhere

				🟧	
	060899 Zoology not elsewhere classified	2	0.40	🟩	
	070711 Veterinary Surgery	1	0.20	🟩	Capability can be accessed elsewhere
Sociology and Ethics	160808 Sociology & Social Studies of Science & Technology	0	0	🟧	No current capability. Potential for capability to be accessed elsewhere although is in general in short supply
	160804 Rural Sociology	0	0	🟧	No current capability. Potential for capability to be accessed elsewhere although is in general in short supply
	220107 Professional Ethics (incl. research ethics)	3	0.30	🟧	Capability could be accessed in govt agencies and universities
	160899 Sociology not elsewhere classified	1	0.05	🟧	
	170113 Social and Community Psychology	2	0.50	🟥	Need to establish linkages with Psychology for human-animal relationship
	220199 Applied Ethics not elsewhere classified	2	0.15	🟧	
	160801 Applied Sociology, Program Evaluation and Social Impact Assessment	1	0.10	🟥	Increasing importance. Build capability in key providers including postgraduates
	179999 Psychology and Cognitive Sciences not elsewhere classified	4	1.20	🟧	
	220101 Bioethics (human and animal)	1	0.10	🟧	Capability could be accessed in govt. agencies and universities
Economics	140201 Agricultural Economics	2	0.30	🟩	Capability can be accessed elsewhere
Education & Industry Extension Development	Industry Information Packages	6	0.70	🟧	Likely require increased capacity and expertise
	130212 Science, Technology and Engineering Curriculum and Pedagogy	4	0.50	🟧	Likely require increased capacity and expertise

	200101 Communication Studies	1	0.10	Likely require increased capacity and expertise

Legend

Strong	Very good capability and capacity for future delivery in line with strategy outcomes. Capability includes good spread of age/career development, solid science standing and experienced senior leadership. Postgraduate students exist.
Well placed	Sound capability and capacity currently exists for delivery on current and near term industry outcomes but actions likely to be required to ensure capability meets medium to longer term industry requirements. Some capability is tenuous and/or gaps are emerging that require action. Continued emphasis on building experience and science standing (publications/leadership) is required. Capacity exists in other sectors of RD&E that can be readily identified and sourced
Concern	Existing capability shows weaknesses, in areas such as capacity, experience and/or development of new researchers via postgraduate training. An urgent re-assessment of required capability to meet industry outcomes is required and action initiated to address the gaps. No or limited capacity in other sectors of RD&E that can be sourced.

Contents

1.   Introduction

The (former) Primary Industries Ministerial Council (PIMC) in April 2007, with support from all research and development corporations (RDCs) and the Australian Council of the Deans of Agriculture (ACDA), agreed to establish a National Framework for Primary Industries Research, Development and Extension (the 'Framework).

The intent of the Framework was to facilitate greater coordination amongst the Commonwealth and State governments, CSIRO, RDCs, industry and university sectors to better harmonise their roles in R,D&E for Australia's primary industries and enable effective cooperation and collaboration in order to maximise the net benefits to the primary industries sectors.

The Framework includes the aim to strengthen national research capability and focus research, development and extension (R,D&E) resources so they are used more effectively, efficiently and collaboratively, thereby reducing capability gaps, fragmentation and unnecessary duplication. Under the Framework, individual agencies and organisations retain and build capability in fields strategically important to their jurisdictions and industries.

The National Animal Welfare R,D&E Strategy

PIMC endorsed the Framework in 2009 and subsequently endorsed 14 sector and 7 cross sectoral RD&E strategies under the Framework. The *National Animal Welfare R,D&E Strategy* was released in 2010.

Under the Framework, sector and cross sector strategies, such as the *National Animal Welfare R,D&E Strategy*, set out priorities for the R,D&E investors, providers and broader industry stakeholders to cooperate on a national basis to address the strategic R,D&E needs of an industry sector. The Framework prescribes that the contents of individual industry strategies should include "**Capability analysis against the plan**: Compare information from current resource analysis and the requirements to address the future R,D&E plan in order to identify future capability needs and gaps".

The 2010 *National Animal Welfare R,D&E strategy* guided investment in animal welfare R,D&E between 2010 and 2016. In 2016, the *National Animal Welfare R,D&E Strategy Steering Committee* determined that it was an appropriate time to review the priorities established in 2010 to ensure they were still relevant and appropriate in 2016 and beyond. The updated *Animal Welfare R,D&E Strategy* will be released in 2017.

Only one previous inventory of the R,D&E capability and infrastructure needs for the animal welfare industries has been undertaken (Kroker & Edge 2009) and was used to inform the National Animal Welfare R,D&E Strategy in 2010. The audit identified that there were approximately 25 organisations (including 2 in New Zealand) with 42.5 Full Time Equivalents (FTE) dedicated to animal welfare R,D&E in Australia. This includes 29 FTE identified as Researchers, 7.2 FTE identified as Research Support and 6.3 FTE identified as Extension and Education providers. They also identified 23 postgraduate students in their study. They concluded that over 40% of people involved in animal welfare R,D&E were older than 51 years and highlighted the need for succession planning to maintain R,D&E capability. They identified capability gaps in the main disciplines of animal physiology, ethology (animal behaviour),

veterinary science, psychology and animal production as applied to cross sector issues, but reported that many postgraduate students were undertaking on-going training in many of these disciplines, and that there were only potential future capability gaps emerging in animal genetics, animal production, psychology and social sciences.

In relation to infrastructure and facilities, Kroker & Edge (2009) reported that the major Fields of Research capability had adequate access to sufficient infrastructure within the participating organisations, however, there were some challenges in ensuring its availability for intended animal welfare R,D&E because most infrastructure was shared between animal production, health and welfare research and teaching priorities.

2.   Objectives

With the 2017 refresh of the *National Animal Welfare R,D&E Strategy,* the NAWRDE Strategy Steering Committee released their terms of reference to assess future research R,D&E capability and infrastructure needs and subsequently ensure effective plans are in place to retain and build the capability and infrastructure that is needed for the future. Understanding current levels of capability and identifying likely future requirements is critical to guiding the investors and partners in the *National Animal Welfare RD&E Strategy.*

A relatively small community of animal welfare researchers and consultants exists within Australia. This community may be capable of servicing the short term R,D&E requirements of Australia's livestock industries, however this existing capability needs to be assessed for its adequacy to meet the emerging animal welfare R,D&E priorities. Skill sets other than traditional animal welfare RD&E skills may be required to meet evolving RD&E requirements.

Therefore the *National Primary Industries Animal Welfare R,D&E Strategy* Steering Committee sought to undertake a detailed analysis of current and future (5 year) animal welfare R,D&E capability, identify current and emerging gaps, and develop strategies to address these gaps.

The terms of reference for this study were to:

1. With reference to the 2009 capability and infrastructure audit (contained within the AW R,D&E Strategy), update capability and infrastructure data. Capability will include scientists, research assistants, PhD students, Masters students, technical staff and consultants engaged in animal welfare R,D&E, however, investment by providers, RDCs and Governments will not form part of this audit;
2. Undertake a detailed analysis of current and future capability requirements, perform a gap analysis and deliver recommendations on processes required to address the gaps
3. Assess and document the quality of existing capability, including, but not limited to; quality of research, impact of research and age ranges of those engaged in animal welfare R,D&E;
4. Consult with key co-investors and providers to identify future capability and capacity requirements;
5. In consultation with stakeholders, recommend strategies to address capability gaps.

The Terms of Reference also noted that;

I.   The work to be performed in the project should consider Australian R,D&E that is primarily undertaken to understand and/or improve the welfare of livestock species. R,D&E which is undertaken primarily to improve the health and/or production of livestock species, which improves animal welfare as a 'by product' is not considered as part of the scope of the project
II.   The scope of extension capability and capability analysis should focus on skills available for development of animal welfare extension strategies and preparation of resources and coursework materials rather than on generic extension delivery. The "Route to Market" which RDCs and research providers take in the D&E component of research should be considered together with 'case studies' which could illustrate and inform this Strategy.

In the AgInsight proposal to conduct the animal welfare capability assessment, AgInsight listed the following assumptions, which were subsequently accepted by the National Animal Welfare R,D&E Strategy Steering Committee:

1. The R,D&E capability audit will consider researchers and infrastructure that are primarily focused on understanding and/or improving the welfare of farm livestock species. Capability and infrastructure that is primarily used to improve the health and/or production of livestock species are not considered as part of the scope of the audit.

2. The R,D&E capability and infrastructure audit will consider researchers and infrastructure that are primarily working on farm livestock animals (i.e. cattle, sheep, goats, pigs and poultry). Researchers addressing issues of companion animals (such as cats and dogs), zoo animals, wild animals (including vertebrate pest animals), fish and animals used for experimentation or recreation are not considered as part of the scope of the audit.

3. The R,D&E capability audit will consider scientists, research assistants, PhD students, Masters Students, technical staff and consultants engaged in animal welfare R,D&E. Capability and capacity engaged in policy and regulatory functions, extension delivery and consultants primarily engaged in animal health and animal management are not considered as part of the scope of the audit.

4. Extension (E) capability and capacity will focus on skills available for the development of animal welfare extension strategies and preparation of resources and coursework materials rather than on generic extension delivery. Capability and capacity of extension delivery agents *per see* are not considered as part of the scope of the audit.

3.   Methodology

To address the requirements in the Terms of Reference, the refreshed capability analysis was initially based on the Kroker & Edge (2009) methodology but with significant additionality to aid trend analysis with reference to the previous strategy, the future intentions of the major R,D&E providers, a capability gap assessment and assessment of science quality. Additional inputs generated were the future priorities and intentions of the livestock Research and Development Corporations and information where projects or programs had undergone formal evaluation. Infrastructure and facilities required for animal welfare R,D&E were also assessed.

Assessment of prior capability reviews

The approach, findings and recommendations of the Kroker & Edge (2009) capability audit were reviewed. However, it was only possible to compare summary data from Kroker & Edge (2009) that was contained in the NAWRDE Strategy (2010) as the original reports that informed the summary were not able to be located. The consequences of this is that the study team could only make high level comparisons with the findings in the original audit.

In addition to recommendations in Kroker & Edge (2009), the *National Animal Welfare R,D&E Strategy (2017)* Priority Themes were assessed, as well as the national animal welfare R,D&E priorities of the livestock Research and Development Corporations. One-on-one discussions were also held with senior representatives in each livestock RDC and with other Project Management Team members. These assessments and discussions enabled confirmation of the background, proposed approach and issues, and therefore finalised the parameters of the review.

Survey design and capability data generation

Capability surveys provide a point-in-time assessment of parameters such as scale, type, location and quality of research expertise. Such surveys contain a mixture of quantitative and qualitative data and while they are a 'snap-shot' in time, they enable comparisons in trends against past surveys, as well as an assessment of the current capability prospectively available to meet the forward R,D&E needs over the next 5- 10 years. The survey in this study was designed to capture the required information, examine changes over time by cross-comparison with the previous survey (where past data were available), and to establish a baseline for future surveys of this nature.

The survey was initially based on the methodology of Kroker & Edge (2009) but with a number of refinements to improve relevance, efficiency and clarity. An on-line survey was conducted, using the AgInsight Survey Tool © which is a searchable database (that can be extensively interrogated to a greater extent than the spreadsheet approach used in the previous survey and readily applied in future to update information). This searchable database has been used in other capability audits that we have conducted (e.g. Research capability needs of the Australian dairy industry, 2016).

As the capability survey was to collect information relating to individuals, it was necessary to ensure that both the collection and use of data complied with the Australian *Privacy Act 1988* (Privacy Act),

updated 2014. Consequently, the survey was designed to be completed by individuals (not by staff managers on behalf of staff) and included a comprehensive Privacy Notification/Collection Statement (see Appendix 2). Potential participants of the survey project were identified by;

- Advice from the Project Management Team;
- AgInsight contacting relevant organisations and asking them to forward the details of the project to relevant staff; or
- Individuals were known to be relevant to the survey (because AgInsight has prior knowledge of their involvement in animal welfare related RD&E or because of publicly available information).

An additional advantage of the requirement for the survey to be completed by individuals was the overcoming of 'double counting' that was possible where survey completion was fully or partially performed by managers. A potential shortcoming of this approach, however, was a failure of some relevant individuals to complete the survey. This latter issue was minimised by a combination of repeat invitations to the survey and consultation with key provider representatives.

The fields of data to be collected in the survey were designed to meet the requirements specified in the Terms of Reference. In addition, although the project specification was to focus on R,D&E capability and researcher quality, a further field of investigation was included to assess the degree to which researchers have capability and skills to effectively deliver research outputs to 'extension intermediaries' (such as farm management consultants).

Examples of the survey questions are shown in Appendix 3. While each question required a quantitative response (for example, number of publications, years of research experience), some questions were a qualitative self-assessment (for example, the question "How would industry and non-researchers rate your ability to deliver research outputs to extension intermediaries such as farm management consultants and non-researchers?"). These latter questions were necessarily a self-assessment to comply with privacy provisions and as such the results may tend to comprise of overly optimistic assessments, however, the results do provide a valuable insight.

To collect specific data on the R,D&E expertise currently being applied to animal welfare issues of the livestock industry, the Australian and New Zealand Standard Research Classification (ANZSRC) Fields of Research (FOR) codes were used as the underpinning basis. ANZSRC was developed for use in the collection, analysis and dissemination of research and experimental development (R&D) statistics in Australia and New Zealand.

ANZSRC was released in March 2008 and was jointly developed by the Australian Bureau of Statistics (ABS) and Statistics New Zealand (Statistics NZ), with input from many academic and research professionals, government departments, research organisations, professional associations and peak industry bodies. Although comprehensive, since 2008 there has been an increase in the appearance and use of several fields of research endeavour, particularly in fields relating to the 'omics'. Consequently, in defining the Fields of Research to be used in the animal welfare capability study, the ANZSRC codes were supplemented with additional fields considered to be relevant and important to the livestock animal welfare research. These additional fields were identified by the AgInsight Study Team, in consultation with the Project Management Team (Appendix 4) and a number of senior animal welfare research experts. The full list of the Fields of Research used can be found in Appendix 6.

Prior to release of the survey, it was tested for completeness and ease of use with the Project Management Team and a number of senior animal welfare researchers.

The organisation and individual mailing lists for the survey were built from a combination of sources including current research project lists, organisational websites, advice from the Project Management Team, organisations and delegates who attended the 6th Animal Welfare R,D&E Strategy Forum, and knowledge of the AgInsight study team and animal welfare research leaders.

The on-line survey commenced on 22nd August 2016 and was scheduled to conclude on 30th September 2016. During this period, reminders were sent to relevant organisations and/or individuals on five occasions. Although the specified completion date for the survey was 30th September, a preliminary review of the data indicated a small number of organisations had either not responded or appeared to under respond. Consequently, further follow up was required and the survey held open until 17th October 2016.

Collection and analysis of survey data

The role of a survey respondent determined in which capability analysis category their data was included. The role categories were:

1. Researchers (defined as scientists, including postgraduate students, who currently undertake original research directed at animal welfare for the primary industry sectors, with researchers being accountable for the design, conduct and reporting of research),
2. Research support (defined as research assistants, technical assistants, laboratory assistants and field assistants who assist researchers in undertaking animal welfare research), and
3. Education and industry extension package developers (defined as people who are responsible for taking the information and results from research studies and packaging this information into education packages or industry extension packages).

Within each role category, respondents were asked a number of general questions relating to their age, qualifications, current postgraduate study status (if relevant), industry focus and experience. These were then followed by a number of questions specifically relevant to their role.

For Researchers, they were then asked a series of questions relating to their experience in research leadership, science quality and science standing.

Researchers were also asked to identify one or more of three specific research Discipline Groups (Animal and Veterinary Sciences, Sociology and Ethics, and Economics). A fourth Discipline Group option was provided, "Education and Industry Extension Development" to enable Researchers to indicate the extent to which they were directly contributing to dissemination of the outputs and impact of their research. Subsequently, within each Discipline Group, a Researcher was asked to identify one or more "Fields of Research" (including FTE commitment to each) to describe their current research activity. These Fields of Research are shown in Appendix 6 and are based on the ANZSRC (2008) codes.

Research Support respondents were asked to categorise their support role (including FTE commitment) into one of four Fields of Capability (Animal management/husbandry, Field services

assistance, General laboratory assistance, Surgery assistance). Also included was an opportunity to indicate if they were involved in Education and Industry Extension Package Development.

Education and Industry Extension Package Developers were asked to categorise their role into one or more of three Discipline Groups (Science, Technology and Engineering Curriculum and Pedagogy, Communication Studies, Industry Information Packages). Subsequently, within each Discipline Group, respondents were asked to identify one or more "Fields of Capability" (including FTE commitment) to describe their current activity (Appendix 6).

The Discipline Groups used in the analysis for the present study were based on those identified by Kroker & Edge (2009) in their analysis of animal welfare RD&E capability. However, Kroker & Edge (2009) only analysed data by the number of FTEs associated with science discipline, industry sector, age profile and postgraduate students. As a result, only limited comparisons with the previous study could be made.

Individual Fields of Research were only analysed if they had 3 or more respondents or were identified as being gaps in the previous survey, by the Project Management Team or by the authors (the latter based on a review of survey responses).

Appendix 7 shows the criteria utilised in the overall summary assessment of capability. The analyses and findings are presented in Chapter 5. Full data sets on the R,D&E capability are presented in Appendix 10.

Future prospective trends of Research and Development Corporations

As major funders of animal welfare R,D&E, the livestock Research and Development Corporations (RDCs) provide the priorities and direction to enable RD&E providers to respond. An understanding of the forward planning and priorities provides valuable insights in assisting the consideration of future RD&E capability requirements, emerging gaps and strategies to be addressed.

Senior representatives in the Australian Egg Corporation Limited (AECL), Animal Health Australia (AHA), Australian Wool Innovation (AWI), Australian Pork Limited (APL), Dairy Australia (DA), LiveCorp, Meat and Livestock Australia (MLA) and RIRDC Chicken Meat were interviewed about current and future changes in priorities and investment in R,D&E, as well as any areas where they could foresee any capability gaps emerging. Information was also requested about preferred pathways to market for R,D&E projects and their approach to evaluation of these projects. Summarised information for each RDC is presented in Chapter 6.

Identification of animal welfare R,D&E priorities

The NAWRDE Strategy (2017) was being refreshed in parallel with this study. Emerging priorities were informed by the outputs from the 6th Animal Welfare R,D&E Strategy Forum (August 2016). It should be noted that the focus was upon cross-sector R,D&E priorities, and not individual sector priorities in line with the remit of the NAWRDE Strategy.

The six priority themes identified in the NAWRDE Strategy 2017 are:

1. **Animal welfare assessment** - For the whole value chain: novel methods of assessment (physiological and behavioural, remote); welfare assessment protocols; demonstration of continuous improvement in animal welfare; minimisation of negative states; positive welfare states.
2. **Pain assessment & management** - Novel methods of assessment and pain management; improvement/replacement of aversive practices.
3. **Management, housing and husbandry** - Also to include mortality and environmental enrichment.
4. **Transport, euthanasia and slaughter**
5. **Attitudinal effects on the welfare of livestock throughout the value chain**
   a. The effects of the attitudes of stockpeople, animal handlers and animal owners on the welfare of their animals,
   b. The effects of attitudes to animal welfare on consumer and community behaviour, and
   c. Effective communication between industry and the community.
6. **Education, training and extension** - Effective technology transfer; development of appropriate cross-sectoral training programs; understanding/removing barriers to adoption of new technologies and practices.

Capability gap analysis and potential methods to fill gaps

The detailed analysis of the survey data and associated information identified trends in capability and current or emerging gaps in capability. The analysis of current or emerging gaps drew on the priorities identified above. As the gaps were clarified, an assessment was made of the capability potentially available to address these gaps. This assessment comprised of two components:

1. An assessment of the gaps against the current postgraduate students (as identified in the on-line capability survey) and the identified trends in capability development and deployment of major research providers.
2. A desktop survey of major R,D&E providers nationally who prospectively possess the necessary capability but which is currently not directed towards cross sector animal welfare issues. These prospective providers were identified by the Study Team in conjunction with the Project Management Team and leaders of major R,D&E providers. The assessment was determined qualitatively based on the Study Team's knowledge, together with publicly available information available on each organisation. This was supplemented with telephone conversations with a small number of providers as necessary. Other capability exists in international R,D&E providers, especially in New Zealand, but the study Team was asked not to include these in the analysis.

Assessment of infrastructure and facilities

The major providers of R,D&E services to the animal welfare livestock industries provide the key platform for the current and future capability required to meet the sectors objectives. An understanding of these R,D&E provider's forward infrastructure and facilities planning and priorities provides a valuable insight in assisting the consideration of future infrastructure and facilities requirements, emerging gaps and strategies to fill the gaps.

Senior leaders in CSIRO, the University of Melbourne, SARDI/University of Adelaide, University of Sydney, University of Western Australia, Charles Sturt University, University of Queensland/QAAFI, University of New England, Murdoch University and DAFWA were requested to complete an inventory outlining infrastructure and facilities available for animal welfare R,D&E. This was followed by telephone interviews seeking information on prospective future changes, critical infrastructure gaps emerging and any unique facilities that they had available or could access. Summarised information is contained in Chapter 6, and the infrastructure and facilities inventory is shown in Appendix 11.

4.   R,D&E Capability and Assessment

Response rate

Invitations to participate in the on-line survey were sent to 54 organisations which resulted in 32 organisations responding (although two organisations had respondents that were not currently undertaking R,D&E) (Appendix 5). This represents an overall response rate of 62%. In consultation with the Project Management Team, we believe that all major R,D&E providers contributed to the survey.

Of the 30 organisations who were identified as currently undertaking animal welfare RD&E,

- 11 out 16 universities who were invited to participate responded,
- 6 out of 7 Government Agencies (including CSIRO) who were invited to participate responded,
- 1 out 3 CRCs who were invited to participate responded,
- 5 out of 8 RDCs who were invited to participate responded, and
- 9 out of 20 private sector organisations who were invited to participate responded.

The study Team received feedback from a small number of private sector consultants with prior involvement in animal welfare Education and Industry Extension Development who chose not to participate in the on-line survey, as they were not currently undertaking animal welfare R,D&E.

Survey responses were received from 103 individuals including 12 postgraduate students. However, eight respondents indicated that they were not currently undertaking R,D&E and were therefore excluded from the analysis. Of these 95 respondents (72.9 FTE), 68 people (55.25 FTE) identified as Researchers, 13 people (11.70 FTE) as Research Support, and 14 people (5.95 FTE) as Education and Industry Extension Package Developers. Follow-on interviews with group leaders in those organisations with more than 3 FTEs highlighted a very high response rate (>90%) to the survey by individuals in these organisations. These numbers compare very favourably with those reported by Kroker & Edge (2009) of 42.5 FTE (plus 23 postgraduate students) dedicated to animal welfare R,D&E in Australia.

4.1 Animal Welfare Researchers

Background

People defined as Researchers were scientists, including postgraduate students, who currently undertake original research directed at animal welfare for the primary industry sectors, with Researchers being accountable for the design, conduct and reporting of research.

In the capability survey of Researchers, three specific Discipline Groups for animal welfare research were used;

- Animal and Veterinary Sciences
- Sociology and Ethics
- Economics

A fourth discipline group, 'Education and Industry Extension Development', was included to ascertain the extent to which researchers were directly contributing to dissemination of the outputs and impact of their research. A brief analysis of this fourth discipline group is included in this chapter, with a more detailed analysis included in a later section of the report entitled 'Education and Industry Development'

Within each Discipline Group, specific Fields of Research capability were identified (see Table 4.2). The alignment of each Field of Research with the NAWRDE Strategy priority themes is shown in Appendix 6)

The on-line survey of researchers also included a number of questions specific to researchers to provide indicators of research quality, leadership and outputs.

Overall analysis of Animal Welfare Research Capability.

The survey recorded 68 people (including 12 current postgraduate students) who identified as Researchers. Their total animal welfare research capability commitment was 54.35 FTE (inclusive of 1.3 FTE directed to the development of Education and Industry Extension Packages).

Table 4.1 lists the organisations and associated number of researchers identified through the survey. The largest concentration of current animal welfare researchers was located at the University of Melbourne, SARDI, CSIRO and University of Queensland, each having between 6 and 11 researchers. A second group of organisations, comprising University of WA, Murdoch University, University of New England, University of Adelaide and University of Sydney each have 3 – 4 researchers.

Table 4.1 Organisation, number and FTE of Researchers who responded to the capability survey.

Organisation	Number of current animal welfare researchers	Total Animal Welfare Research FTE
Central Queensland University	1	0.3
CSIRO	7	5.8
Charles Sturt University	2	2.0
DAFWA	1	0.6
Inspiring Excellence Consulting	1	0.2
James Cook University	2	1.5
Murdoch University	3	3.0
NSW DPI	1	0.1
Pork CRC	1	0.75
Rivalea	1	1.0
SARDI	10	7.1
SunPork Farms	2	2.0
Tarwin Vet Clinic	1	0.05
Tasmania Institute Agriculture	1	1.0
Univ. Adelaide	4	2.5
Univ. New England	4	4.0

Organisation	Number of current animal welfare researchers	Total Animal Welfare Research FTE
Univ. Melbourne	11	10.5
Univ. Sydney	4	3.6
Univ. Queensland	6	4.5
Univ. Western Australia	4	2.85
Westpork	1	1.0
Total	**68**	**54.35**

The distributions of age and research experience of researchers (Figures 1 and 2) shows a good spread of experience and scope for succession. Most researchers hold postgraduate qualifications, 72% with a PhD and 12% with a Master's degree.

Figure 1. Age distribution of Researchers
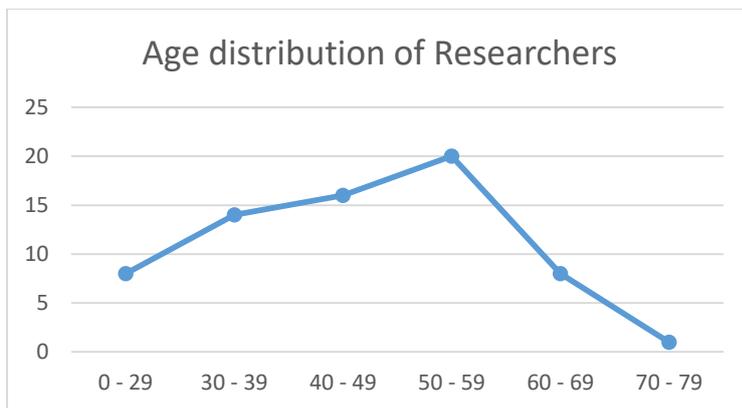
Figure 2. Years of research experience of Researchers
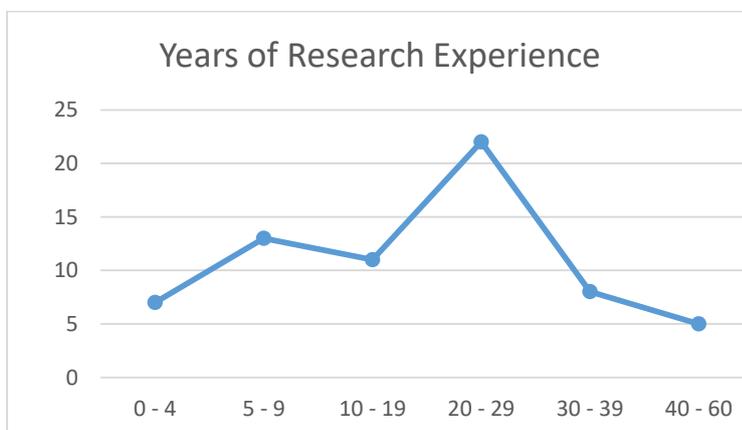
- Research leadership experience overall is moderate, with 29% of researchers having no project leadership role and just 33% of researchers leading multi-discipline projects or programs.
- Peer recognition is strong, with 31% identifying as International Experts and a further 35% as National Experts.
- Research publications are generally moderate, with over 50% of researchers having less than 30 peer reviewed publications. Only 20% of researchers have more than 60 research publications. Overall experience associated with invited conference publications is also moderate with 71% of researchers having less than 15 invited conference publications.
- Noting that almost 50% of researchers did not provide their citation index history, only 19% of researchers identified with an index greater than 15 and only 7% with an index exceeding 30.
- For two indicators of science impact, 72% of researchers did not identify instances where their research had resulted in new or revised industry codes or government outcomes in the last 5 years, and 81% did not indicate that they had provided representation on animal welfare regulatory committees. However, a significant group of 28% of researchers indicated that their research had resulted in one or more such codes and 19% indicated they had provided representation on animal welfare regulatory committees over the last 5 years. Not surprisingly, these latter people were commonly experienced researchers with significant publication records, senior research leadership roles and high levels of recognition as national or international experts by their peers.

Table 4.2 shows the number of researchers who indicated that at least a part of their animal welfare research effort was directed towards a particular Field of Research capability. The total FTE commitment to each Field of Research is also shown. A detailed assessment of specific Fields of Research capability is contained later in this chapter, however, it is evident from Table 4.2 that most research effort is directed towards the Animal and Veterinary Sciences, particularly the associated Fields of Research of Animal Behaviour and Animal Management.

Table 4.2. Discipline Groups and associated Fields of Research capability, together with number of Researchers and FTE.

Discipline Group	Fields Of Research	No. Researchers with some % effort directed to the Field of Research.	Total Researcher FTE
Animal and Veterinary Sciences	Animal Behaviour (Ethology)	33	15.55
	Engineering Instrumentation (incl. automated welfare monitoring systems)	3	0.75
	Agricultural Engineering (incl. animal housing)	0	0
	Animal Breeding	13	4.25
	Animal Management	28	7.80
	Animal Production not elsewhere classified	12	2.65

	Animal Nutrition	13	4.20
	Humane Animal Treatment	10	4.00
	Animal Growth and Development	14	3.05
	Veterinary Sciences not elsewhere classified	6	2.05
	Veterinary Anaesthesiology & Intensive Care	0	0
	Agricultural Biotechnology Diagnostics (incl. Biosensors)	3	0.60
	Veterinary Pharmacology	3	1.00
	Animal Neurobiology	6	2.45
	Veterinary Anatomy and Physiology	3	1.40
	Zoology not elsewhere classified	2	0.40
	Veterinary Surgery	1	0.20
Sociology and Ethics	Sociology & Social Studies of Science & Technology	0	0
	Rural Sociology	0	0
	Professional Ethics (incl. research ethics)	3	0.30
	Sociology not elsewhere classified	1	0.05
	Social and Community Psychology	2	0.50
	Applied Ethics not elsewhere classified	2	0.15
	Applied Sociology, Program Evaluation and Social Impact Assessment	1	0.10
	Psychology and Cognitive Sciences not elsewhere classified	4	1.20
	Bioethics (human and animal)	1	0.10
Economics	Agricultural Economics	2	0.30
Education & Industry Extension Development	Industry Information Packages	6	0.70
	Science, Technology and Engineering Curriculum and Pedagogy	4	0.50
	Communication Studies	1	0.10

All industry sectors have some level of researcher focus (Table 4.3), with the meat industries being dominant.

Table 4.3. Industry association of Researchers.

Industry Sector	No. Researchers indicating the industry as a priority	Total FTE of Researchers
Pigs	19	9.20
Sheep Meat	33	12.25
Beef	28	11.80
Wool	23	8.20

Chicken Meat	15	4.80
Dairy	13	4.40
Eggs	16	4.10
Live Export - Beef	5	0.50
Live Export - Sheep	5	0.55
Live Export - Dairy	2	0.10
Goats	2	0.10

In the following analysis of capability, each Discipline Group and associated Fields of Research capability are examined. A summary assessment table is provided at the end of this chapter.

Animal and Veterinary Sciences

The Animal and Veterinary Sciences covers all major Fields of Research with a focus on the physical, biological and engineering sciences associated with animal welfare research.

Sixty six people identified as undertaking Animal and Veterinary Sciences research, with a combined capability of 50.35 FTE, thus representing the majority of all Animal Welfare Researchers.

The industry focus of these researchers is described in Table 4.4, while the FTE capability for each specific Field of Research capability (and its organisational location) is shown in Table 4.5.

The major research capability is associated with the fields of Animal Behaviour, Animal Management, Animal Breeding, Humane Animal Treatment, Animal Nutrition and Animal Growth and Development. A detailed analysis has been made of each of these fields of research capability and considered in relation to the forward R,D&E priorities associated with the National Animal Welfare R,D&E Strategy. For most Fields of Research capability with <3.0 FTE, only summary comments are provided.

Table 4.4. Industry focus of Animal and Veterinary Science Researchers

Industry Sector	No. Researchers indicating the industry as a priority
Pigs	18
Sheep Meat	33
Beef	27
Wool	23
Chicken Meat	13
Dairy	13
Eggs	14
Live Export – Beef	4

Live Export – Sheep	5
Live Export – Dairy	2
Goats	2

Table 4.5. Organisational researcher capability in 'Animal and Veterinary Sciences'

Organisation	Animal Behaviour (Ethology)	Animal Neurobiology	Zoology not elsewhere classified	Animal Breeding	Animal Growth and Development	Animal Management	Animal Nutrition	Humane Animal Treatment	Animal Production not elsewhere classified	Veterinary Anaesthesiology and Intensive Care	Veterinary Anatomy and Physiology	Veterinary Pharmacology	Veterinary Surgery	Veterinary Sciences not elsewhere classified	Agricultural Engineering (incl. animal housing)	Engineering Instrumentation (incl. automated welfare	Agricultural Biotechnology Diagnostics (incl. Biosensors)	Total FTE
Central Queensland University																		0
CSIRO	2.75			1.65	0.10		0.05	0.80	0.05					0.05		0.05	0.20	5.70
Charles Sturt University		0.30				0.30					1.00	0.40						2.00
DAFWA				0.40		0.20												0.60
Inspiring Excellence consulting						0.20												0.20
James Cook University				0.80	0.10		0.40		0.10									1.40
Murdoch University	1.70		0.30			0.40		0.15						0.15				2.70
NSW DPI	0.10																	0.10
Pork CRC					0.30													0.30
Rivalea	1.00																	1.00
SARDI	1.30	1.50		0.75	0.75	1.15	1.05		0.30							0.10	0.10	7.00
SunPork Farms	0.95			0.25	0.40	0.30	0.10											2.00

Organisation	Animal Behaviour (Ethology)	Animal Neurobiology	Zoology not elsewhere classified	Animal Breeding	Animal Growth and Development	Animal Management	Animal Nutrition	Humane Animal Treatment	Animal Production not elsewhere classified	Veterinary Anaesthesiology and Intensive Care	Veterinary Anatomy and Physiology	Veterinary Pharmacology	Veterinary Surgery	Veterinary Sciences not elsewhere classified	Agricultural Engineering (incl. animal housing)	Engineering Instrumentation (incl. automated welfare	Agricultural Biotechnology Diagnostics (incl. Biosensors)	Total FTE
Tarwin Vet Clinic														0.05				0.05
Tasmania Institute Agriculture							0.60											0.60
Univ. Adelaide	0.50			0.20	0.30	0.40	0.70											2.10
Univ. New England	2.25					1.40			0.20									3.85
Univ. Melbourne	3.10	0.30	0.10		0.30	1.75		1.85			0.30			1.50				9.20
Univ. Sydney	0.80					0.60		0.60	0.40			0.30		0.30		0.60		3.60
Univ. Queensland	0.10				0.80	1.00	1.30		0.50			0.30	0.20				0.30	4.50
Univ. Western Australia	1.00	0.35		0.20		0.10		0.60	0.10		0.10							2.45
Westpork									1.00									1.00
Total	15.55	2.45	0.4	4.25	3.05	7.80	4.20	4.00	2.65	0	1.40	1.00	0.20	2.05	0	0.75	0.60	**50.35**

Animal Behaviour

Researchers in Animal Behaviour represent the largest field of research capability, with almost half of all researchers (33 people) identifying some time commitment to this field of research (including 8 postgraduate students). Total researcher commitment was 15.55 FTE. These researchers are located at a range of organisations (Table 4.5) with the largest concentration being at the University of Melbourne, CSIRO and University of New England.

- 33% of researchers in Animal Behaviour are in the 30 – 39 age bracket, with an even spread across all other age brackets. Research experience is also spread quite evenly from early researchers through to experienced researchers with over 40 years research. 79% of researchers hold postgraduate qualifications and there are 8 postgraduates in training.
- *Research leadership* is overall moderate, with 33% of researchers leading multi-disciplinary projects or programs. Peer recognition is quite strong with 30% of researchers identifying as International Experts and a further 33% as National Experts.
- *Science quality* as represented by invited conference papers, peer reviewed publications and citation index reflects the age and research leadership distributions. 21% of researchers have 16 or more invited conference papers, 39% have more than 60 peer reviewed publications and 24% have a citation index greater than 16. While overall moderate, there are 20% of researchers who are highly experienced in invited conference presentations (>30) and publications (>90) and 12% with a citation index exceeding 31.
- *Recognised expertise in providing advice to intermediaries* is also generally moderate, with only 21% identifying at the expert level.
- *Science impact* indicators were relatively low with only 30% of researchers identified with more than 1 instance where their R&D had resulted in new or revised industry codes or government policies in the last 5 years (6% identifying more than 4 instances) and 21% identifying as having more than 1 representation on national animal welfare regulatory committees (9% with 5 or more instances).
- Researchers identifying some or all of their research associated with Animal Behaviour were commonly also involved in one or more of a range of other research disciplines, particularly those of Animal Management, Animal Nutrition, Humane animal treatment, Animal Neurobiology, Animal Growth and Development.

For Animal Behaviour researchers, their industry associations are shown in table 4.6

Table 4.6. Industry associations of Animal Behaviour researchers.

Industry Sector	No. Researchers indicating the industry as a priority
Pigs	14
Sheep Meat	17
Beef	9
Wool	12
Chicken Meat	9
Dairy	4

Industry Sector	No. Researchers indicating the industry as a priority
Eggs	11
Live Export – Beef	3
Live Export – Sheep	2
Live Export – Dairy	1
Goats	2

Animal Behaviour research capability is a fundamental contributor to several of the NAWRDE Strategy priority themes, in particular those of 'Management, Housing and Husbandry', Animal Welfare Assessment' and 'Transport, Euthanasia and Slaughter. Current capability is assessed as strong, with a large complement of researchers located within a number of major research organisations and with wide industry linkages. Senior leadership is available with a solid group of scientists building experience, supported by new postgraduate students offering succession development.

Animal Management

Twenty eight researchers (including 7 postgraduate students) identified with the Animal Management research capability (7.8 FTE). This represents 42% of all Animal and Veterinary Science researchers involved in animal welfare.

The largest centres of Animal Management capability are located at the University of Melbourne, the University of New England, SARDI and the University of Queensland (Table 4.5).

- There is a good representation of researchers in Animal Management across all 10 year age brackets, although around 55% are aged > 50. Research experience is strong and well distributed across 10 year brackets together with 50% of researchers having 20 – 39 years of experience. 86% of researchers hold postgraduate qualifications and there are 7 postgraduates in training.

- *Research leadership* is strong, with 43% of researchers leading multi-disciplinary projects or programs. Similarly, Peer Recognition is strong with 39% of researchers identifying as International Experts and a further 29% as National Experts.

- *Science quality* as represented by invited conference papers, peer reviewed publications and citation index is moderate to strong with 21% of researchers having more than 15 invited conference papers, 50% of researchers have more than 30 peer reviewed publications (including 25% with more than 60 publications) and five researchers (18%) with a citation index greater than 16.

- *Recognised expertise in providing advice to intermediaries* is moderate, with 33% identifying at the expert level and a further 25% identifying as 'intermediate'.

- *Science impact* indicators were relatively low. Six researchers (21%) identified with between 1 and 3 instances where their R&D had resulted in new or revised industry codes or government policies in the last 5 years. Four researchers identified as having between 1 and 4 representations on national animal welfare regulatory committees and a further researcher identified with 5 – 10 such representations in the last 5 years.

- Researchers identifying some or all of their research associated with Animal Management were also involved in a range of other research disciplines, mainly Animal Behaviour, Animal Nutrition and Animal Growth and Development.

For Animal Management researchers, their industry associations are shown in table 4.7.

Table 4.7. Industry associations of Animal Management researchers.

Industry Sector	No. Researchers indicating the industry as a priority
Pigs	7
Sheep Meat	14
Beef	11
Wool	11
Chicken Meat	4
Dairy	6
Eggs	5
Live Export – Beef	2
Live Export – Sheep	1
Live Export – Dairy	1
Goats	1

Similar to Animal Behaviour, Animal Management research capability is a fundamental contributor to the NAWRDE Strategy research priorities of 'Animal Welfare Assessment' and 'Pain Assessment and Management'. Current capability is assessed as strong, with a large complement of researchers and particular strengths in research leadership and science quality. Age and research experience distributions of animal management researchers, together with on-going postgraduate development, indicates strong scope for building and retaining good capability in this field.

Animal Nutrition

Thirteen researchers (including 3 postgraduate students) identified with the Animal Nutrition research capability (4.2 FTE). This represents 20% of all Animal and Veterinary Science researchers involved in animal welfare. The researchers were predominantly located at SARDI and the University of Queensland (Table 4.5).

- Animal Nutrition researchers are predominantly in the older age brackets, 62% being aged 50 or above. Research experience is more evenly spread, with around 10% in each of the 10 year brackets from 1-10 through to 30-39. 77% of researchers hold postgraduate qualifications and there are 3 postgraduates in training.

- *Research leadership* is generally low to moderate, with 77% of researchers' leadership not extending beyond project leadership. Peer recognition is quite strong with 38% of researchers identifying as International Experts and a further 23% as National Experts.
- *Science quality* as represented by invited conference papers, peer reviewed publications and citation index is overall moderate with just 30% of researchers have 6 or more invited conference papers, 30% with more than 30 peer reviewed publications and 15% have a citation index greater than 16. While overall moderate, there are two researchers who are highly experienced in invited conference presentations (>30) and publications (>90) and one with a citation index exceeding 31.
- *Recognised expertise in providing advice to intermediaries* is quite low, with only two people (15%) identifying at the expert level.
- *Science impact* indicators were also relatively low. Just two researchers identified with 1- 3 instances where their R&D had resulted in new or revised industry codes or government policies in the last 5 years and similarly just 2 researchers identifying as having 1 - 4 representations on national animal welfare regulatory committees.
- Researchers identifying some or all of their research associated with Animal Nutrition were often also involved in other research disciplines, primarily those of Animal Management, Animal Behaviour and Animal Growth and Development.

For Animal Nutrition researchers, their industry associations are shown in table 4.8.

Table 4.8. Industry associations of Animal Nutrition researchers.

Industry Sector	No. Researchers indicating the industry as a priority
Pigs	4
Sheep Meat	6
Beef	4
Wool	4
Chicken Meat	5
Dairy	3
Eggs	4
Live Export - Sheep	1
Goats	1

The identified research capability in Animal Nutrition indicates that this capability is generally well placed for the immediate term requirements of the NAWRDE Strategy, particularly the themes of 'Management, Housing and Husbandry' and 'Transport, Euthanasia and Slaughter'. This rating may be some-what tenuous due to the reliance on scientists late in their career, relatively low levels of research leadership and indicators of science impact. A small number of postgraduates in training could strengthen this capability. Animal Nutrition expertise is, however, well represented in all livestock industry productivity research and accessing this capability to assist in animal welfare research should be readily achievable to meet future requirements.

Animal Breeding

Thirteen researchers (including 2 postgraduate students) identified with the Animal Breeding research capability (4.25 FTE). This represents 20% of all Animal and Veterinary Science Researchers involved in animal welfare.

The largest scale of animal breeding capability is located with CSIRO, followed by SARDI and James Cook University (Table 4.5).

- The age spread of researchers in Animal Breeding is quite uniform across each 10 year age bracket from 20-29 through to 60-69. Research experience is generally also spread, with a peak (30%) in the 20 – 29 years research experience. 85% of researchers hold postgraduate qualifications and there are 2 postgraduates in training.
- *Research leadership* is predominantly at the lower end, with 85% of researchers' leadership not extending beyond project leadership. Only 2 researchers lead multi-disciplinary projects or programs. Peer recognition is moderate with 23% of researchers identifying as International Experts and a further 31% as National Experts.
- *Science quality* as represented by invited conference papers, peer reviewed publications and citation index is also overall moderate. 77% of researchers have less than 15 invited conference papers, 62% have less than 30 peer reviewed publications and only 2 researchers (15%) have a citation index greater than 16. While overall moderate, there are 3 researchers who are highly experienced in invited conference presentations (>30) and two with publications exceeding 90 and a citation index exceeding 31.
- *Recognised expertise in providing advice to intermediaries* is low, with only one researcher identifying at the expert level.
- *Science impact* indicators were relatively low. Just three (23%) researchers identified with between 1 and 3 instances where their R&D had resulted in new or revised industry codes or government policies in the last 5 years and no researchers identifying as having representation on national animal welfare regulatory committees.
- Researchers identifying some or all of their research associated with Animal Breeding were also involved in other research disciplines, mainly Animal Behaviour and Animal Management.

For Animal Breeding researchers, their industry associations are shown in table 4.9.

Table 4.9. Industry associations of Animal Breeding researchers.

Industry Sector	No. Researchers indicating the industry as a priority
Pigs	3
Sheep Meat	9
Beef	9
Wool	8
Chicken Meat	1
Dairy	1
Eggs	1

Similar to the assessment of Animal Nutrition capability, the survey results indicate that the capability in Animal Breeding is generally well placed for the immediate term requirements of the NAWRDE

Strategy ('Management, Housing and Husbandry' theme). A sound base of age distribution and research experience (including a small number of postgraduates) exists, although research leadership and science quality indicators could be enhanced. However, animal breeding research capability is strongly available in most animal industries for productivity research priorities and accessing this capability to assist in animal welfare research should be readily achievable to meet future requirements.

Humane Animal Treatment

Ten researchers (including 2 postgraduate students) identified with the Humane Animal Treatment research capability (4.0 FTE). This represents 15% of all Animal and Veterinary Science researchers involved in animal welfare.

The largest scale of Humane Animal Treatment capability is located with the University of Melbourne, with smaller capability at CSIRO, University of Sydney, University of WA, SARDI and Murdoch University (Table 4.5).

- The age spread of researchers in Humane Animal Treatment is concentrated in the 30 – 39 (40%) and 50 – 59 (30%) age brackets. Research experience is generally also spread, with a peak (30%) in the 20 – 29 years research experience. 90% of researchers hold postgraduate qualifications and there are 2 postgraduates in training.
- *Research leadership* is moderate, with 60% of researchers' leadership not extending beyond project leadership and 40% leading multi-disciplinary projects or programs. Peer recognition is also moderate with 20% of researchers identifying as International Experts and a further 50% as National Experts.
- *Science quality* as represented by invited conference papers, peer reviewed publications and citation index is also relatively low with 70% of researchers have less than 5 invited conference papers and just one with more than 30. Only two researchers have more than 30 peer reviewed publications and only 2 researchers have a citation index greater than 16.
- *Recognised expertise in providing advice to intermediaries* is low, with only one researcher identifying at the expert level and one identifying as 'intermediate'.
- *Science impact* indicators were also relatively low. Just two researchers identified with between 1 and 3 instances where their R&D had resulted in new or revised industry codes or government policies in the last 5 years and one identified with 9 – 12 instances. Just one researcher identified as having representation on national animal welfare regulatory committees (albeit with 5 – 10 instances in the last 5 years).
- Researchers identifying some or all of their research associated with Animal Breeding were also involved in other research disciplines, mainly Animal Behaviour.

For Humane Animal Treatment researchers, their industry associations are shown in table 4.10.

Table 4.10. Industry associations of Humane Animal Treatment researchers.

Industry Sector	No. Researchers indicating the industry as a priority

Pigs	3
Sheep Meat	7
Beef	3
Wool	4
Chicken Meat	3
Dairy	2
Eggs	1
Live Export – Beef	3
Live Export – Sheep	2
Live Export – Dairy	1

Humane Animal Treatment research capability is a key contributor to the NAWRDE Strategy priorities, particularly the themes of 'Pain Assessment and Management', Management, Housing and Husbandry' and 'Transport, Euthanasia and Slaughter'. Growing market and community concerns are likely to necessitate increasing demand for this capability. The results from the capability assessment suggest that current capability is generally well placed for current requirements, but likely to be a concern for adequacy for intermediate and longer term needs. Age and research experience distributions generally show a developing group of researchers, with only a small number of new postgraduates to support future growth in capability. Increasing the scale of capability, research leadership skills and opportunities to participate in development of industry codes and regulatory committees should be priorities.

Animal Growth and Development

Fourteen researchers (including 3 postgraduate students) identified with the Animal Growth and Development research capability (3.05 FTE). The largest scale of Animal Growth and Development capability is located with SARDI and the University of Queensland (Table 4.5).

- The age brackets of 30 – 39 and 50 – 59 (29% and 36% respectively) contain the largest number of researchers. Research experience is spread quite uniformly across ten year brackets, a small peak (29%) in the 20 – 29 years research experience. 90% of researchers hold postgraduate qualifications and there are 3 PhD postgraduates in training.
- *Research leadership* experience is moderate with 71% of researchers' leadership not extending beyond project leadership, although these people are supported by 4 researchers leading multi-disciplinary projects or programs. Peer recognition is reasonably strong with 29% of researchers identifying as International Experts and a further 36% as National Experts.
- *Science quality* as represented by invited conference papers, peer reviewed publications and citation index is also overall low - moderate. 85% of researchers have less than 15 invited conference papers, only 4 (29%) of researchers have more than 30 peer reviewed publications (although 3 of these researchers have over 90 publications) and only 2 researchers (15%) have a citation index greater than 16.
- *Recognised expertise in providing advice to intermediaries* is low, with only two researchers identifying at the expert level and four at the intermediate level.

- *Science impact* indicators were relatively low. Just three (21%) researchers identified with between 1 and 3 instances where their R&D had resulted in new or revised industry codes or government policies in the last 5 years and just one researcher identifying as having representation on national animal welfare regulatory committees (between 1 and 4 in the last 5 years).
- Researchers identifying some or all of their research associated with Animal Growth and Development were also involved in several other research disciplines, mainly Animal Nutrition, Animal Behaviour and Animal Management.

For Animal Growth and Development researchers, their industry associations are shown in table 4.11, with a strong focus being for the pig and poultry industries.

Table 4.11. Industry associations of Animal Growth and Development researchers.

Industry Sector	No. Researchers indicating the industry as a priority
Pigs	7
Sheep Meat	5
Beef	5
Wool	3
Chicken Meat	5
Dairy	2
Eggs	4
Live export sheep	1
Goats	1

The survey results indicate that the capability in Animal Growth and Development is generally well placed for the immediate term requirements of the NAWRDE Strategy. A small cohort of researchers exist with an overall moderate research leadership and science standing although access does exist to 2 or 3 very senior experienced people. If additional capability is required, animal growth and development research capability is strong and available in most animal industries for productivity research priorities and accessing this capability to assist in animal welfare research should be achievable to meet future requirements.

Animal Neurobiology

Six researchers (no postgraduates) identified with the Animal Neurobiology research capability (2.45 FTE). The largest scale of Animal Neurobiology capability (Table 4.5) is located with SARDI (two people, 1.5 FTE), with the University of Western Australia also recording two people (0.35 FTE).

- The age brackets of 30 – 39 and 50 – 59 each contain 33% of researchers, with the balance equally in the 40 – 49 and 60 – 69 year brackets. Research experience peaks with 33% in the 20 – 29 years research experience, with equal numbers in all other brackets. All researchers hold PhD qualifications.

- *Research leadership* experience is strong with over 80% of researchers' leadership at the multi-discipline project leadership or program leadership levels. Peer recognition is also strong with over 80% of researchers identifying as International Experts.
- *Science quality* as represented by invited conference papers, peer reviewed publications and citation index is strong. 50% of researchers have more than 31 invited conference papers, 83% of researchers have more than 30 peer reviewed publications, including 50% with over 90 publications. 66% of researchers have a citation index greater than 16.
- *Recognised expertise in providing advice to intermediaries* is also strong, with four researchers (66%) identifying at the expert level.
- *Science impact* indicators were relatively moderate. One researcher identified with between 4 and 8 instances where their R&D had resulted in new or revised industry codes or government policies in the last 5 years, although three researchers identified as having representation on national animal welfare regulatory committees (two between 1 and 4 and one between 5 and 10 instances) in the last 5 years.
- Researchers identifying some or all of their research associated with Animal Neurobiology were also involved in several other research disciplines, particularly Animal Behaviour, Veterinary Pharmacology and Veterinary Anatomy and Physiology.

For Animal Neurobiology researchers, their industry associations are shown in table 4.12, with a strong focus being for the pig and poultry industries.

Table 4.12. Industry associations of Animal Neurobiology researchers.

Industry Sector	No. Researchers indicating the industry as a priority
Pigs	3
Sheep Meat	5
Beef	1
Wool	2
Chicken Meat	3
Dairy	2

The survey results indicate that the capability in Animal Neurobiology is generally well placed, although relatively small at 2.45 FTE, for the future requirements of the NAWRDE Strategy priority theme of 'Pain Assessment and Management'. The capability currently available is experienced with strong research leadership and science standing and there should be opportunities for seeking to attract additional capacity from capability that is currently associated with other sectors, such as domestics animals. Building future capability through postgraduates would be advantageous.

Engineering Instrumentation (including automated welfare monitoring systems), Agricultural Biotechnology Diagnostics (including biosensors) and Veterinary Anatomy & Physiology.

These three Fields of Research recorded limited current capability, yet all three could be increasingly valuable contributors to research for the AWRDE Strategy themes of 'Animal Welfare Assessment' and 'Management, Housing and Husbandry and 'Transport, Euthanasia and Slaughter'.

Engineering Instrumentation recorded three people (two postgraduates) with a total of 0.75 FTE, including one person, a postgraduate at the University of Sydney, at 0.6 FTE. The industry focus for these researchers was recorded as wool, sheep meat and beef.

Agricultural Biotechnology Diagnostics recorded three people (no postgraduates), with a total of 0.6 FTE. These people were predominantly mid-career researchers, aged 30 – 49 years, 10 – 29 years research experience, good peer recognition (two national experts, one international expert) and two people had 1 – 4 representations on Regulatory Committees in the last 5 years. The industry focus for these researchers was recorded as wool, sheep meat, chicken meat and eggs, pigs, goats and beef.

Veterinary Anatomy and Physiology also recorded three people (no postgraduates) with a total of 1.4 FTE, including one person at Charles Sturt University at 1.0 FTE. Two people were aged 50 – 59 and one 30 – 39. The experience of these researchers ranged from one early career scientist through to one highly experience, well published and internationally recognised scientist. The industry focus across these researchers was recorded as pigs, chicken meat, eggs, sheep meat and live export – sheep.

For each of these Fields of Research, the limited current capability could be considered a concern, however, capability in each of these fields does exist widely in the non-agriculture sectors and in many agricultural production research fields. Consequently, building linkages with these other sectors should enable access to the necessary research capability.

Veterinary Anaesthesiology & Intensive Care, Veterinary Pharmacology.

These two Fields of Research can be valuable contributors to research for the NAWRDE Strategy themes of 'Pain Assessment & Management' and 'Transport, Euthanasia and Slaughter'.

No researchers identified with Veterinary Anaesthesiology.

Veterinary Pharmacology recorded three people (no postgraduates), with a total of 1.0 FTE. These people were predominantly well experienced scientists, aged 40 – 59 years, mainly 20+ years research experience, peer recognition at national and international expert levels, together with good publication and invited conference paper records. The industry focus across these researchers was recorded as beef, wool, sheep meat and dairy.

For both of these fields, strong capability exists within all University Veterinary Faculties. Building linkages and raising awareness of the research needs and priorities for the agriculture animal welfare sector will provide opportunities for accessing the required capability.

Sociology and Ethics

For all the animal based agricultural industry sectors, central to the identification and prioritisation of animal welfare R,D&E is an understanding of;

- The attitudes to animal welfare of animal owners and all people involved in the handling of animals along the production and marketing chain
- The attitudes to animal welfare of consumers and the broader community, who determine the 'social licence to operate' for the animal based industries.

The Sociology and Ethics Discipline Group incorporates important Fields of Research capability for developing this understanding and thereby supporting the NAWRDE Strategy theme of 'Attitudinal Effects on the Welfare of Livestock throughout the Value Chain'.

Ten researchers (no postgraduate students) identified with research capability for Sociology and Ethics (2.40 FTE), with the largest capability at the University of Melbourne, followed by the University of Adelaide (Table4.13). Except for one person at the University of Melbourne who identified with a 1.0 FTE focus on Sociology and Ethics, all other researchers indicated their capability focus on Sociology and Ethics was <0.4FTE and commonly only 0.10 FTE.

As the total capability in Sociology and Ethics was small, with limited capability in each specific Field of Research (refer Table 4.13), the discipline group is analysed as a whole only.

- The age spread of researchers in Sociology and Ethics is concentrated (40%) in the 50 – 59 age bracket, with 20% in each of the 30 – 39, 40 – 49 and 60-69 age brackets. Research experience peaks (40%) in the 20 – 29 years research experience, with a further 20% having > 30 years of experience and 40% <20 years of experience. 90% of researchers hold postgraduate qualifications.
- *Research leadership* is strong, with 50% of researchers leading multi-disciplinary projects or programs. Peer recognition is moderate with 20% of researchers identifying as International Experts and a further 50% as National Experts.
- *Science quality* as represented by invited conference papers, peer reviewed publications and citation index is moderate to strong with 30% of researchers having more than 15 invited conference papers and 50% of researchers having more than 30 peer reviewed publications. Two researchers have a citation index greater than 16.
- *Recognised expertise in providing advice to intermediaries* is moderate, with three (30%) of researchers identifying at the expert level but only a further one researcher identifying at the 'intermediate' level.
- *Science impact* indicators were also moderate. Just two researchers identified with between 1 and 3 instances where their R&D had resulted in new or revised industry codes or government policies in the last 5 years and one identified with 9 – 12 instances. One researcher identified as having representation on national animal welfare regulatory committees (with 5 – 10 instances in the last 5 years).
- Researchers identifying some or all of their research associated with Sociology and Ethics were also involved in other research disciplines, mainly Animal Behaviour and Humane Animal Treatment.

Table 4.13. Organisational researcher capability in 'Sociology and Ethics'

Organisation	Applied Sociology, Program Evaluation and Social Impact Assessment	Rural Sociology	Sociology and Social Studies of Science and Technology	Sociology not elsewhere classified	Social and Community Psychology	Psychology and Cognitive Sciences not elsewhere classified	Bioethics (human and animal)	Professional Ethics (incl. research ethics)	Applied Ethics not elsewhere classified	Total FTE
Central Queensland University					0.30					0.30
CSIRO				0.05						0.05
Charles Sturt University										0
DAFWA										0
'Inspire Excellence'										0
James Cook University										0
Murdoch University								0.10		0.10
NSW DPI										0
Pork CRC									0.10	0.10
Rivalea										0
SARDI										0
SunPork Farms										0
Tarwin Vet Clinic										0
Tasmania Institute Agriculture								0.10		0.10
Univ. Adelaide					0.20	0.10		0.10		0.40
Univ. New England										0
Univ. Melbourne	0.10					1.05			0.05	1.20
Univ. Sydney										0
Univ. Queensland										0
Univ. Western Australia					0.05	0.10				0.15
Westpork										0
Total	0.10	0	0	0.05	0.50	1.20	0.10	0.30	0.15	**2.40**

For Sociology and Ethics researchers, their industry associations are shown in table 4.14.

Table 4.14. Industry associations of Sociology and Ethics researchers.

Industry Sector	No. Researchers indicating the industry as a priority
Pigs	5
Sheep Meat	5
Beef	3
Wool	4
Chicken Meat	4
Dairy	4
Eggs	4
Live Export - Beef	4
Live Export - Sheep	2
Live Export - Dairy	1

An understanding of, and utilisation of, expertise in Sociology to assist the identification, prioritisation, conduct and delivery of research is increasing across most agricultural industry sectors (for all research interests, including productivity, sustainability and market access issues). Available capability for the agricultural sectors, particularly from the university sector (such as Melbourne University, University of Southern Queensland, and University of Adelaide) is increasing, although so is demand. Animal welfare R,D&E priorities are heavily driven by market and community perceptions, views and values. Sociology and Ethics capability is thus a key contributor now and increasingly into the future. This is recognised in the NAWRDE Strategy priorities, particularly 'Attitudinal effects on animal welfare'.

The current capability assessment indicates that Sociology and Ethics capability is a concern. A capability of only 2.40 FTE, with no postgraduates in training, an ageing team (60% over 50 years of age) and fragmented across many people and locations is unlikely to be adequate for current NAWRDE Strategy priorities nor those of the future. Although Sociology research capability does exist in Australia supporting agricultural sector productivity issues and non-agricultural sectors, the capability is in high demand and building linkages with these groups together with developing new animal welfare focussed capability including postgraduate training will be of high importance.

Agricultural Economics

Economics assessment of the costs and benefits to farm businesses and the broader community arising from new technologies and management practices is an important contributor to the prioritisation, design and conduct of R,D&E.

Only two researchers (no postgraduate students) identified with Agricultural Economics research capability (0.30 FTE), with one person at the Tasmanian Institute of Agriculture and one at the Pork CRC (Table 4.15).

For both of the researchers identifying with Agricultural Economics, this discipline was not their major animal welfare research focus and consequently a detailed assessment of their research experience and standing here is not warranted. In summary, the two researchers differ, often markedly, in their publication levels, research leadership roles and postgraduate qualifications. Neither researcher

identified with instances where their R&D had resulted in new or revised industry codes or government policies in the last 5 years or as having representation on national animal welfare regulatory committees.

One researcher was solely focussed on the pig industry and the other solely on the dairy industry.

Overall, the presence of a very small capability in agricultural economics research associated with animal welfare could be seen as a significant capability gap. Such economics research is a key input in understanding issues such as the costs and benefits associated with new practices or community expectations on farm profitability and sustainability. However, it should be noted that a capability survey is a snapshot in time and economics research input may be relatively transient in comparison with the more fundamental capabilities associated with the Animal and Veterinary Sciences. Across the major universities involved in animal welfare research, as well as CSIRO, there is considerable resources in agricultural economics that can be drawn upon to assist with animal welfare R,D&E. The current capability assessment does indicate a potential gap in the application of economics research and should at least flag the need for careful assessment of the extent of its inclusion in future animal welfare R,D&E projects.

Table 4.15. Organisational researcher capability in 'Agricultural Economics' and in 'Education and Industry Extension Package Development'

Organisation	Agricultural economics FTE		Industry Information Packages FTE	Communication Studies FTE	Science, Technology and Engineering Curriculum and Pedagogy FTE
Central Queensland University					
CSIRO			0.05		
Charles Sturt University					
DAFWA					
'Inspire Excellence'					
James Cook University					0.10
Murdoch University					0.20
NSW DPI					
Pork CRC	0.15		0.20		
Rivalea					
SARDI			0.10		
SunPork Farms					
Tarwin Vet Clinic					
Tasmania Institute Agriculture	0.15		0.15		

Organisation	Agricultural economics FTE		Industry Information Packages FTE	Communication Studies FTE	Science, Technology and Engineering Curriculum and Pedagogy FTE
Univ. Adelaide					
Univ. New England					0.15
Univ. Melbourne			0.10		
Univ. Sydney					
Univ. Queensland					
Univ. Western Australia			0.10	0.10	0.05
Westpork					
Total	0.30		0.70	0.10	0.50

Education and Industry Extension Development by Researchers

Researchers are, naturally, well placed to have a detailed knowledge and understanding of current research outputs and their prospective application by industry. Consequently, researchers can, and arguably should, be involved in the preparation of Education and Industry Extension Development packages.

Ten (of 68) Researchers were identified as contributing capability to Education and Industry Extension Package Development in the fields shown in Table 4.15. These Researchers are predominantly associated with universities (being one each from University of Melbourne, James Cook University, Murdoch University; two each from University of New England and University of Western Australia; and one each from the agencies SARDI, TIA, Pork CRC).

The researchers involved are predominantly highly qualified, with significant research experience including high level peer recognition and extensive publications and conference presentations).

50% of the researchers involved had 10-19 years of experience in Education and Industry Extension Package Development and 30% identified as being recognised by industry as being experts in package development.

Overall, the limited number and small current FTE commitment by Researchers to Education and Industry Extension Development packages suggests that there is a capability available that might be more effectively engaged.

Researcher Skills in Interfacing with Industry Advisory Intermediaries

The approach to the provision of technology advice to industry is undergoing significant change as public sector agencies progressively withdraw from 'extension' services, the number of private sector farm management consultants increases and industry bodies take on more roles for providing farmer interfaces for knowledge and information dissemination. In this changing environment, one increasingly important aspect is the need for, and ability of, researchers to effectively interface with Industry Advisory Intermediaries (such as Farm Management Consultants, Industry staff) and provide information on their research activities, outputs and the potential impacts on farm activities.

Survey researcher respondents were asked to rate themselves against the question 'How industry advisors and non-researchers would describe you for your ability and experience in translating research information to them in an easily understood style'. The survey provided respondents with three options: Industry Recognised Expert; Intermediate, and; Developing.

In this survey, 15 researchers (22% of all researchers) rated themselves as 'Industry Recognised Experts', while a further 10 researchers (15%) rated themselves as 'Intermediate'.

Table 4.16. Characteristics of researchers identifying as "Industry Recognised Experts"

	Number of researchers identifying as "Industry Recognised Experts"
Gender	
Female	3
Male	12
Age Bracket	
0 – 29	0
30 – 39	2
40 – 49	3
50 – 59	6
60 – 69	4
70 – 79	0
Research Experience yrs	
0 – 4	0
5 – 9	1
10 – 19	3
20 – 29	4
30 – 39	5
40 – 60	2
Leadership	
Researcher	1
Project Leadership	3
Multi Discipline Project Leadership	2
Program Leadership	4
Multi Agency Program Leadership	5

Peer Recognition	
Local Expert	1
National Expert	2
International Expert	11
Invited Conference Papers	
0 – 5	5
6 – 15	5
16 – 30	0
31 – 1000	5
Publications	
0 – 10	2
11 – 30	3
31 – 60	4
61 – 90	0
91 – 1000	6
Years in Education Development	
0 – 4	7
5 – 9	0
10 – 19	2
20 – 29	3
30-39	3

It is evident that the people who identified as 'Industry Recognised Experts' primarily are those who are the most experienced researchers, commonly being aged 40+, 20+ years research experience, senior research leadership roles and very high publication rates and scientific peer recognition.

An examination of the data for people who identified as 'intermediate', shows that there is only a small cohort (15 % of researchers) and interestingly 90% of these researchers are aged over 40 and 70% have more than 20 years research experience. Younger and mid-career researchers tended to predominantly rate themselves in the lowest category of 'developing'.

As new extension models evolve, it is highly likely that there will be a growing need for access to researchers who can effectively interface with Industry Advisory staff. The qualitative results from the present study suggest there is a small number of such people available from amongst the senior researchers, with an even smaller number of researchers coming through with these skills. To expand the number of suitable researchers, particularly in the short to medium term, emphasis could be placed on the cohort of mid-career researchers but this would require a planned and perhaps structured approach. Structured approaches are commonly applied in building skills and experience for researchers in delivering presentations to science peers (e.g. science conferences) and a similar approach should be successful particularly if designed and implemented jointly by research organisations and industry and implemented from university training and throughout early career development.

Postgraduates

All the postgraduates identified in the current capability assessment (12) were associated with the Animal and Veterinary Sciences. Their Fields of Research and Industry association are shown in Tables 4.17 and 4.18.

Table 4.17. Fields of Research for current postgraduate student studies.

Fields Of Research	No. Postgraduate students with some % effort directed to the Field of Research	Total FTE
Animal Behaviour (Ethology)	8	5.45
Engineering Instrumentation (incl. automated welfare monitoring systems)	1	0.05
Animal Breeding	2	0.20
Animal Management	7	3.70
Animal Production not elsewhere classified	1	0.20
Humane Animal Treatment	2	0.75
Animal Nutrition	3	0.95
Animal Growth and Development	3	0.70

Table 4.18. Industry association (relevance of thesis) for animal welfare postgraduate students

Industry Sector	No. postgraduate students with some % effort of their study directed to the industry	Total FTE
Pigs	1	1.00
Wool/Sheep Meat	7	6.80
Beef	2	1.20
Chicken Meat	2	2.00
Dairy	1	1.00

The results in Tables 4.17 and 4.18 highlight that current postgraduate training is predominantly occurring in the Fields of Research of Animal Behaviour and Animal Management, two fields that are comparatively well resourced by existing researchers. It is noteworthy that there is a lack or shortage of postgraduates in a number of the key capabilities required for the updated NAWRDE Strategy priority themes, such as Animal Neurobiology, Engineering Instrumentation, Humane Animal Treatment and Sociology and Ethics.

In the capability assessment conducted at the time of the original Animal Welfare R,D&E Strategy, it was reported that there were 23 postgraduate students (neither industry association or fields of research focus were reported). Results from the current capability assessment would indicate a decline in postgraduate training.

Overall, it is questionable if the current level of postgraduate training is sufficient to meet the growing and future demand for animal welfare R,D&E. Additionally, indications are that the current Fields of Research focus of postgraduates (and possibly the industry associations) will not adequately address current and emerging capability gaps.

Assessment of Animal Welfare Research Capability against Priority Themes in the NAWRDE Strategy.

The preceding analysis in this chapter provides an assessment of the status of capability for individual Fields of Research relevant to animal welfare R,D&E for the NAWRDE Strategy. A summary overview is provided in Table 4.19.

Based upon the analysis of specific Fields of Research and the key relevance of each Field of Research to a NAWRDE Strategy theme (as shown in Appendix 6), the overall researcher capability indicates;

Animal Welfare Assessment theme:

Existing capability, primarily through Animal Behaviour expertise, is strong however increased access to capability associated with fields such as automated welfare monitoring systems and biosensors will be necessary to meet the objectives of this theme. This additional capability exists in other RD&E sectors (both agriculture and non-agriculture) and should be accessible.

Pain Assessment & Management theme:

Existing capability is generally well placed, although there are multiple, relevant Fields of Research capability (for example Veterinary Anaesthesiology, Pharmacology, Neurobiology) that will need to developed or accessed from other RD&E sectors to meet the likely capacity requirements to achieve the themes' objectives. Expanded capability in Humane Animal Treatment is likely to be required.

Management, Housing & Husbandry theme:

Of all the NAWRDE Strategy priority themes, the 'Management, Housing & Husbandry theme' is best placed to achieve its objectives based upon current animal welfare researcher capability. Most of the key relevant Fields of Research are strong and readily available.

Transport, Euthanasia & Slaughter theme:

This theme shares key relevant capability requirements with several other themes, particularly 'Animal Welfare Assessment', 'Pain Assessment & Management' and 'Management Housing & Husbandry'. Consequently, is has strong capability in a number of key fields, such as Animal Behaviour, Animal Management and Animal Nutrition. However, meeting the objectives of this theme will, in concert with other themes, require accessing several key capabilities from other RD&E sectors, such as for welfare monitoring, engineering/housing and humane animal treatment.

Attitudinal Effects on the Welfare of Livestock throughout the Value Chain theme:

Of all the NAWRDE Strategy themes requiring researcher capability, the results from the capability survey would suggest that this theme warrants greatest consideration for the adequacy of capability to meet the immediate and near term priorities of the NAWRDE Strategy. The key capabilities required for this theme are all contained within the 'Sociology and Ethics' discipline group. Total current capability is limited and increased capacity will be required. There is potential capacity in the social sciences in several government departments and universities, however, social science capability is increasingly being sought by the agricultural production sector (particularly in the design and development of new extension delivery models and for research design and prioritisation). Consequently, the ease and assuredness of being able to access the necessary capability from other RD&E sectors needs further investigation.

There are indications that this theme is of increasing importance for the NAWRDE Strategy. It is also noteworthy that this theme will be highly interactive and contributory to all other themes of the strategy.

Education, Training & Extension theme:

This theme is of comparatively lower priority with respect to researcher capability, with the key capability being provided by non-researchers. However, researchers can provide a valuable degree of supporting capability. The results from the capability survey indicate that a small percentage of current animal welfare researchers directly participate in this theme and thus opportunities exist for broadening researchers' engagement and skills to support the theme.

Summary assessment of Animal Welfare Researcher Capability

Table 4.19 summarises the Discipline Groups and associated Fields of Research, together with the number, FTE and summary capability assessment of Researchers currently undertaking animal welfare R&D.

Table 4.19. Discipline Groups and associated Fields of Research, together with the number, FTE and summary capability assessment of Researchers currently undertaking animal welfare R&D.

Discipline Group	Fields Of Research	No. Researchers with some % effort directed to the Field of Research.	Total Researcher FTE	Summary capability assessment	Key needs/opportunities
Animal and Veterinary Sciences	Animal Behaviour (Ethology)	33	15.55	🟩	
	Engineering Instrumentation (incl. automated welfare monitoring systems)	3	0.75	🟧	Capability available in other sectors. Build linkages
	Agricultural Engineering (incl. animal housing)	0	0	🟧	Capability available in other sectors but must incorporate knowledge of Animal Behaviour
	Animal Breeding	13	4.25	🟩	
	Animal Management	28	7.80	🟩	
	Animal Production not elsewhere classified	12	2.65	🟩	
	Animal Nutrition	13	4.20	🟩	Capability can be accessed elsewhere
	Humane Animal Treatment	10	4.00	🟧	
	Animal Growth and Development	14	3.05	🟩	Capability can be accessed elsewhere
	Veterinary Sciences not elsewhere classified	6	2.05	🟩	
	Veterinary Anaesthesiology & Intensive Care	0	0	🟧	No current capability. Potential for capability to be accessed elsewhere
	Agricultural Biotechnology Diagnostics (incl. Biosensors)	3	0.60	🟧	Capability available in other sectors. Build linkages
	Veterinary Pharmacology	3	1.00	🟧	Capability could be accessed in University Vet Schools.
	Animal Neurobiology	6	2.45	🟧	Capability available in other sectors. Build linkages
	Veterinary Anatomy and Physiology	3	1.40	🟧	Capability can be accessed elsewhere

	Zoology not elsewhere classified	2	0.40	🟩	
	Veterinary Surgery	1	0.20	🟩	Capability can be accessed elsewhere
Sociology and Ethics	Sociology & Social Studies of Science & Technology	0	0	🟧	No current capability. Potential for capability to be accessed elsewhere although is in general in short supply
	Rural Sociology	0	0	🟧	No current capability. Potential for capability to be accessed elsewhere although is in general in short supply
	Professional Ethics (incl. research ethics)	3	0.30	🟧	Capability as required could be accessed in govt agencies and universities
	Sociology not elsewhere classified	1	0.05	🟧	
	Social and Community Psychology	2	0.50	🟥	Need to establish linkages with Psychology for human-animal relationship
	Applied Ethics not elsewhere classified	2	0.15	🟧	
	Applied Sociology, Program Evaluation and Social Impact Assessment	1	0.10	🟥	Increasing importance. Build capability in key providers including postgraduates
	Psychology and Cognitive Sciences not elsewhere classified	4	1.20	🟧	
	Bioethics (human and animal)	1	0.10	🟧	Capability as required could be accessed in govt agencies and universities
Economics	Agricultural Economics	2	0.30	🟩	Capability can be accessed elsewhere
Education & Industry Extension Development	Industry Information Packages	6	0.70	🟧	Likely require increased capacity and expertise
	Science, Technology and Engineering Curriculum and Pedagogy	4	0.50	🟧	Likely require increased capacity and expertise

	Communication Studies	1	0.10		Likely require increased capacity and expertise

Legend

Strong	Very good capability and capacity for future delivery in line with strategy outcomes. Capability includes good spread of age/career development, solid science standing and experienced senior leadership. Postgraduate students exist.
Well placed	Sound capability and capacity currently exists for delivery on current and near term industry outcomes but actions likely to be required to ensure capability meets medium to longer term industry requirements. Some capability is tenuous and/or gaps are emerging that require action. Continued emphasis on building experience and science standing (publications/leadership) is required. Capacity exists in other sectors of RD&E that can be readily identified and sourced
Concern	Existing capability shows weaknesses, in areas such as capacity, experience and/or development of new researchers via postgraduate training. An urgent re-assessment of required capability to meet industry outcomes is required and action initiated to address the gaps. No or limited capacity in other sectors of RD&E that can be sourced.

4.2 Education and Industry Extension Package Developers

Background

Education and Industry Extension Package Developers are people (including academics, government staff, industry and private providers) who are responsible for taking the information and results from research studies and packaging this information into education packages or industry extension packages. The focus of the capability assessment is the capability associated with the development of the information packages, it DOES NOT include assessment of the capability available for front-line extension delivery, such as the delivery of specific information to farmers.

Education and Industry Extension Package Development assessment comprised of three Fields of capability;

- Science, Technology and Engineering Curriculum and Pedagogy; referring to the development of the content and teaching methods for animal welfare subjects delivered by teaching institutions and/or organisations
- Communication studies; referring to consideration of how information is delivered (such as face-to-face conversations, mass media approaches) and how messages are interpreted.
- Industry Information packages; referring to the specific development of information packages developed from research outputs that are subsequently utilised by educators, advisors and extension personnel in delivering animal welfare advice to end users, such as farmers, farm management consultants.

Overall analysis of Education and Industry Extension Package Development capability.

The survey recorded 14 people (no current postgraduate students) who identified specifically as Education and Industry Extension Package Developers (these people were not undertaking research or research support). Their combined time commitment was 5.95 FTE.

Table 4.21 lists the organisations, number of people and associated FTE. MLA clearly has the largest capability.

Table 4.21. Organisations, and FTEs associated with Education and Industry Extension Package Development.

Organisation	Total number of people involved	Industry Information Packages FTE	Science, Technology & Engineering Curriculum & Pedagogy FTE	Communication Studies FTE
DAF	1	0.2	-	-

Organisation	Total number of people involved	Industry Information Packages FTE	Science, Technology & Engineering Curriculum & Pedagogy FTE	Communication Studies FTE
MLA	3	1.7	0.5	0.5
RIRDC	1	0.2	-	-
NSW DPI	1	0.3	-	-
Uni Melb	1	0.5	-	-
Harris Park	1	0.05	-	-
MINTRAC	1	0.4	0.4	-
Dairy Aust	1	0.3	-	0.1
CSU	2	-	0.2	-
LiveCorp	1	0.2	0.25	-
Private Consultant	1	0.15	-	-
Total	**14**	**4.0**	**1.35**	**0.6**

Table 4.22. Education and Industry Extension Package Development capability

Fields Of Education and Industry Extension Package Development	Number of people involved	FTE
Industry Information Packages	12	4.0
Communication Studies	2	0.6
Science, Technology and Engineering Curriculum & Pedagogy	5	1.35
TOTAL		**5.95**

- Although there were no people identified aged less than 29, there was an even age distribution across all 10 year age brackets from 30-39 through to 60-69.
- Six people hold graduate qualifications, six hold a Master's degree and two people hold PhD degrees. This group of people is generally well experienced, with 64% having more than 10 years of experience in Education and Industry Extension Development.
- Three people (21%) identified as being recognised as Industry Experts for recognised skills in developing animal welfare education packages or industry extension packages. These people were not associated with a university, instead being associated with an industry organisation (Dairy Australia, MINTRAC) or a private sector organisation (Harris Park Group). A further 3 people identified as being 'intermediate' in this skill set.

All industry sectors had some capability addressing their industry (Table 4.23), with the greatest focus being for the meat industry sectors.

Table 4.23. Industry association of Education and Industry Extension Package Developers

Industry Sector	Number of people involved
Beef	6
Live Export - Beef	3
Pigs	3
Dairy	4
Chicken Meat	2
Eggs	1
Sheep Meat	5
Goats	3
Wool	1
Live Export - Dairy	2
Live Export - Sheep	2

Industry Information Package Development

Current Capability

A total of 12 people (no postgraduates) were identified with capability in the development of Industry Information Packages, with a total time commitment of 4.0 FTE. The largest capacity resides with MLA (2.7FTE).

- Currently, the age spread is quite uniform across the 10 year age brackets from 30-39 through to 60-69.
- 67% of this group of people have more than 10 years of experience in Industry Information Package Development, and 25% identified as Industry Recognised Experts for 'recognised skill in industry extension package development'.

Communication Studies

Current Capability

Only 2 people (no postgraduates) were identified, with a total of 0.6 FTE. Both people were from industry RDCs, one from Dairy Australia and one from Meat and Livestock Australia (with a beef, sheep meat and goats industry focus).

As capability associated with Communication Studies involves 'consideration of how information is delivered (such as face-to-face conversations, mass media approaches) and how messages are interpreted", it might be anticipated that this capability would be complimentary with, and interactive with, capability associated with Sociology (1.8FTE, as reported in Chapter 4.1).

Science, Technology and Engineering Curriculum and Pedagogy

Current Capability

A total of 5 people (no postgraduates) were identified, with a total of 1.35 FTE. Two people were from CSU and one each from MLA, LiveCorp and MINTRAC.

- The age spread is skewed towards people aged over 40 (80%), with 20% aged over 60, suggesting that there is a need to encourage younger entrants and succession planning.
- 60% of people have more than 10 years of experience in the development of curriculum and pedagogy.

Perhaps surprisingly, only one person indicated that they were recognised (by industry) as being experts in developing animal welfare education packages. One other person identified as being recognised as 'intermediate' for these skills.

Contributions to Education and Industry Extension Package Development from Researchers and Research Support Personnel.

In addition to the 14 survey respondents who indicated that their specific capability focus was as Education and Industry Extension Package Developers, 10 Researchers and one Research Support person indicated that they spent a portion of their time contributing to Education and Industry Extension Package Development.

Current Capability from Researchers

Ten (of 68) Researchers are contributing capability to Education and Industry Extension Package Development in the fields shown in Table 4.24. These Researchers are predominantly associated with universities (being one each from University of Melbourne, James Cook University, Murdoch University; two each from University of New England and University of Western Australia; and one each from the agencies SARDI, TIA, Pork CRC).

The researchers involved are predominantly highly qualified (70% with PhDs), with significant experience (80% aged 40+, 70% with >10 years research experience, 60% as national or internationally recognised expertise, extensive publications and conference presentations).

50% of the researchers involved had 10-19 years of experience in Education and Industry Extension Package Development and 30% identified as being recognised by industry as being experts in package development.

Table 4.24: Fields of Education and Industry Extension Package Development identified by Researchers

Fields Of Education and Industry Extension Package Development	Total	FTE
Industry Information Packages	6	0.70
Communication Studies	1	0.10
Science, Technology & Engineering Curriculum & Pedagogy	4	0.50
TOTAL		**1.30**

The industry focus of the 10 researchers is shown in Table 4.25, although it should be noted that this industry list applies to the researchers' combined research and education/industry information package activities. Consequently, the information in the table should be considered as illustrative rather than a definitive allocation of the researchers' education and extension package development activity for specific industries.

Table 4.25. Industry association of the 10 Researchers who contribute to the development of Education and Industry Extension Development packages.

Industry Sector	No. Researchers
Sheep Meat	6
Beef	4
Wool	2
Eggs	2
Pigs	3
Dairy	3
Chicken Meat	2
Live Export – Sheep	1
Goats	1
Live Export – Beef	1

Current capability from Research Support Personnel

One (of 13) Research Support person (from the University of Queensland) identified as providing 0.8 FTE to Science, Technology & Engineering Curriculum & Pedagogy activity. Their industry focus (for combined research and education/extension support) identified as goats (70%), beef (15%) and sheep meat (15%).

Total Education and Industry Extension Package Development capability identified from all survey respondents.

The total capability directed to Education and Industry Extension Package Development identified through the on-line survey, arising from a total of 23 people (including 10 Researchers and one Research Support person) is shown in table 4.26.

Table 4.26: Total Education and Industry Extension Package Development capability

Fields Of Education and Industry Extension Package Development	FTE
Industry Information Packages	4.70
Communication Studies	0.70
Science, Technology and Engineering Curriculum & Pedagogy	2.65
TOTAL	**8.05**

Overall, recognising that the capability shown in Table 4.26 is that present to address both specific industry sector and cross sectoral animal welfare education and extension package development, the total capability is likely to be marginal at best for the future. The development of education and extension packages covering key animal welfare issues will be an increasingly important mechanism for securing changes in practices by industry and securing broader community support for the agricultural sector. The development of such packages requires a unique combination of skills, including technical knowledge, understanding adult education principles, a knowledge of demographic preferences in information and learning, an ability to distil complex R&D findings into simple messages and a knowledge of contemporary information media. Suitable capability could be accessed from the private sector, particularly private veterinary practices and agricultural consultants. The Review Team spoke to several such individuals and organisations who identified that they had previously provided such services but at the time of the capability survey were not currently engaged. Additional capability could be accessed from the agricultural production R&D sector and the non-agriculture R&D sector (although the latter would need additional support on technical knowledge) particularly from universities, as well as from private sector information and extension organisations (for example the Kondinin Group). Retired animal welfare researchers might also provide a resource pool for consideration. A cross sectoral approach to defining the scale of required future capability together with developing a panel of interested and available organisations and individuals containing the necessary capability could be advantageous.

4.3 Research Support

Research Support refers to the capability provided by Research Assistants, Technical Assistants, Lab Assistants and Field Assistants (people with or without tertiary qualifications) who assist Researchers in undertaking animal welfare research;

The assessment of Research Support considered four fields of capability directly associated with support for research, being;

- Animal management/husbandry
- Field Services Assistance
- General Laboratory Assistance
- Surgery Assistance

In addition, to identify if any research support staff were also contributing to the provision of education and extension package development, the following capability fields were included in the Research Support survey;

- Science, Technology and Engineering Curriculum and Pedagogy
- Communication studies
- Industry Information packages;

Overall assessment of Research Support capability.

The survey identified 13 people whose role was Research Support. Their combined time commitment to the role was 11.7 FTE. Organisational associations were 5 with CSIRO, 3 with the University of Melbourne, 3 with SARDI and one each with the University of Adelaide and the University of Queensland.

A non-graduate (5) or graduate (6) qualification is most common with this group of people, although one person holds a Masters and one person a PhD.

- 62% of people have over 10 years of experience in providing research support. 30% have less than 4 years of experience. The age of Research Support people is evenly spread across the 10-year age brackets from 20-29 through to 50-59.
- The primary field of research support was Animal Management/Husbandry (Table 4.27).
- Perhaps not surprisingly, only one person (located with the University of Queensland) indicated that they were involved in support for Education and Extension Package Development.

Table 4.27. Fields of Research Support capability

Fields Of Research Support	Total No.	FTE
Animal Management/Husbandry	13	6.65

Field Services Assistance	7	2.7
General Laboratory Assistance	6	1.45
Surgery Assistance	1	0.10
Science, Technology and Engineering Curriculum & Pedagogy	1	0.80
Communication studies	0	0
Industry Information Packages	0	0
TOTAL		**11.70**

All industry sectors (except for live export) had some capability (Table 4.28), with the greatest focus being for the meat industry sectors.

Table 4.28. Research Support by industry sector

Industry Sector	Total No.	FTE
Eggs	6	1.20
Pigs	7	5.15
Chicken Meat	2	0.50
Sheep Meat	4	1.25
Dairy	1	0.10
Beef	5	1.25
Wool	3	1.05
Goats	1	0.70
Live Export - Dairy	0	0
Live Export – Beef	0	0
Live Export - Sheep	0	0

The scale and type of R&D Support will depend on the type of research being undertaken. The 11.7 FTE identified in the present study is a small increase on the 7.2 FTE identified by Kroker & Edge (2009). It is likely that transient research support from production R&D and non-agricultural animal welfare R&D is available within each of the major R&D providers and could be redirected if required.

5. Future prospective trends of Research and Development Corporations

Context

The livestock Research and Development Corporations (RDCs) provide the objectives and priorities to enable R,D&E providers to respond. An understanding of the forward planning and priorities, while necessarily a qualitative assessment, provides valuable insights in assisting the consideration of future R,D&E capability requirements, emerging gaps and strategies to be addressed.

Senior leaders in Dairy Australia (DA), Australian Egg Corporation Limited (AECL), Australian Wool Innovation (AWI), Meat and Livestock Australia (MLA), LiveCorp, Australian Pork Limited (APL), RIRDC Chicken Meat, and Animal Health Australia (AHA) were interviewed about current and prospective future changes in priorities and investment in R,D&E, as well as any areas where they could foresee any capability gaps emerging. Information was also requested about pathways to market for animal welfare R,D&E projects and their approach to evaluation of these projects. Summarised information for each RDC is included below.

Australian Pork Limited (APL)

Animal welfare is seen as part of animal management, with other aspects, such as biosecurity issues and animal health issues impinging on welfare. APL is not contemplating any significant changes in priorities over the next 5 years. APL's strategic priorities include:

- On-farm welfare assessment
- Effective enrichment and positive welfare indicators
- Improving welfare of sow in farrowing crates
- Pain relief
- E-learning packages
- Lameness and associated pain
- Housing to engage pigs
- Group housing
- Alternatives to farrowing crates

APL is prospectively planning to increase its investment in animal welfare R,D&E in the next 5 years. In the last few years, they have been progressively increasing investment in extension based activities as the state Agencies have withdrawn from extension. They are currently co-funding most, if not all, of the cross–sector projects being conducted as part of the National Animal Welfare R,D&E Strategy. New areas for possible investment include breeding for animal welfare resilience, utilising E-extension platforms and positive indicators of animal welfare, as used successfully in the chicken industries.

Many of the larger commercial piggery operations fund their own R,D&E on animal welfare. APL maintain that they have a very strong and stable group of R&D providers, without any noticeable capability gaps, who service the pig industry.

In terms of program or project evaluations, APL conduct their own evaluations and regularly survey industry members on the uptake of new information.

Animal Health Australia (AHA)

Whilst not theoretically a RDC, AHA is a member based organisation and has responsibility for development and extension of key messages on animal biosecurity, surveillance and animal welfare to support market access and trade. AHA is in the first year of its current 5 year strategic plan and is not contemplating any significant changes in priorities over the next 5 years. Its three strategic priorities include:

- Effectively manage and strengthen Australia's emergency animal disease response arrangements through successful partnerships with members.
- Enhance the emergency animal disease preparedness and response capability of AHA and its members.
- Strengthen biosecurity, surveillance and animal welfare to enhance animal health and support market access and trade.

AHA is not planning to change its investment in animal welfare RD&E in the next 5 years, although it does keep a watching brief on animal welfare research. AHA is currently managing the 'national livestock welfare standards and guidelines" project, under the guidance of the National Animal Welfare R,D&E Strategy Steering Committee. In terms of future projects for investment, AHA is interested in areas that affect industry standards and in projects that highlight positive impacts of industries addressing animal welfare issues.

In terms of program or project evaluations, AHA conduct their own evaluations. They are currently strengthening the monitoring and evaluation aspects by training all staff in these techniques.

Australian Egg Corporation Limited (AECL)

AECL has recently produced a new "Hen Welfare Strategy" and given the extensive industry consultation prior to its development, further significant changes over the next five years are unlikely. The new strategy identifies the following priorities for R,D&E:

- Societal preferences and community understanding of hen welfare issues
- Furnished cages and conventional cage modification
- Free range systems design
- Rearing pullets for specific production systems
- Osteoporosis and bone fracture reduction
- Stockmanship for different production systems
- Feather pecking and cannibalism – alternatives to beak trimming
- Spent hen euthanasia, disposal and transport
- Sex determination and cull chick disposal

AECL has adopted a strong focus on hen welfare and will be directing an increased proportion of its R,D&E budget to this area. It is likely that some funds will be redirected to animal welfare from environmental sustainability, feed availability and nutrition.

In terms of cross sectoral projects, AECL co-invests in most projects commissioned by the National Animal Welfare R,D&E strategy and is willing to collaborate with others where there are benefits to the egg industry. Potential new cross sectoral animal welfare R,D&E opportunities of interest to AECL are different approaches to the objective measurement of welfare that are relevant to the egg

industry and public attitudes to welfare, societal expectations and building community confidence and trust.

Until recently, AECL's main form of communication with industry on animal welfare R&D has been through industry forums held twice per year where scientists present R&D findings to industry. These have generally not been considered effective and AECL has recently appointed an Extension Manager who will be responsible for running more frequent, better targeted and highly practical workshops for growers and training opportunities for egg industry workers. The egg industry QA program has recently been refreshed with new standards and is also considered to be an important mechanism for driving change and communicating animal welfare R&D findings to industry.

Animal welfare projects with a successful pathway to market include the 'Managing Fowl Behaviour" manual, "Best Practice Euthanasia" manual and a project on "Stockperson's attitudes", but none of these have been formally evaluated. AECL does undertake monitoring and evaluation activities each year and in 2009/10 a suite of 7 welfare projects were formally evaluated. The total cost of these projects was $4.133 million and the net present value was estimated at $20.6 million (a benefit cost ratio of 4.8:1).

At present AECL believes it has access to good animal welfare science capability and did not identify any capability gaps. However, they noted that a number of key scientists are nearing retirement age and their departure could create significant gaps. Similarly AECL relies on one person in particular for the development of extension packages, and that person could retire in the near future.

Australian Wool Innovation (AWI)

AWI's current animal welfare R,D&E priorities include:

- Invasive procedures – develop alternatives for mulesing and improved technology for castration and tail docking.
- Pain relief – develop better pain relief products at competitive prices and broaden patents to include a wider range of applications.
- Stockmanship – develop improved training packages on sheep husbandry and handling.
- Fly strike – develop a better understanding of the sheep blow fly genome with a view to reducing chemical use.
- Pest animal control (dogs, foxes, wild pigs, rabbits) – develop more humane and better targeted toxins, with antidotes
- Mortality – improve lamb and weaner survival through breeding and management
- On-farm practice change – increased use of pain relief, adoption of the National Wool Declaration, use of breech strike resistance genetics, improved stockmanship and husbandry.

No significant changes to these priorities are envisaged over the next 5 years.

Expenditure on animal welfare R&D is intended to be at least maintained, possibly increased, but additional funding will be directed towards animal welfare extension activities. A full time employee has commenced to better communicate the R,D&E priorities and practice changes along the supply chain. AWI plans to reduce expenditure on sheep breeding and genetics, following the completion of a major 10 year breeding project, with additional resources directed towards the sheep blowfly genome, alternatives to mulesing and better and cheaper pain relief products.

AWI currently invests in cross sectoral projects through the National Animal Welfare R,D&E Strategy, the Invasive Animals CRC and with MLA. AWI is interested in further investment in cross sectoral projects that are relevant to the sheep and wool industry. Prospective new areas that would be attractive to AWI include pain assessment and modelling.

In addition to direct communication with wool growers via electronic newsletters and other publications, AWI makes use of existing extension networks, such as BestWool:BestLamb in Victoria. AWI has established a "Producer Advisory Panel" in each state and these panels largely determine what is communicated and how it is delivered. In future, AWI will devote 1 FTE to extension on animal welfare, compared to 0.3 FTE in the past and there is likely to be greater involvement of private sector deliverers in animal welfare extension and communication activities.

AWI routinely evaluates significant R,D&E programs. For example, "Lifetime Ewe Management" has been delivered mainly by the private sector through extension networks and has achieved a 9-10 % increase in lamb and weaner survival. Similarly "Paraboss" has assisted the sheep industry to achieve more effective control of both internal and external parasites and formal evaluation has identified a Benefit Cost Ratio of 7:1.

In terms of capability gaps, AWI believes that the withdrawal of many state agencies from extension has left a significant gap, which they are attempting to fill by increasing their investment in this area. In future they see a much greater role for private sector deliverers in relation to animal welfare extension.

AWI does provide limited funding to the private sector for animal welfare R,D&E services, but most animal welfare research and information package development is done by CSIRO and the universities who conducted the research.

Dairy Australia (DA)

Dairy Australia has a National Dairy Industry Animal Welfare Strategy that is regularly reviewed and refreshed. The current priorities for the dairy industry are:

- Calf Management - Ensuring calves are managed across the supply chain to meet agreed industry practices and standards.
- Tail Docking - The Australian dairy industry does not support tail docking and promotes alternatives.
- Calving Induction - Reduced requirement for calving induction through support of sound farm management practices.
- Disbudding - Disbudding of calves is undertaken in preference to dehorning of cattle at an older age.
- Lameness - Minimise lameness through adoption of practices to prevent, detect and treat cases on farms.

No major changes to these priorities are envisaged over the next 5 years, however, as the strategy is continuously reviewed any changes will likely be additive rather than changes in direction.

No changes to current levels of investment or portfolio balance are envisaged over the next 5 years. Although budgets are generally trending downwards due to the low global milk prices, no cutbacks in animal welfare R,D&E are expected.

DA currently invests in some, but not all, cross sector animal welfare projects. They already invest significantly in sector specific attitudinal research projects such as through annual dairy farmer surveys and quarterly Situation Outlook Reports. However, whilst they will not initiate any cross sector projects in the current environment, they will consider new projects on a case by case basis. Projects that focus on engagement and adoption of recommended practices will be viewed more favourably than social research or animal research projects associated with assessment of pain.

DA has well-defined pathways to market for animal welfare R,D&E and are currently strengthening extension capability within the Regional Development Programs. They use a number of different pathways to market including private training providers (NDCE) with well-developed curricula subjects, academic (Vets in Residence program at the University of Melbourne), farmer discussion groups and dairy company advisors and on-farm quality assurance systems, that include animal welfare, providing evidence through the Sustainability Framework. However, in contrast to many R,D&E projects that demonstrate a productivity or animal health benefit, the target audience for animal welfare programs is the bottom quartile of farmers.

DA conducts most monitoring and evaluation in-house and animal welfare is often evaluated as part of larger programs. Many of their programs have been very effective. For example, in 2005 more than 50% of farmers were tail docking but now this has declined to less than 10% of farmers. However, few programs or projects in animal welfare have been formally evaluated and those that have been formally evaluated are considered confidential.

DA could not identify any R,D&E capability gaps in animal welfare. They maintain strong relationships with scientists in the Animal Welfare Science Centre at the University of Melbourne and several senior staff are engaged in the Dairy Animal Welfare Community of Interest. They also maintain strong relationships with the other livestock Research and Development Corporations and benefit from cross sector interaction in animal welfare.

DA does provide limited funding to the private sector for animal welfare R,D&E services, but most animal welfare research and information package development is done by the university academics who conducted the research.

Meat and Livestock Australia (MLA)
In recent years, MLA's priorities for animal welfare R&D have been:

- Replace adverse husbandry practices
- Refine technologies to improve animal welfare
- Reduce pain associated with essential husbandry procedures
- Reduce lamb and weaner mortality

Following a period of extensive industry consultation and economic analysis, in late 2015 the National Meat Industry Strategic Plan 2015-20 (MISP) was launched. This strategy identifies the loss of community support, particularly in relation to animal welfare, as the single highest risk confronting the red meat industry to 2030. During 2016, MLA has realigned its priorities for animal welfare R,D&E to more closely reflect the MISP. Current priorities are:

- Securing community approval of meat production systems
- Continuous improvement of animal welfare
- Develop objective measures of animal welfare and use for benchmarking

- Increase industry compliance with best practice procedures
- Feedlots – reduce heat stress and the incidence of dags
- Live exports- reduce heat stress on ships
- Maintain industry capacity to respond to welfare issues (stockmanship training, R&D, regulation

Given the prominence of animal welfare in the new MISP, MLA has recently decided to increase expenditure on animal welfare by up to 600%. Some of this increased expenditure is associated with the establishment of a new animal welfare strategic partnership or consortium. In the short term, there will be a substantial increase in R&D on welfare indicators and benchmarking and addressing mortality, especially lamb and weaner sheep mortality (southern Australia) and cull cow mortality (northern Australia).

MLA is co-funding 4 cross sectoral projects through the National Animal Welfare R,D&E Strategy and works collaboratively with AWI (e.g. pain relief and footrot in sheep) and DA (bobby calf welfare). MLA highlighted that additional opportunities for increased investment in cross sectoral projects could be objective welfare indicators, pain relief, maintaining community support and livestock transport.

MLA invests in extension adoption networks, such as BestWool: BestLamb in Victoria, and produces a range of publications including a monthly "Feedback Magazine" and a weekly electronic newsletter distributed to MLA company members and others. There has also been some work on QA programs and brand labelling. The main challenge in communicating information about animal welfare is "reaching small producers and the bottom 20%". In future, MLA will rely more heavily on QA programs linked to product brands as the main route to market for animal welfare information.

ACIL Allen have recently completed the "MLA Impact and Performance Review" which includes an evaluation of MLA's animal welfare projects. The report indicates that returns to industry of $124 million were achieved from MLA's expenditure on the on-farm welfare portfolio of $16 million, with a Benefit Cost Ratio of 7.7:1. "Fit to load" is an example of an MLA animal welfare project with a successful pathway to market that has been formally evaluated.

MLA uses four internationally recognised animal welfare R&D groups that they believe generally have good RD&E capability. Overall however, MLA stated that capability gaps are likely to emerge due to possible retirements in beef cattle husbandry (northern Australia), social science (consumer attitudes, producer behaviour) and neuroscience.

MLA regularly funds private sector providers to develop extension and information packages and to deliver extension and training on animal welfare related topics.

LiveCorp

LiveCorp's current priorities for animal welfare R,D&E are:

- Objective measures of animal welfare, data collection and benchmarking
- Reduce mortality on ships (salmonella, heat stress)
- Continuous improvement of animal welfare on board ships (e.g. provision of bedding)
- Improvements to animal welfare in overseas markets (slaughter practices, infrastructure and handling, extension /education)

In future LiveCorp will place greater emphasis on risk management, with a focus on identifying new and emerging animal welfare issues as well as traceability of Australian livestock in overseas markets.

LiveCorp currently allocates up to 70% of its R&D budget to animal welfare and the development of a QA program and this level of expenditure is intended to be maintained. The only change to portfolio balance is likely to be an increased focus on extension and adoption, particularly in overseas markets.

Constrained by a small R&D budget, LiveCorp is currently not investing in any cross sectoral projects as such, although it is partnering with both MLA and DA on projects directly related to the live animal export trade. In future, LiveCorp would consider investing in cross sectoral projects with clear benefits to the live export trade. Possible areas of interest include new approaches to extension and adoption, a whole of chain approach that includes live animal exports and understanding public attitudes and how to build community confidence and trust.

In terms of pathways to market for animal welfare R,D&E, LiveCorp funds individuals to undertake RD&E in overseas markets, maintains a comprehensive website, distributes information via email, conducts webinars and podcasts and has produced two phone apps. LiveCorp has recently established an increased budget for communications and extension and will be looking for new and innovative ways to communicate and achieve adoption of improved welfare practices.

To date LiveCorp has not completed any formal evaluations. A new salmonella vaccine funded by LiveCorp is currently in the process of being commercialised, but this work has not been formally evaluated.

LiveCorp uses three animal welfare R&D groups and is not aware of any capability gaps at present. Private sector providers are frequently engaged by LiveCorp to undertake animal welfare R,D&E.

RIRDC Chicken Meat

Consumer pressure has driven adoption of changes to chicken meat production ahead of the R&D being undertaken and RIRDC's Chicken Meat priorities reflect the need to assist industry to address consumer concerns in a cost effective manner. Current priorities are:

- Free range chicken meat production systems
- Objective measures of welfare, including validation of overseas work with poultry.
- Stockmanship, with a focus on contract staff and people involved in the industry post-farm gate (particularly bird transport and processing).

Unless new issues emerge more rapidly than expected, such as community concerns about the use of antibiotics by the livestock industries, these priorities are unlikely to change over the next five years.

No changes to current levels of investment or portfolio balance are envisaged, but RIRDC Chicken Meat is planning to move to better targeted projects that deliver greater value for industry. Instead of relying completely on an "open call" process, in future RIRDC Chicken Meat will be commissioning more projects to meet specific industry needs.

RIRDC Chicken Meat currently invests in cross sectoral projects through the National Animal Welfare R,D&E Strategy and is interested in further cross sectoral investment where there are benefits to the chicken meat industry. Some areas of interest to the chicken meat industry are further work on public attitudes to welfare with a view to building community confidence and trust, addressing community concerns about the use of antibiotics in the livestock industries and more humane stunning and slaughter techniques.

In terms of information flow and pathways to market, the chicken meat industry is unique in that only the relatively small number of processing companies pay levies and industry funded information passes through them rather than direct to their contracted growers. Processing companies are highly competitive and tend not to share information. While RIRDC Chicken Meat communicates mainly with processor managers or their Animal Welfare Officers on welfare related matters, there is also some electronic or mail communication direct to growers and occasionally RIRDC conducts workshops for growers. In future, RIRDC Chicken Meat aims to improve the coordination and flow of information on animal welfare to both processors and growers.

In the past there have been no reviews or evaluations of pathways to market and little is known about what happens to information that is sent to processors.

The Poultry CRC has been effective in filling most capability gaps. However, R&D to develop more humane stunning and slaughter technologies remains a significant gap, due mainly to difficulties in obtaining approval from animal ethics committees.

RIRDC Chicken Meat funding of private providers and consultants is limited. Most extension and information packages are developed in house by RIRDC and where external people are engaged to develop extension packages, they are usually the scientists who have been involved in conducting the research.

Concluding remarks

Animal welfare R,D&E is a high priority for all livestock industry RDCs and all are planning to either increase or maintain their current levels of investment in this area. All RDCs have clear priorities for animal welfare R,D&E and although these priorities reflect the specific issues confronting each industry, there are many commonalities. Common themes to emerge were around the need to understand and meet community expectations in relation to animal welfare standards, how to build community confidence and trust, and how to establish reliable and objective measures of animal welfare, pain relief and stockmanship.

The majority of livestock RDCs are already investing in cross sectoral projects identified as high priorities in the NAWRDE Strategy (2010). All RDCs are interested in future investment in cross sectoral projects of relevance to their industry, with areas of common interest including breeding animals for welfare resilience, future use of antibiotics by the livestock industries, maintaining community support and the "social licence" to operate, pain relief and objective measures of animal welfare.

The preferred "pathway to market" for animal welfare R&D findings varies across industries, but all livestock RDCs were using training forums and workshops as well as magazines and/or newsletters, with increasing emphasis on the use of emails and other forms of direct electronic communication. Quality assurance programs are also seen as an important means of communicating science based information on animal welfare standards, with the larger industries also using producer groups and extension networks.

Although all but two livestock RDCs are undertaking at least an economic evaluation of some of their investments in animal welfare R,D&E, there is little evidence that the findings are being shared and used to maximum benefit. In many cases, animal welfare evaluations are regarded as 'commercial in confidence'. All livestock RDCs should consider undertaking formal, independent evaluations of their investments in animal welfare R,D&E, broadening the scope to include social and environmental, as well as economic, benefits and sharing the findings with all stakeholders. Evaluations could then be

used to identify industry outcomes and benefits and demonstrate progress towards achieving higher standards of animal welfare. They could also assist with continuous improvement of animal welfare RD&E as well as industry planning and priority setting.

As well as demonstrating the impact of investment in R,D&E, formal and structured evaluation can be used for learning and continuous improvement and for planning and priority setting for the future. The following case studies are intended to provide examples of substantial R,D&E projects or programs of work that have identified opportunities for improved animal welfare outcomes, have a successful "route to market" and have achieved significant impacts demonstrated through formal evaluation. Unfortunately very few independent project or program level evaluations of animal welfare RD&E have been conducted, and most that have been completed are "commercial in confidence".

Case studies of animal welfare R,D&E projects demonstrating successful evaluation

Case study 1 Lamb and Weaner Survival

Lamb and weaner mortality is a significant animal welfare issue and a major source of economic loss confronting the sheep industry across southern Australia. On many properties, the difference between scanned pregnancy rates and the weaning rates subsequently achieved is of the order of 30-50%. The main factors involved are difficult births, low lamb birth weights and inclement weather within 3 days of birth, predation and internal parasites.

Over recent years, the state agencies and universities working through the Sheep CRC have conducted extensive research to improve sheep welfare and reproductive performance. This work, together with the Australian Wool Innovation (AWI) funded "Lifetime Wool Project" has identified opportunities for large improvements in lamb and weaner survival.

The key findings and principles to emerge from this body of research have been incorporated into a comprehensive training package developed by Rural Industries Skill Training Centre (RIST) and the Victorian Department of Economic Development, Jobs, Transport and Resources.   "Lifetime Ewe Management" (LTEM) is a nationally accredited training course delivered to groups of 4-6 sheep producers through 6 sessions over a 12 month period. In order to maximise impact, the course has been structured to ensure high levels of knowledge retention, skills development and practice change, based on learnings about producer attitudes from a formal evaluation of the "Triple P" program. Each producer monitors a mob of their own ewes to demonstrate the effects of nutrition and improved management in their own production environment.

LTEM is coordinated nationally by RIST, and is delivered mainly by private specialists and some state agency staff, usually through existing extension networks such as "BestWool:BestLamb" in Victoria.

A formal evaluation of Victorian producer participants in LTEM in 2008, 2009 and 2010 (Trompf *et al.,* 2011) indicated an average improvement in lamb marking rate of 11-13% (depending on enterprise type) and a decrease in annual ewe mortality rates of almost 50%. Since then, data on sheep survival collected by producer participants across Australia have been collated and monitored by RIST. To date, LTEM has been delivered to over 3000 sheep producers nationally

representing more than 20% of the national ewe flock. Over the period from 2008 to 2015, LTEM participants have increased weaning rates by 8% and decreased ewe mortality from 4.2% to 2.8%.

Senior staff involved in the delivery of LTEM believe that a number of factors have contributed to its success. A major contributor has been that in developing the course, complex R&D findings from a range of sources have been distilled down to a few key principles and relatively simple extension messages, such as ewe body condition score targets at critical stages of the annual production cycle. Other important features of LTEM are:

- The very practical, "hands on" approach taken to course delivery
- Small groups of just 4-6 producers who monitor the welfare and performance of some of their own sheep
- Producers contribute to course costs and value their own learning.

Case Study 2 Prohand Pigs

ProHand Pigs – *a Professional Pig Handling Training Program for Stockpeople* – aims to improve the attitudes and behaviours of stockpeople towards the handling of pigs in their care, resulting in improved pig behaviour, productivity and welfare. The program has been available to industry for well over 15 years although its content was revised in 2008/09 and again in 2015/16. It is delivered by trained and accredited facilitators to small groups at the workplace.

Whilst ProHand Pigs has not been formally evaluated for economic, social and environmental benefits by independent evaluators, it does provide a good example of R,D&E that has achieved changes in the attitudes and behaviours of stock handlers.

Past research by Hemsworth and Coleman in The Animal Welfare Science Centre in Victoria has demonstrated that pigs handled calmly and positively, in accordance with best practice, show a reduction in fear responses, resulting in improvements in reproduction and growth performance, ease of handling and welfare outcomes. These benefits include improvements in average daily weight gain of 5% and litter size (pigs/sow/year) of 7%.

An assessment of the effectiveness of the ProHand Pig training program in improving stockperson's attitudes and behaviours was conducted by Rural Solutions SA in 2010. Personal questionnaires were completed by 190 South Australia and Western Australia pig stockpersons, who had previously completed ProHand Pig training. Questions were structured to include multiple examples of how stockperson attitude and behaviour may have/have not changed since their completion of ProHand training, with a selection of response scales (*Never-Occasionally-Always* and *Strongly Agree-Neutral-Strongly Disagree*) used to enable qualitative analysis of their answers.

The results of this study confirmed that delivery of the ProHand Pig training program resulted in measurable change in stockperson attitudes and behaviours, and an improved animal welfare outcome. Further, respondents believed that they had significantly increased the frequency with which they "positively" handled their animals and decreased their frequency of "negative" handling, leading to improvements in their overall working conditions and ease of working with pigs.

A number of factors have contributed to its success:

- Complex R&D findings have been distilled down to a few key principles and relatively simple extension messages.
- The very practical, "hands on" approach taken to course delivery by trained facilitators to small groups of employees at their workplace,
- Benefits to pig handlers in their overall working conditions.

Based largely on the success of ProHand Pigs, the Dairy industry has developed a training program along similar lines, called ProHand Dairy. There has not been wide uptake of this program due, in part, to an outdated CD –Rom based delivery platform.

Case Study 3. Land Transport of Livestock Regulation

Road transport can have significant implications for the welfare of livestock. In addition to problems associated with the transport of injured, diseased or weak animals, the duration of the transport period and time off water has long been a contentious issue.

The "Australian Animal Welfare Standards for the Land Transport of Livestock" were adopted in 2015. These standards are enforceable, and define specific requirements in relation to livestock transport throughout Australia. They replace the individual state and territory livestock transport provisions of the Australian model codes of practice for the welfare of animals.

For cattle over 6 months of age and sheep over 4 months old, the new standards provide for a maximum period of 48 hours off water. Many animal activists and welfare lobby groups had argued for a maximum time off water of 28 hours. However scientific studies funded by MLA, and particularly research conducted by CSIRO, showed that both cattle and sheep in good physiological condition can cope with transport periods of up to 48 hours without any major compromise to their welfare. As a result of this research, the RSPCA did not challenge the 48 hour limit proposed by industry, and the research outcomes are reflected in the new standards.

The Centre for International Economics (CIE) has completed an "Impact Assessment of MLA Expenditure 2010/11 to 2014/15", including expenditure on a range of animal welfare related activities. This indicates that "MLA expenditure on the on-farm animal welfare portfolio provides industry returns of $124 million from expenditure of $16 million, with a BCR of 7.7:1. The impact of imposing a legal transport time of 36 hours, instead of the accepted 48 hour limit, was calculated to be additional transport costs of $52 million p.a. for beef cattle and $36 million p.a. for sheep.

In addition to the substantial cost savings, the CIE Impact Assessment identifies other benefits from the new standards, including the provision of greater certainty to industry.   With a 48 hour time limit, the large numbers of cull cows from northern Australian properties can be transported to processing plants in southern Australia, rather than dying on farm.

To assist industry to improve the welfare of livestock during land transport, MLA produced a "Fit to Load" guide, which has been their most requested publication (over 56,000 hard copies ordered since its revision in 2012). Although not quantified, this publication has undoubtedly contributed to the development and application of the new standards and the improvement of land transport of livestock within Australia.

The CIE Impact Assessment indicates that in addition to having credible research backing, extensive consultation and engagement with animal welfare organisations was a critical factor in achieving a successful outcome in relation to the new standards. Prior to the development of the standards, MLA engaged with a number of animal welfare organisations such as the RSPCA and Animal Angels, and secured their support for some of industry's key animal welfare activities, such as the "Fit to Load" guide. This significantly reduced the chances of a reduced legal transport time being imposed.

Generally all RDCs believe that they currently have ready access to world class animal welfare R&D, due in part to the effectiveness of the CRC Program (Pork, Poultry, Dairy, Sheep and Beef CRCs) in helping to maintain capability. However, with constrained federal and state government budgets and the completion of the livestock CRCs, they recognise that this situation may change in the near future. Whilst some RDCs reflected that a number of impending retirements were possible in their industry that may lead to R,D&E capability gaps, the survey data (Chapter 4) indicated that there was a good number of developing researchers available in all industries. In the short term, the main R&D capability gap identified by the RDCs was in the area of social science, particularly in relation to understanding community and producer attitudes towards animal welfare, whereby such information would assist in identifying how industry should be responding.

With the downsizing and withdrawal of state agencies from the provision of extension services, RDCs generally see this as a significant and immediate capability gap. Some RDCs are responding to this by employing more "in house" extension staff, but all envisage a much greater role for private sector providers of extension and adoption services. Whilst the capability survey was not designed to identify the capability in extension delivery, the results of the capability survey (Chapter 4) identified only 8.05 FTE in the private sector, industry bodies and R,D&E providers who identified as currently engaged as Education and Industry Extension Information Packagers. Although there are some private providers with specialised extension expertise in animal welfare, there is scope for industry to help build the capacity of the private sector in this area to meet the growing demand.

6.   Future prospective infrastructure trends of major R,D&E provider organisations

Context

The major providers of animal welfare R,D&E services to the livestock industries provide the key platform for the current and future capability required to meet industry's objectives. An understanding of these research providers forward infrastructure planning and priorities, while necessarily a qualitative assessment, provides valuable insights in assisting the consideration of future industry infrastructure requirements, emerging gaps and strategies to be addressed.

Senior leaders were contacted in the major R,D&E provider organisations, including CSIRO, the University of Melbourne, SARDI/University of Adelaide, University of Sydney, University of Western Australia, Charles Sturt University, University of Queensland/QAAFI, University of New England, Murdoch University and DAFWA. Senior leaders were requested to complete a table outlining infrastructure and facilities available for animal welfare R,D&E. In telephone interviews, they were also asked about prospective future changes, critical infrastructure gaps emerging, and any unique facilities that they had available or could access. Summarised information for each major R,D&E provider is included below and in Table 7.1 by industry, and the full data are contained in Appendix 8.

University of Western Australia

The small animal welfare R&D group at the University of Western Australia (UWA) has a focus on sheep. Animal welfare is a moderate priority for the university.

UWA owns a 1600 ha research farm running 5000 merino ewes, and with an animal house and surgery of hospital standard, together with analytical laboratories of international standard, the organisation is well placed for sheep welfare R&D. The ewe flock has been selected for calm vs nervous temperament for 25 generations, and is a unique resource for research on animal behaviour and temperament. Similarly the high throughput analytical laboratories, applied to molecular genetics and the analysis of numerous blood metabolites, including those related to stress and welfare, is also unique.

While on-campus animal welfare R&D facilities are of outstanding quality, UWA is planning a major upgrade of research farm infrastructure, including shearing, sheep handling and laboratory facilities over the next 5 years.

UWA currently lacks infrastructure for R&D on heat stress and responding to climate change, and has no infrastructure for working on species other than sheep.

The University of Melbourne

Animal welfare R,D&E is a high priority for The University of Melbourne. The newly merged Faculty of Veterinary and Agricultural Sciences is examining its strategic priorities and it is highly likely that animal welfare will continue to be a strategic focus.

The University of Melbourne has significant farm land, sheep, cattle and dairy cows, a dairy cow robotic milking shed (the University of Sydney also has a similar facility) and unique equipment relating to video capture and analysis of animal and human behaviour. They have historically accessed infrastructure and facilities through its close relationship with Agriculture Victoria. In recent years, changes in priorities in Agriculture Victoria have resulted in some research infrastructure and facilities being closed and not available for use by the University.

As part of its strategic review, prospective new infrastructure is under consideration particularly housing for small to medium sized animals (poultry, pigs, sheep and calves) and a video room for direct monitoring of animals.

Much of the research is now conducted in commercial facilities with the advantages of increased scale and industry relevance but disadvantages of reduced flexibility and significant distances involved. It has access to significant commercial piggeries and poultry facilities and specialised facilities such as dairy cow environmental chambers at the Ellinbank Dairy Research Centre in Agriculture Victoria.

CSIRO

The CSIRO animal welfare R&D group is based at Chiswick in Armidale, NSW, where they have access to significant infrastructure. CSIRO scientists and students also have offices at UNE to facilitate joint research. With a new animal welfare scientist and a new post-doc appointed, following a period of constrained budgets, animal welfare is clearly a priority for CSIRO.

CSIRO staff are based at a large research farm near Armidale (1200 ha), and with an experimental feedlot, an animal house, a surgery and research laboratories, the organisation is well equipped for conducting R&D on the welfare of cattle and sheep in both intensive and extensive grazing situations. Some areas of specialisation include the welfare of cattle in feedlots, welfare assessment of analgesics for painful husbandry procedures, humane slaughter of cattle and sheep, virtual fencing, animal welfare assessment, monitoring and benchmarking and assessment of affective states. CSIRO also owns a free range poultry facility, and with access to UNE poultry facilities as well, there is also a critical mass in R&D on free range poultry production.

Although there are no plans to replace, expand or downsize animal welfare R&D facilities over the next five years, CSIRO will be investing in more advanced R&D equipment, such as improved technology for remote sensing, monitoring and data collection.

CSIRO has no facilities for conducting animal welfare R&D that is specific to the pig or dairy industries, but much of the research conducted has application to these species.

SARDI/University of Adelaide

With significant animal welfare science capability and extensive infrastructure and facilities associated with livestock research in SARDI and the School of Animal and Veterinary Sciences at the University of Adelaide, animal welfare R,D&E is considered a high priority for SARDI/University of Adelaide.

SARDI/University of Adelaide has large land holdings, herds and infrastructure and facilities available for livestock R,D&E at Struan, Roseworthy, Kybybolite, and Minnipa. They are well equipped to undertake animal welfare R,D&E particularly for the beef cattle, sheep, pig and poultry sectors. In terms of unique facilities, the Roseworthy piggery with 350 sows is the most flexible discovery piggery available in Australia. Minnipa Agricultural Centre on the Eyre Peninsular is located in a low rainfall area with broad acre mixed farming land and facilities mimic industry enterprises for a large portion of the mixed farming regions in South Australia.

In the next 5 years, SARDI/University of Adelaide propose to invest significant amounts of money to upgrade and improve facilities at the Roseworthy piggery and Roseworthy poultry facilities for animal welfare dedicated R,D&E. At Minnipa, they propose to improve facilities for sheep, including prospective improvements to yards, animal housing sheds, and the sheep feedlot.

University of New England

The University of New England (UNE) animal welfare group works collaboratively with CSIRO at Armidale, and is currently upgrading and renewing key components of its animal welfare R&D infrastructure. Animal welfare R&D is a priority for the university.

UNE has good facilities and a critical mass in animal welfare R&D for the beef, sheep and poultry industries, but there are no facilities for pig or dairy research. With some 4000 ha of farmland, a 2000 head beef feedlot, a meat laboratory with substantial chiller capacity, a large animal house for both cattle and sheep, a multi-species surgery able to accommodate sheep and calves and a large research laboratory complex, the university is well equipped for conducting animal welfare R&D on beef cattle and sheep. Both the beef feedlot and the animal house are considered unique in terms of their size and design for experimental purposes. The university also owns substantial layer and broiler sheds as well as a free range facility for 3000 laying hens.

In terms of changes to infrastructure, the animal house is currently being upgraded and will be renewed by the end of 2017, and the university is also considering upgrading the experimental beef feedlot. All other facilities will be maintained.

Although UNE has conducted very little R&D on goats in the past, existing sheep facilities can also accommodate goats.

Murdoch University

Being located in close proximity to a key embarkation port for live animal exports, where animal welfare is a major concern, animal welfare R,D&E is a moderate priority for Murdoch University.

The university owns or has access to large areas of farmland, a small abattoir with chiller capacity and an animal house with 80 individual pens for sheep. It also owns a piggery with a capacity of up to 120 pigs. Overall facilities are adequate for conducting R&D for the cattle and sheep industries, but additional pig housing capacity is required. The close proximity of Murdoch research facilities to export feedlots (40 km) and the embarkation port for live animal exports (20 km) is a unique feature of the infrastructure currently available.

In terms of future changes, the university plans to develop land currently occupied by the animal house and indoor sheep facility at Murdoch, most likely resulting in the loss of this infrastructure. There are also plans to upgrade cattle yards and handling equipment on one of the existing leased properties. At this stage there are no plans to address the critical gap in relation to pig housing.

University of Sydney

The University of Sydney owns significant facilities and infrastructure for conducting animal welfare R&D and teaching in relation to all species of farm livestock, and animal welfare is a high priority for the university.

With 7200 ha of farmland, the university runs very large numbers of beef cattle and sheep used for animal welfare R&D and teaching purposes. Cattle and sheep facilities include a small sheep feedlot and a veterinary surgery, offering unique opportunities for undertaking R&D on invasive procedures and pain mitigation. The university also runs a 400 cow dairy herd, and dairy research facilities at Camden include a robotic rotary dairy with 24 stalls. The poultry unit has both cage and free range facilities for both egg and chicken meat production, and is considered unique in relation to its size and capacity for replicated experiments. Pig housing facilities are small and outdated, but are still used for research and teaching.

Due to the proposed development of Sydney airport, the University of Sydney is likely to replace the existing piggery and substantially upgrade the poultry unit. Although no firm plans are in place, these changes are under serious consideration. At the very least, existing facilities will be maintained.

With access to engineering capability and the existing skills and infrastructure within the animal welfare group, the University of Sydney also has the capacity to undertake R&D on automated technologies and remote monitoring and data collection.

University of Queensland

With significant animal welfare science capability and extensive infrastructure associated with the School of Veterinary Science and the School of Agriculture and Food Sciences, animal welfare R,D&E is a high priority for the University of Queensland (UQ). The university is enhancing its capability in animal welfare and behaviour research with a senior academic appointment in 2017. This appointment will lead the reestablishment of welfare research in QAAFI, a UQ research institute.

UQ has large land holdings near Brisbane and Gatton, and combined with excellent facilities at the Queensland Animal Science Precinct (QASP), the university is well equipped to undertake animal welfare R&D for particularly cattle, sheep, goats and pigs. QASP facilities include an accredited research feedlot, a large metabolism unit, climate controlled rooms, an animal behaviour complex, two animal houses suitable for cattle, sheep, goats and pigs and a cattle tick research facility. Many of the QASP facilities may be considered unique, particularly the tick facility and the animal behaviour complex.

At this stage existing facilities are expected to meet UQ's needs over the next 5 years, and although they will be maintained, there are no plans for expansion or any significant change.

Most of UQ's animal welfare R&D facilities are located within QASP at the Gatton campus, and all have been designed with flexibility in mind. Apart from the cattle tick facility, most facilities can be modified or altered to suit the specific needs of an experiment or the species of interest (including poultry if required).

Charles Sturt University

Animal welfare RD&E is considered an important priority stream for the Graham Centre and it is likely that a greater proportion of its activities will be directed to animal welfare in the future.

CSU has significant farm land, sheep, cattle and dairy cows to undertake clinical, production and reproduction trials. The beef cattle feedlot with a capacity of 120 head is currently being upgraded. Pig R,D&E facilities for clinical and behaviour studies are small scale but staff have access to a commercial scale piggery for larger scale research projects. CSU is developing a new sheep feedlot and small pen housing is planned for 2019. It is prospectively considering upgrading its dairy cow facilities.

CSU has broad and unique infrastructure through its close relationship with NSW DPI to undertake animal welfare research on all large production species.

DAFWA

In the National Primary Industries RD&E Framework, animal welfare R,D&E is a low priority for DAFWA.

DAFWA has undergone significant organisational change in the last few years and will likely undergo further organisational change in the near future. Their main sheep research facility is at Katanning and they will continue to maintain facilities for animal welfare research for industry in the near future.

Pig research facilities in Perth are currently used for nutrition and meat quality studies, however these facilities are located in the metropolitan area where prospective new commercial developments have been identified.

Table 7.1 Summary of infrastructure and facilities owned or accessed for animal welfare R,D&E on different livestock types.

Industry	University of Western Australia	University of Melbourne	CSIRO	SARDI/ University of Adelaide	University of New England	Murdoch University	University of Sydney	University of Queensland	Charles Sturt University	DAFWA
Cattle – extensive		***	***	***	***	***	***	***	***	
Cattle – intensive		***	***	***	***	***		***	***	
Sheep - extensive	***	***	***	***	***	***	***		***	***
Sheep - intensive		***		***		***	***		***	
Goats					*	*				
Dairy		***					***	***	*	***
Pork - extensive		***								***
Pork - intensive		***		***		***	***	***	*	
Poultry – extensive		***	***	***	***		***			
Poultry - Intensive		***		***	***		***	***		
Surgery	***	***	***	***	***		***		***	
Animal restraints	***	***	***	***	***	***	***	***	***	
Indoor animal housing	***	***	***	***	***	***		***	***	
Transport		***				***			***	
Unique facilities	Sheep genetic resources.	Large animal heat chambers. Robotic dairy	Remote capture of data.	350 head Roseworthy discovery piggery.	2000 head cattle feedlot.	Facilities close to export feedlots and embarkation sites.	Robotic dairy.	Climate rooms. Specialist PC2 and PC3 large animal facility. Animal behaviour complex.		

Areas of emerging concern	Access to climate chambers for heat stress R&D.	Access to calf rearing facilities, broiler facilities, and preference testing facilities.	Access to facilities for conducting dairy cattle or pig welfare R&D.	More infrastructure is needed for intensive animal welfare RD&E.		Pig housing at scale.	Some current facilities required for urban growth. Pig housing needs replacing.	On-site processing of feed for the feedlot	Dairy milking shed needs replacing.	Some current facilities required for urban growth.

*** Facilities and infrastructure generally adequate.

* Facilities generally small scale or inadequate for large scale experimentation.

Concluding remarks

Infrastructure and facilities available for animal welfare R,D&E appear to be adequate for virtually all of the major R,D&E organisations contacted. Whilst some organisations identified that a lack of suitable infrastructure and facilities in some areas was a concern, (for example, animal environmental chambers to measure heat stress), collaboration with other organisations to access infrastructure and facilities will likely overcome these concerns. No organisation stated that they did not have good access to adequate Infrastructure and facilities for animal welfare R,D&E. Most infrastructure and facilities were not solely dedicated for animal welfare but were available as part of larger teaching, animal production or animal health programs. Most infrastructure and facilities appeared to be owned directly by the R,D&E organisation or able to be accessed through arrangements with State Government agencies or commercial operators. Specialised infrastructure and facilities, such as animal surgery, were generally associated with organisations that had a veterinary school. Large animal environmental chambers, used for assessing animal heat stress, were available for animal welfare R,D&E in several organisations.

The cattle, sheep, pork and poultry sectors have good access to adequate infrastructure and facilities. There were a small number of facilities for R,D&E on goats however, goat R,D&E could be conducted in facilities designed for sheep, for which there is adequate infrastructure and facilities.

Some R,D&E organisations (e.g. SARDI/University of Adelaide, University of New England) were updating infrastructure and facilities dedicated to animal welfare R,D&E. Other organisations (e.g. University of Melbourne) were in the early stages of planning for new facilities.

No organisation indicated that they will reduce infrastructure and facilities for animal welfare R,D&E in the next five years. However, the University of Sydney and DAFWA both indicated that some infrastructure and facilities currently used for animal welfare RD&E were at locations that were required for urban development and replacement facilities would be subject to budget availability and could possibly be at risk in future.

7.   Conclusions and Recommendations

Each of the preceding chapters included considerable discussion on the specific capability focus of the chapter and has been utilised in formulating the following conclusions and recommendations.

Capability surveys provide a point-in-time 'snap-shot' of the type, scale and strength of capability currently applied to address industry priorities. When similar surveys have been conducted in the past (e.g. the current study represents the second formal survey of animal welfare R,D&E capability and infrastructure inventory for the Australian livestock industries), trends can be examined in the context of previously identified gaps and changing priorities over time.

Assessing the suitability and adequacy of existing capability to meet the future requirements of the livestock industries requires consideration of existing priorities (as described in the NAWRDE Strategy, 2017), and the possible evolution of new priorities together with the broader operating environment. In framing the recommendations and actions described below, the Project Team has sought to achieve both.

Current and Emerging Capability Gaps

Chapter 4 of this report is devoted to 'An Assessment of animal welfare R,D&E Capability', wherein the Project Team has analysed **current** R,D&E capability and its' strengths and weaknesses to address industry priorities (expressed in the NAWRDE Strategy, 2017) over the next 5-10 years.

The assessment of research capability currently being applied to animal welfare indicates that the livestock industries and the NAWRDE Strategy are well placed to have access to the necessary capability to address current and emerging priorities. The research capability in many of the key science disciplines (Fields of Research), such as Animal Management and Animal Behaviour, is strong, while in most other relevant science disciplines there is good scope to access additional capability, as required, from the agricultural production R&D sector and non-agricultural sectors. However, this study has identified a small number of science disciplines that will be important to address the agreed priorities over the next 5 years for which specific capability building actions are likely to be required, for example in Humane Animal Treatment and Rural Sociology where accessing existing capability in these fields may be more difficult, necessitating an investment in growing capability.

Capability surveys provide a point-in-time 'snap-shot' of the type, scale and strength of capability currently applied to address industry priorities. However, in situations where priorities may change quickly due to consumer attitudinal changes and where key capability has been identified as low and dispersed and reliant on accessing capabilities from the production sector or non-agriculture sector, more frequent review of existing capability in key fields is warranted.

Recommendation 1. That the NAWRDE Strategy Steering Committee commit to an annual meeting of animal welfare R,D&E investors and providers to assess progress in securing and sustaining key capabilities within each of in the six priority themes in the NAWRDE Strategy.

Humane Animal Treatment is specific to animal welfare and while a reasonable cohort of capability currently exists, this may well be insufficient for any increase in the priorities of the NAWRDE themes of 'Pain Assessment and Management' and 'Transport, Euthanasia and Slaughter'. Building new capability is likely to be important.

The NAWRDE Strategy (2017) identifies the priority theme of "Attitudinal Effects on the Welfare of Livestock throughout the Value Chain" and it is this theme that warrants greatest consideration for the adequacy of capability. The key research capabilities required for this theme are all contained within the 'Sociology and Ethics' disciplines, where the total current capability is limited and increased capacity will be required. There is potential capacity in the social sciences in several government departments and universities associated with the agricultural productivity and non-agricultural sectors, however, social science capability is increasingly being sought by the agricultural production sector (particularly in the design and development of new extension delivery models and for research design and prioritisation). Consequently, the ease and assuredness of being able to access the necessary capability from other RD&E sectors needs further investigation. Developing new animal welfare focussed capability including postgraduate training is likely to be important.

Recommendation 2. That the NAWRDE Strategy Steering Committee support a review, involving investors and providers, to determine the future scale and requirements for Sociology and Ethics research capability and explore options to strengthen capability by:

 a. *Establishing a database of interested and available organisations and individuals containing the necessary capability;*
 b. *Examining the prospect of investing in additional postgraduate student training in Sociology and Ethics capability; and*
 c. *As Sociology and Ethics is a cross – sectoral issue, consider a strategic appointment in animal welfare Sociology and Ethics within an R,D&E provider organisation with strong critical mass to provide national leadership and to build linkages and partnerships.*

The development of education and extension packages covering key animal welfare issues will be an increasingly important mechanism for securing changes in practices by industry and broader community support for the agricultural production sector. This is a focus in the NAWRDE Strategy theme of 'Education, Training and Extension'. The capability identified in the survey that is currently being applied to address both specific industry sector and cross sectoral animal welfare education and extension package development is likely to be marginal at best for the future. The development of such packages requires a unique combination of skills, including technical knowledge, understanding adult education principles, a knowledge of demographic preferences in information and learning, an ability to distil complex R&D findings into simple messages and a knowledge of contemporary information media. There is likely to be scope, and a need, to access suitable capability from the private sector, particularly private veterinary practices and agricultural consultants, several of which have had previous engagement in animal welfare practice delivery. The agricultural production and non-agricultural sectors also offer potential capability. The increasing importance and in some cases urgency for new education and information packages suggests a cross sectoral approach to defining the required future capability scale and priority targets for packages, together with developing a panel of interested and available organisations and individuals containing the necessary capability, could be

advantageous. Additionally, the results from the capability survey indicate that a small percentage of current animal welfare researchers directly participate in this theme and thus opportunities exist for broadening researchers' engagement and skills to support the theme.

Recommendation 3. *That the NAWRDE Strategy Steering Committee supports a review by investors and providers to determine the future scale and priority information targets for Education and Extension Information Package Development capability and explore options to strengthen capability in the private sector and utilising experienced researchers by establishing a database of interested and available organisations and individuals containing the necessary capability.*

Postgraduate students are a key mechanism for developing the next generation of researchers in order to sustain existing capability and/or to develop new fields of capability required to address industry priorities in the medium to long term. The current postgraduate training is predominantly occurring in the Fields of Research of Animal Behaviour and Animal Management, two fields that are comparatively well resourced by existing researchers. There is a lack or shortage of postgraduates in a number of the key capabilities required for the NAWRDE Strategy priority themes, such as Animal Neurobiology, Engineering Instrumentation, Humane Animal Treatment and Sociology and Ethics.

Recommendation 4. *That the NAWRDE Strategy Steering Committee support a cross-sectoral approach to building capability through postgraduate student training in key disciplines for animal welfare R,D&E that have low and dispersed capability (for example, Engineering Instrumentation, Humane Animal Treatment, and Animal Neurobiology) and that are reliant on accessing capabilities from the production sector or non-agriculture sector.*

Strategic Partnerships to Address Capability Gaps

There is a requirement for an on-going commitment by animal welfare R,D&E providers to ensure capability is well integrated and linked to other capability across Australia (and new Zealand), particularly for multi-disciplinary research programs and where the existing scale of capability in a Field of Research is limited and/or distributed across multiple locations or organisations. Many RDCs and research providers are establishing large-scale strategic partnerships as a means of addressing important capability issues and ensuring research is focussed on priority industry issues. The rationale is to bring research agencies, funding bodies and sometimes regulatory organisations together, in either bilateral or multilateral agreements, to combine skills and resources to either deliver an integrated outcome or fill a capability gap.

There are a number of different partnership models that exist currently across a number of different agriculture sectors. Some of these have been developed to address a large issue that one organisation could not address on its own (e.g. The CRCs for dairy, beef, pork, poultry and sheep) while others have been specifically developed in response to a particular need, such as low levels of capability and

capacity in a particular area (e.g. AWSC for animal welfare). The new Animal Welfare Strategic Partnership for the Red Meat industries, currently being established by Meat and Livestock Australia to address animal welfare priorities identified in the Meat Industry Strategic Plan 2015, is an excellent example of an emerging initiative involving multiple organisations in a strategic partnership. Another excellent example of a multi-organisation partnership is the Animal Welfare Science Centre which has considerable animal welfare R,D&E capability to address four of the six priority themes in the NAWRDE Strategy (2017), including Animal Welfare Assessment; Management, Housing and Husbandry; Attitudinal Effects on the Welfare of Livestock; and Education, Training and Extension. Capability to address the other two priority themes is low in the AWSC and dispersed across a number of R,D&E organisations. However, capability to address the priority theme "pain assessment" is available in most university veterinary faculties.

From discussions held with the major R,D&E providers, it is evident that strategic partnerships with industry bodies are highly valued for their ability to build relationships with industry, provide clarity of priorities, a level of funding security and a building of critical mass in key capabilities. For R,D&E providers, additional benefits include assistance in identifying future staff capability requirements and planning for post-graduate student enrolments, while for industry the R,D&E provider partnerships enable access to existing expertise that might otherwise be applied to other agricultural sectors and can enable industry content input to undergraduate programs.

Recommendation 5. *That the NAWRDE Strategy Steering Committee*

   a. *recognises the value and importance of multi-organisational strategic partnerships, such as the AWSC, in building capability and maintaining a critical mass to address animal welfare RD&E priorities;*

   b. *actively supports existing strategic partnerships through co-investment arrangements and long term funding agreements that provide R,D&E organisations with the funding certainty required to maintain and build capability; and*

   c. *identifies and promotes opportunities to establish new collaborative arrangements to help maintain existing capability and to fill capability gaps.*

Assessment of Future trends of RDCs

From the analysis conducted in chapter 5, animal welfare R,D&E is a high priority for all livestock industry RDCs and all are planning to either increase or maintain their current levels of investment in this area. The majority of livestock RDCs are already investing in cross sectoral projects identified as high priorities in the NAWRDE Strategy (2010).

As well as demonstrating the impact of investment in R,D&E, formal and structured evaluation can be used to demonstrate effective pathways to market. We have documented three case studies as examples of effective pathways to market demonstrating the impact of research outcomes. From our analysis, there is little evidence that evaluation findings are being shared and used to maximum

benefit. In many cases, animal welfare evaluations are regarded as 'commercial in confidence'. The NAWRDE Strategy Steering Committee should support the undertaking of formal, independent evaluations of investments in animal welfare R,D&E, broadening the scope to include social and environmental, as well as economic, benefits and sharing the findings with all stakeholders. Evaluations could then be used to identify industry outcomes and benefits and demonstrate progress towards achieving higher standards of animal welfare.

Recommendation 6. That the NAWRDE Strategy Steering Committee advocate for and support formal, independent evaluations of investments in animal welfare R,D&E, broadening the scope to include social and environmental, as well as economic, benefits and sharing the findings with all stakeholders, with a particular focus on providing guidance to Education and Extension capability and improving service delivery.

Assessment of Infrastructure and Facilities

From the analysis conducted in Chapter 6, Infrastructure and facilities available for animal welfare R,D&E appear to be adequate for virtually all of the major R,D&E organisations contacted. Whilst some organisations identified that a lack of suitable infrastructure and facilities in some areas was a concern, (for example, animal environmental chambers to measure heat stress), collaboration with other organisations to access infrastructure and facilities will likely overcome these concerns. No organisation stated that they did not have good access to adequate Infrastructure and facilities for animal welfare R,D&E.

Recommendation 7. That the NAWRDE Strategy Steering Committee note that infrastructure and facilities were generally adequate for R,D&E, and where localised concerns arise, organisations requiring specialised facilities should be encouraged to collaborate with other organisations with those facilities.

8. References

Centre for International Economics. 2016. An Impact Assessment of MLA Expenditure 2010/11 to 2014/15. Meat and Livestock Australia Internal Report.

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9. Appendices

The appendices can be found in the separate Volume 2 of the report.