Final report

Lifetime Animal Wellbeing Index (LAWI) – Scope and Governance Project
Final Report

Abstract

The red meat industries are increasingly under pressure to demonstrate and validate strong commitments to animal welfare and ethical treatment. Due to the challenging and complex nature of an objective approach to describe lifetime animal wellbeing, the objective of this project was to scope out the design for an approach to describe lifetime animal wellbeing in the red meat industries. Existing welfare frameworks and stakeholder needs were explored. Other project components included a framework for cost-benefit analysis, and a proposal for database requirements and governance principles.

Early in the project, it emerged that the initial idea of exploring a lifetime animal wellbeing index might not meet the diversity in industry stakeholder needs and the scope was opened to alternatives, such as modular approaches that enable early delivery of a minimum viable product.

The proposed industry Livestock Wellbeing Assurance Program can be established using animal measures routinely collected by industry but brought together and reported on following the development of key enabling technologies. Industry familiarity with the measures should promote early adoption, while phased development enables the optimisation of past and future investments, by utilising measures and systems already in operation but providing scope for enhancement as new and credible measures are validated. Successful delivery would enable both current and bespoke Welfare/Wellbeing Assurance schemes providing the opportunity to assure a minimum standard but also allow product differentiation when required.

To achieve this in practice will be highly challenging and complex. The envisaged impact of a Livestock Wellbeing Assurance Program has clear impacts for improved outcome for the animals, with economic, social and environmental outcomes being secondary flow-on impacts. Such a program will underpin the sustainability of the whole red meat supply chain.

Executive summary

Background

The red meat industries are increasingly under pressure to demonstrate and validate strong commitments to animal welfare and ethical treatment, however the assessment of livestock wellbeing over the lifetime of an individual animal and a mechanism to deliver the information to end-users is both highly challenging and complex. As a pre-requisite, it is essential to develop a compelling business case for an industry program to describe lifetime animal wellbeing and to define the scope and path to impact, including risk mitigation, delivery mechanisms, underpinning data platforms, and governance.

Objectives

The objective was to scope out the design for an approach to describe lifetime animal wellbeing in the red meat industries.

Methodology

To scope the development of a Lifetime animal wellbeing index existing welfare frameworks and stakeholder needs were explored. A global scan of existing frameworks was conducted, an impact pathway was developed, stakeholder interviews conducted, including an R&D workshop. A framework for a cost-benefit analysis was established and principles for database requirements and governance have been proposed.

Results/key findings

The proposed industry Livestock Wellbeing Assurance Program can be established using animal measures routinely collected by industry but brought together and reported on following the development of key enabling technologies. Industry familiarity with the measures should promote early adoption, while phased development enables the optimisation of past and future investments, by utilising measures and systems already in operation but providing scope for enhancement as new and credible measures are validated. Successful delivery would enable both current and bespoke Welfare/Wellbeing Assurance schemes providing the opportunity to assure a minimum standard but also allow product differentiation when required. To achieve this in practice will be highly challenging and complex.

Benefits to industry

The primary impact of a Livestock Wellbeing Assurance Program would be the improved wellbeing outcomes for the animals, with other economic, social and environmental outcomes being secondary flow-on impacts. An approach to objectively describe lifetime animal wellbeing is unlikely to generate a long-term competitive advantage for an individual industry stakeholder but will facilitate the sustainability of the whole red meat supply chain.

Future research and recommendations

The exploration of the current red meat supply landscape, with respect to welfare assurance schemes and stakeholder needs, has provided principles to guide the concept for design and implementation of a Livestock Wellbeing Assurance Program. The existence of knowledge gaps and missing detail is acknowledged, but these should not prevent initiation and design of the Program. Indeed, these gaps should become the focus of a supporting research and development plan. The development and implementation of the proposed program should be phased to optimise existing

and future investments and increase adoption. The proposed Livestock Wellbeing Assurance Program is applicable to both sheep and cattle.

List of abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABRI	Agricultural Business Research Institute
ABSF	Australian Beef Sustainability Framework
ALFA	Australian Lot Feeders' Association
API	Application Programming Interface
AUS	Australia
BL	Baseline
C&A	Commercialisation and adoption
CSSHREC Committee	CSIRO Social and interdisciplinary Science Human Research Ethics
CWB	Cattle Welfare Benchmarking
DAFF	Department of Agriculture, Fisheries and Forestry
EU	European Union
eNVD	electronic National Vendor Declaration
GAP	Global Animal Partnership
I	Implementation
LAW	Lifetime Animal Wellbeing
LAWI	Lifetime Animal Wellbeing Index
LDL	Livestock Data Link
LIP	Livestock Information Platform
LPA	Livestock Production Assurance
MDC	MLA Donor Company
MEL	Monitoring, Evaluation and Learning
MSA	Meat Standards Australia
MVP	Minimum Viable Product
NABRC	Northern Australia Beef Research Council
NFAS	National Feedlot Accreditation Scheme
NFF	National Farmers Federation
NLIS	National Livestock Identification System

NSQA	National Saleyard Quality Assurance Program
NVD	National Vendor Declaration
NZ	New Zealand
PIPA	Participatory Impact Pathway Analysis
RSPCA	Royal Society for the Prevention of Cruelty to Animals
SALRC	Southern Australia Livestock Research Council
S&G	Standards and Guidelines
SMG	Sustainable Management Group
SSF	Sheep Sustainability Framework
R&D	Research and Development
UK	United Kingdom
US	United States

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1. Background

1.1   Introduction

Livestock producers, livestock industry managers and supply chain actors are increasingly under pressure to demonstrate and validate strong commitments to animal welfare and ethical treatment. The pressure to provide robust animal welfare data and information stems from a range of influential actors including investors, regulators, multinational traders, animal advocacy and welfare groups, retailers, and consumer groups.

For businesses that produce, trade, or sell livestock and their products, the measurement of animal wellbeing presents opportunities for mitigating brand and social license risk, but it also presents market opportunities to build trust in the supply chain for differentiating products based on assurance of higher animal welfare standards.

Australia's red meat industries are taking a proactive approach to the risks and opportunities around verifying animal welfare. This includes commitments to the application of "world class animal health, welfare, biosecurity and production practices" which was central to the livestock focussed priorities listed in Red Meat 2030 (Red Meat Advisory Council 2019). This is also supported in MLA's Strategic Plan 2025: "To become the trusted source of the highest quality protein the focus should be on product quality and product attributes, including animal health, welfare and environmental credentials".

The assessment of livestock wellbeing over the lifetime of an individual animal and a mechanism to deliver the information to end-users is both highly challenging and complex. It is difficult to define in the first instance, will likely be introduced in a staged manner and it can be constantly evolving due to its multifaceted nature. There are multiple drivers of influence including geographical, environmental, and temporal effects that will impact the welfare experience of an animal over its lifetime. Emphasis on objectivity in the assessment of welfare is paramount. Addressing this problem requires an understanding of the complexity, interconnectedness, trade-offs, and recognition of the requirements of the various stake holders along the supply chain.

1.2   Project Purpose

There is a strong need for standardised, objective information to define animal wellbeing. Capturing wellbeing throughout an animal's life is ambitious and challenging, due to the requirement for an efficient and pragmatic but not over simplified approach that drives industry application and adoption. Notwithstanding this, the development of an approach that describes lifetime animal wellbeing (LAW) objectively is ultimately central to growing consumer and market trust in Australian red meat products. As a precedent, Meat Standards Australia (MSA) has demonstrated that it is possible to capture multiple inputs over the life of an animal and convert these (post-slaughter) into a simple verifiable index that quantifies and conveys eating quality to the consumer. Moreover, this innovation has been internationally recognised highlighting Australia's global leadership in meeting consumer and retailer needs. Similarly, an approach to describe LAW that accounts for the physiological and behavioural changes and adaptations that reflect animals' wellbeing throughout their lifetime will provide a vehicle for continuous improvement to improve both the on-farm and pre-slaughter animal experience and underpin growth in consumer trust and global market access.

The development and validation of methods to assess animal welfare has and continues to be a primary research focus in Australia and internationally. For example, in 2006 the Objective Welfare Measures Program was initiated and jointly funded by MLA, Australian Wool Innovation and Meat and Wool New Zealand. Exploiting the past, integrating the current and initiating new research and development (R&D) will be critical in the development of an innovation framework that breaks new ground in the context of assessing lifetime animal wellbeing. Given the size of the challenge, it will be essential that this framework has clear staged deliverables that can be integrated over time to achieve a comprehensive Livestock Wellbeing Assurance Program.

However, as a pre-requisite, it is essential to develop a compelling business case for an industry program to describe LAW and to define the scope and path to impact, including risk mitigation, delivery mechanisms, underpinning data platforms, and governance. The breadth of key aspects requires a thorough review and analysis with stakeholder consultation being the key mechanism for the creation and implementation of a Livestock Wellbeing Assurance Program. It is essential that key players from industry and other research organisations are engaged in the process from the beginning.

Note that the project brief initially explored a Lifetime Animal Wellbeing Index (LAWI). In the project components stakeholder engagement questions were framed around a LAWI and hence throughout Section 2 - 4 the wording has been retained. However, in the synthesis of the information from the project, the scope pivoted to a Livestock Wellbeing Assurance Program with more flexibility to address stakeholder needs. Therefore, the output from this report is referred to as such from Section 5 onwards.

2. Objectives

2.1   Global scan

Deliver a comprehensive and extensive global scan and evaluation of frameworks and methodologies that assess animal welfare/wellbeing for sheep and cattle, to act as a foundation for the development of this LAWI to understand the regional opportunities, the challenges, and benefits to industry implementation when the information is interpreted in an Australian context. Linkages with other sustainability frameworks, e.g. carbon and biodiversity, will be acknowledged and captured.

This objective has been fully achieved. The global scan has been completed with the report attached to this milestone report.

2.2   Value proposition and cost benefit

Define and describe the value proposition and cost benefit analysis for each part of the red meat supply chain. The value of a LAWI to stakeholders in the red meat supply chain will be evaluated from stakeholder interviews. Extensive interviews will be held with beef supply chain stakeholder and some in relation to the sheep meat supply chain to understand the difference in end-user needs and envisaged value proposition. A workshop with stakeholder in the R&D space will map the current R&D landscape and existing data sources and conduct a research gaps analysis to deliver a staged LAWI that meets end-user needs in the beef and sheep meat supply chain. The latter will assist in defining the necessary R&D including timeframes, estimated budget requirements and co-investment opportunities. The of value to parts of the industry and R&D cost will be drawn together in a cost-benefit analysis.

This objective has been fully achieved. The impacts and outcomes captured in this milestone report serve as a starting point to validate against with stakeholders.

2.3   Governance structure

Recommend a governance structure to oversee all phases of the delivery of a LAWI. Options include but are not limited to a strategic partnership, grants, centre of excellence, or similar collaborative consortium model.
This objective has not been fully achieved. Since the governance structure is highly dependent on the program participates and the funding model, only a high-level description was provided. The final report will detail options more specifically.

2.4   Research and Development program

Define and outline the R&D programs of work to be addressed to enable successful delivery of a LAWI sheep and cattle. This must include at a minimum: objective animal measures during the animal's life; post slaughter measures; on and off animal technological opportunities; physiological and behavioural measures; data platforms and management; retail and consumer buy-in delivery pathways. All the information will be synthesized in the workshop and mapped on a timeline from minimum viable product to most comprehensive LAWI as a pathway for development.

This objective has been fully achieved. The R&D workshop was held at the end of April. The information from the workshop will inform the research pillars proposed in the final report.

2.5   Impact pathway and ex-ante analysis

The impact pathway analysis and ex-ante analysis allow setting of appropriate stop/go points, specifying metrics for validation, monitoring and planning for potential pivot points.
Progress: This milestone has contributed to the progress of this objective. A draft impact pathway for a LAWI has been developed to identify inputs, activities, outcomes and impacts. The impact pathway will evolve and will be refined during the project. The ex-ante analysis, identifying metrics for validation, monitoring success and stop/go points will be conducted when more detailed understanding of the stakeholder requirements and inputs have been attained.

This objective has been fully achieved. The impact pathway provides the narrative to industry how impact will be achieved.

2.6   Timeline and basic cost estimates

Produce a timeline and basic cost estimation for pathway to development of a LAWI and the likely operational costs for delivery and identification of funding opportunities/ partnership opportunities to leverage MDC funding.

This objective has not been achieved. The project team expected to have more information to explore cost estimates. A framework for a cost-benefit analysis has been developed.

2.6   Stakeholder engagement

Bring together all stakeholders (workshop/s) to socialise all possible avenues and ideas that may contribute to the design and implementation of a LAWI. This will include deliverers of the appropriate research, representatives from industry and appropriate government agencies.

This objective has been fully achieved. Extensive stakeholder feedback has been received and has contributed to the pivot in the project.

3. Methodology

3.1 Global scan - Evaluating international assessment schemes

3.1.1 Identifying schemes for beef and sheep

To identify international beef assurance schemes an online Google search was conducted using terms of 'beef cattle welfare assurance', 'beef animal welfare certified', 'welfare assessment scheme beef', 'beef animal welfare assurance', 'beef cattle welfare assurance South America', 'feedlot welfare assurance', and feedlot welfare assurance USA'. A list was comprised of all schemes that were identified during the online search. Many of these schemes covered multiple agricultural animal species and thus also included standards for sheep. Other existing welfare assurance schemes for sheep were identified, using the search terms 'sheep welfare scheme', 'sheep welfare label' and 'animal welfare labelling'. The PDF files of the specific assessment schemes/criteria that were used were downloaded, or URLs saved for any scheme that did not have a file to download. For schemes that were not available online, contact was made with the assurance provider to request a copy of their scheme providing a brief background on why the request was being made. Given the difficulty in knowing if all schemes had been identified or not during online searches (there is no central point that lists international assessment schemes for beef cattle/sheep welfare), individuals who are known to be involved with assessment schemes (research institutions or NGOs) were contacted directly via email for their input. They were supplied with the list of previously identified schemes to confirm whether there were any schemes they knew of that were missing. Via this method, several more schemes were identified and added to the list. Once a collection of over 30 schemes had been collated that spanned across the United Kingdom (UK), European Union (EU), United States (US), Canada, and New Zealand, the standards were examined, and tables compiled to summarise the general information.

3.1.2 Summary of schemes

Once a collection of over 30 schemes had been collated that spanned across the UK, EU, US, Canada, and New Zealand, the standards were examined, and tables compiled to summarise the general information. For each scheme that was available, a range of general information about the scheme was compiled to summarise overarching origins, goals and implementation of the scheme. A selection of 5 schemes were then identified that were internationally recognised, and/or frequently or widely used, and/or highly outcome-based (i.e., animal-based measures), and/or applicable to Australia. These schemes comprised Welfare Quality® (EU), Red Tractor (UK), GAP (Global Animal Partnership, US), RSPCA Assured (uses AssureWel for animal-based indicators, UK), and a recently developed scheme for New Zealand (NZ) extensive pasture-based systems. Using these schemes, a table was created that summarised the general areas of welfare that are covered under each scheme's guidelines.

3.2 Impact pathway analysis

3.2.1 CSIRO Impact pathway framework

The CSIRO impact pathway framework provides a structured tool to break-down and visualise how research translates into real world benefits (Fig. 1). It enables the identification of a critical pathway that specifies the elements that are critically required to achieve impact from innovation. The pathway systematically aggregates information types, including: Inputs (e.g. resources or staff), Activities (e.g. research components), Outputs (e.g. technology, papers, reports), short, long and

medium term Outcomes (e.g. changes in work practices or technology), and long term social, economic and environmental Impacts. For simplicity, the impact pathway is drawn as a linear process with the understanding that it loops back at all stages. A good way of establishing the framework is to start at the high-level impacts ("What is ultimate success?") and step back component by component and ask the question "What needs to happen to achieve the higher-level component?". Project inputs, activities and outputs are often quite easy to define, but outcomes that describe the changes required to achieve the envisaged impact are more difficult to specify. Input, activities and outputs can be planned for and can be controlled. Outcomes and impact are aspirational and reflect intended results.

Figure 1. CSIRO's Impact Pathway Framework derived from the work of the W.K. Kellogg Foundation.
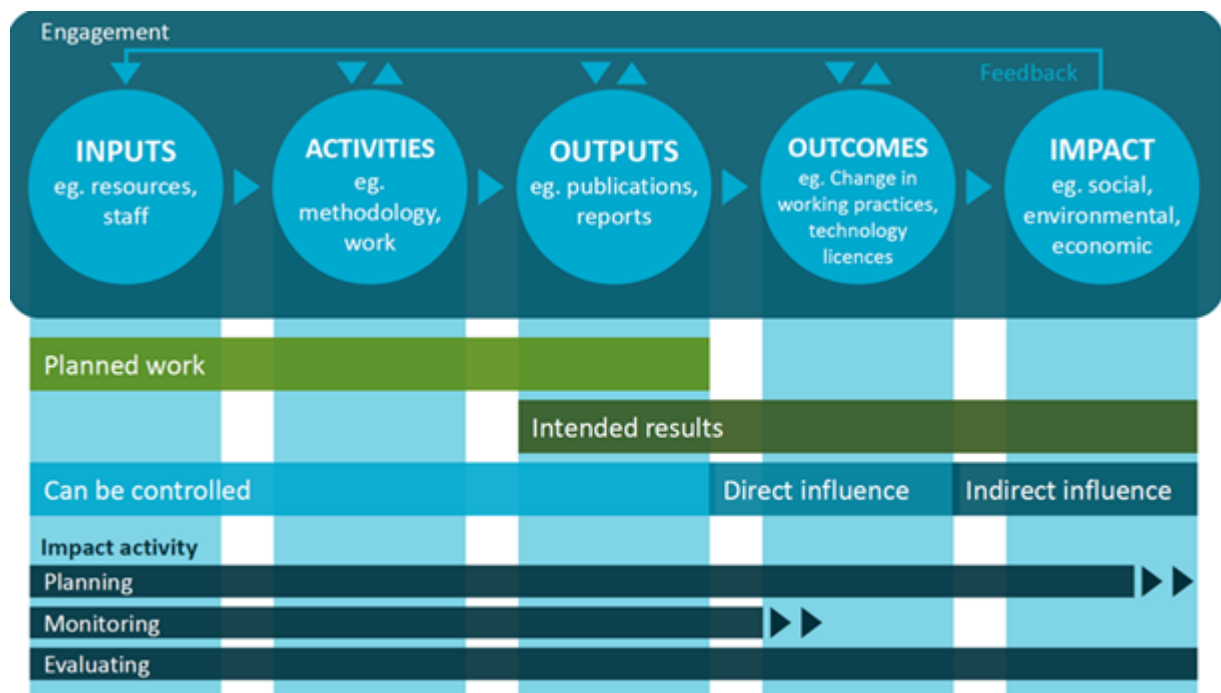
3.2.2 Participatory Impact pathway analysis (PIPA)

Participatory Impact Pathways Analysis (PIPA) has been developed in the research-for-development context (Douthwaite et al. 2007). It is a framework to develop a plan and monitoring and evaluation framework for complex projects.

An externally facilitated online participatory workshop with a diverse range of stakeholders, representing the red meat supply chain, research community, government, allied industries and MLA (see Appendix 9.1 for the list of participants) was convened. Stakeholder assumptions on how a LAWI will create impact in the red meat industries, anticipated outcomes and stakeholder needs were captured in an excel spreadsheet and discussion notes and resulted in the development of a draft an impact pathway. The draft impact pathway will continually evolve throughout the project through stakeholder engagement activities and further input. As part of the workshop, assumptions, risks and counterfactuals were also established.

3.3   Research & Development workshop

3.3.1   Format

The Lifetime Animal Wellbeing (LAW) Research and Development (R&D) face-to-face workshop was held at the Stamford Plaza Hotel, Sydney Airport, on the 27th and 28th of April 2022 f. The workshop was approved by the CSIRO Social and Interdisciplinary Science Human Research Ethics committee as "Lifetime livestock welfare workshop" approval number 067/22. Attendees were mainly researchers, representatives from Meat and Livestock Australia (MLA), one consultant and one representative from a commercial business (Appendix 8.5 provides a list of attendees). The workshop was facilitated by Scott Williams from Forrest Hill Consulting. The workshop involved a mix of presentations and break-out sessions to maximise contributions from attendees.

3.3.2   Workshop Goals

The goal of the workshop was to scope and identify R&D needs to enable the development of a framework to assess lifetime animal wellbeing in sheep and cattle through the supply chain.
The agenda is attached as Appendix 8.6. It was designed with the following goals in mind:
- Inform participants of the objectives of the MLA-funded project and the results it has generated to date in the global scan, stakeholder engagement and impact pathway analysis
- Open up participants' thinking and ask to contribute on what a future, ideal system for measuring and reporting lifetime animal wellbeing (LAW) might look like
- Identify a minimum viable product (MVP) that could be delivered in the short term, using existing data sources
- Describe what R&D gaps exist between the MVP and future ideal approach

3.4 Stakeholder feedback

3.4.1   Define the red meat supply chain

An overview of Australia's red meat supply chain was used to identify relevant governance systems and industry sectors. Stakeholders were selected from across this spectrum.

3.4.2   Approval to conduct survey

An application was prepared and submitted to the CSIRO Social and Interdisciplinary Science Human Research Ethics Committee (CSSHREC) for approval to undertake the stakeholder survey.

3.4.3   Stakeholder interview questions

The following introduction was provided for those running the survey to provide context for all participants. Similar information was also contained in the Participant Information Sheet (8.1) provided to all stakeholders.

Introduction / Background
There is a strong need for standardised, objective information in order to define animal wellbeing. Capturing wellbeing throughout an animal's life is very ambitious and challenging, due to the requirement for an efficient and pragmatic but not over simplified approach that drives industry

application and adoption. Notwithstanding this, the development and application of an objective approach to describe lifetime animal wellbeing is ultimately central to growing consumer and market trust in Australian red meat products. As a precedent, Meat Standards Australia (MSA) has demonstrated that it is possible to capture multiple inputs over the life of an animal and convert these (post-slaughter) into a simple verifiable index that quantifies and conveys eating quality to the consumer. Moreover, this innovation has been internationally recognised highlighting Australia's global leadership in meeting consumer and retailer needs. Similarly, a LAWI that accounts for the physiological and behavioural changes and adaptations that reflect animals' wellbeing throughout their lifetime will provide a vehicle for continuous improvement to improve both the on-farm and pre-slaughter animal experience and underpin growth in consumer trust and global market access.

Red meat supply chain Stakeholder Interview Questions

1)   Describe your business / roll in the red meat supply chain
      a.   For producers
            i.   What type of animals do you handle? How many?
            ii.   What is your approach to the management of animal welfare?
      b.   For other supply chain businesses
            i.   What is / are the target market/s for your product?
            ii.   How do you differentiate your product currently? (If not, why not?) What are the key features of your product?

2)   What existing animal welfare systems / certification schemes are you aware of? (Domestic / International)

3)   Do you currently use any of these welfare systems / or label product with welfare attributes?

4)   Based on your observations of, or experience with welfare assessment/certification, what are the primary benefits and shortcomings of these schemes

5)   Do you think it is feasible to develop an approach to objectively describe animal wellbeing?

6)   Is an approach to describe lifetime animal wellbeing something that your business / the industry needs? (Domestic or international focus or both?)

7)   What would make you use an objective approach to describe lifetime animal wellbeing?

8)   Would you be prepared to measure welfare in different ways?
      a.   Sensors / blood parameters?
      b.   What are the key considerations for adoption? (Cost / automation)

9)   Should a descriptor of lifetime animal wellbeing be a single set of criteria for all, or does it need flexibility? (What are the key considerations?)

10)   How would you use an approach to describe lifetime animal wellbeing in your business? (Compliance, product certification, continuous improvement)

11)   What is the value that it could create for your business / in industry?

12)   Apart from being a challenge to put together, what do you see as the biggest impediments to achieve impact?

13)   Any thoughts/comments on how the major impediments could be managed or overcome?

14)   Is there anyone else that you suggest we should interview?

3.5   Cost-benefit analysis

The process of developing an objective description of lifetime animal wellbeing is complex. This requires a structured approach that defines the scope of a framework to objectively describe lifetime animal wellbeing and a clear understanding of the value of such a system to stakeholders. Our method to define the starting system and the associated benefit, and cost were as follows.

1) Definition of value and associated benefits
   a) Increased product value (premium)
   b) Increased market access
   c) Risk mitigation
2) Define attributes of an objective approach
3) Cost implementation
4) Quantify benefits of an objective approach

Further, the value (economic, social or environmental) of lifetime wellbeing was not well defined and tended to differ between players of the red meat supply chain. Data collected during the project, particularly through the impact pathway mapping, global scan of welfare methodologies and stakeholder survey feedback has only reinforced this position. Significantly the scope of a lifetime wellbeing standard is yet to be defined and agreed (what will be measured and when). Nor is there clarity around whether the wellbeing standard would operate as a single universal system or if variations of a scheme might be required to address concerns around geographical differences in the Australian production system or through consideration of animal type (cattle, sheep, breed). As a consequence, the level of detail required to inform a cost-benefit analysis was not delivered, from earlier project activities (e.g. stakeholder interviews, R&D workshop and impact pathway), at the level of maturity required to inform a credible cost benefit analysis. As an alternative, and in consultation with MLA project managers, it was therefore decided that this milestone should report on the framework, and assumptions, that underpin a cost-benefit analysis.

3.6   Database requirements

Considering the complexity of the Australian red meat supply chain and data collection points throughout, a high-level view of database requirements has been presented. Existing data sources are listed and described how they would fit into a proposed framework that objectively describes lifetime animal wellbeing. A database model with diverse data streams is conceptualised and functionalities of a cloud-based data platform described. As an example, the data plat form that underpins the MLA funded Cattle Welfare Benchmarking is described.

3.7   Governance structure

A governance structure is sketched out suited to an industry program to improve lifetime animal wellbeing will move through different phases of technological maturity and industry delivery:

- Research and Development
- Implementation and Adoption
- Management and Operations (including database management)

3   Results

4.1   Global scan – evaluating international assessment schemes

4.1.2   List of international schemes

A list of available schemes for beef and sheep cattle have been compiled including links to the websites and pdf of their standards if publicly available.

List of international welfare assurance schemes for beef and sheep

- Welfare Quality: http://www.welfarequalitynetwork.net/en-us/reports/assessment-protocols/

- AssureWel: http://www.assurewel.org/beefcattle.html; http://www.assurewel.org/sheep.html

- University of California at Davis: Cow/calf assessment: https://www.ucdcowcalfassessment.com/

- Bord Bia: https://www.bordbia.ie/globalassets/bordbia.ie/farmers--growers/farmers/qas/document-libraries/sblas-pdfs/sustainable_beef_and_lamb_assurance_scheme_standard.pdf, refers to FAWAC animal welfare code: http://www.fawac.ie/publications/animalwelfareguidelines/

- GAP: https://globalanimalpartnership.org/standards/beef; https://globalanimalpartnership.org/standards/sheep/

- Red Tractor: https://assurance.redtractor.org.uk/contentfiles/Farmers-6832.pdf?_=636656002697091706

- Soil Association (SA). https://www.soilassociation.org/

  sa-gb-farming-_growing-standards.pdf (soilassociation.org)

- Quality Meat Scotland (QMS) QMS Cattle & Sheep Assurance Scheme | Quality Meat Scotland (qmscotland.co.uk)

- RSPCA Assured/Freedom Foods RSPCA welfare standards for beef cattle - RSPCA; https://science.rspca.org.uk/sciencegroup/farmanimals/standards/sheep

- NZ Assessment Scheme: presented in research paper. Part 1: https://www.mdpi.com/2076-2615/10/9/1597; Part 2: https://www.mdpi.com/2076-2615/10/9/1592
- Assured British Meat (ABM) uses the Red Tractor Scheme.

- Animal Welfare Approved: Certified Animal Welfare Approved by AGW food label. (agreenerworld.org)

- Certified Humane - A Project of Humane Farm Animal Care. Our Standards - Certified Humane

- NCBA (National Cattleman's Beef Association): https://www.ncba.org/producers/feedyard-audit (uses BQA standards)

- BQA (Beef Quality Audit) https://www.bqa.org/Media/BQA/Docs/cchg2019.pdf

- NAMI (North American Meat Institute): https://animalhandling.org/producers/guidelines_audits

- AHA (American Humane Association): https://certifiedhumane.org/our-standards/

> https://www.americanhumane.org/app/uploads/2021/08/Beef-Cattle-Audit-Tool-1.pdf,
>
> https://www.americanhumane.org/app/uploads/2021/08/Beef-Cattle-Full-Standards-.pdf

- American Grassfed Association | americangrassfed : AGA Grassfed Ruminant Standards - American Grassfed Association

- Food Alliance: Food Alliance - Sustainability for Food and Agriculture : Livestock Producers - Food Alliance

- National Cattle Feeder's Association: Welcome | National Cattle Feeder's Association (nationalcattlefeeders.ca) Microsoft Word - PAACO-Assessment_Guide_ver8_Feb18.docx (nationalcattlefeeders.ca)

- Verified Beef: Home | Verified Beef Production Plus

  VBP_On_Farm_Food_Safety_Self-Assessement_V_2.5_April_2017.pdf (verifiedbeef.ca)

  VBP_Producer_Manual_combined_V_1.6_and_V_7.8_Feb_13_2019.pdf (verifiedbeef.ca)

- Pasture for Life - https://www.pastureforlife.org/certification/the-pasture-for-life-standards/: PfL-Standards-Version-4.3-Feb-2022.pdf (pastureforlife.org)

- Label Rouge – collection of 16 books for beef welfare/production summarised in a research paper: https://www.sciencedirect.com/science/article/pii/S1751731121002007; Part 2: https://pubmed.ncbi.nlm.nih.gov/32906782/

- GAWA About us – Global Animal Welfare Assurance (gawassurance.org)
- Scottish Organic Producers Association (SOPA) AHDB (Agriculture and Horticulture Development Board) Home | AHDB
- Eigenkontrolle Tiergerechtheit' (acronym: EiKoTiGer) Bio Austria: https://www.bio-austria.at/ (https://www.thuenen.de/en/ol/projects/cattle-husbandry/feasibility-of-animal-welfare-indicators-in-on-farm-self-assessment/

  On-farm self-assessment of animal welfare (thuenen.de)

- AsureQuality: Meat – AsureQuality
- Progressive Beef Progressive Beef
- Cultivate – Poland (https://foodworks.pl/en/livestock/cultivate-cattle-farming-system
- BoviWell – France (https://hub.bovine-eu.net/search/boviwell-a-french-tool-to-measure-and-communicate-animal-welfare-on-beef-farms) A French scheme based on Welfare Quality principles.
- Beter Leven - https://beterleven.dierenbescherming.nl/english/ (based on comparable, existing schemes such as RSPCA Assured label from the RSPCA in the UK and Label Rouge in France) Calves - Beter Leven keurmerk Zakelijk (dierenbescherming.nl)
- USDA Organic | USDA: Organic Livestock Requirements.pdf (usda.gov) Sheep Welfare Scheme (Irish farmers association); https://www.ifa.ie/sheep-welfare-scheme/ The Sheep Welfare Scheme provides €10 per ewe to farmers for undertaking actions to make a positive contribution to flock welfare. Actions are detailed on the website.
- Animal Welfare INTEROVIC Spain (AWIS): AW label covering only sheep was created in Spain upon initiative of the interbranch organisation Interovic https://www.interovic.es/awis-en

- Animal Protection Denmark https://www.dyrenesbeskyttelse.dk/en

- "Better Animal Welfare" ("Bedre Dyrevelfærd"), a Danish government animal welfare label https://bedre-dyrevelfaerd.dk/servicemenu/english/

- KRAV (Sweden) https://www.krav.se/en/

- Sigill Kvalitetssystem AB (subsidiary of the Federation of Swedish Farmers) https://www.svensktsigill.se/ public-private partnership.

- https://www.tierschutzlabel.info/ (Germany) The animal protection label "Für Mehr Tierschutz" from the German Animal Welfare Association ("For more animal welfare")

- Bienestar Animal (Welfair) (Spain) https://www.animalwelfair.com/en/ Based on Welfare Quality scheme

4.1.2 Summary of top 5 selected schemes

Table 1 provides information on the general areas of welfare that are covered under the 5 schemes that were selected to highlight the similarities across the schemes as well as areas where they differ such as the Welfare Quality scheme having an assessment for positive behaviour, and RSPCA and GAP having specific enrichment requirements.

Table 1: Summary of the general welfare areas covered across 5 welfare assurance schemes

General Welfare Parameters	Welfare Quality	Red Tractor	GAP	RSPCA Assured (uses AssureWel)	NZ Cow-calf Model
Good feeding	Absence of prolonged hunger	Sufficient food and feeder space	Sufficient food and feeder space	Sufficient food and feeder space	Absence of prolonged hunger
	Absence of prolonged thirst	Sufficient water and drinker space	Sufficient water and drinker space	Sufficient water and drinker space	Absence of prolonged thirst
		Clean food and water	Clean food and water	Clean food and water	
Good housing	Comfort around resting	Safe and clean	Pasture access	Safe and clean	Ease of movement
	Thermal comfort	Appropriate lighting	Safe and clean	Thermal comfort	Absence of hazardous objects / terrain
	Ease of movement	Thermal comfort	Thermal comfort, weather protection	Appropriate lighting	Access to shade
		Appropriate social groups	Ease of movement	Ease of movement	
		Ease of movement	Enrichment	Enrichment	
Good health	Absence of injury	Absence of injury	Absence of injury	Absence of injury	Absence of injury
	Absence of disease	Absence of disease	Absence of disease	Absence of disease	Absence of disease
	Absence of pain induced by management procedures	Absence of pain induced by management procedures	Absence of pain induced by management procedures	Absence of pain induced by management procedures	Absence of pain induced by management procedures
			Good body condition	Good body condition	
			Step 5, no body alterations		
Appropriate behaviour	Expression of social behaviours	Housing facilitates normal behaviour	Housing facilitates normal behaviour, including play, grooming, resting	Expression of social behaviours	Expression of social behaviours
	Expression of other behaviours		Housing facilitates normal social behaviours	Expression of other (normal) behaviours	Expression of negative behaviour
	Positive emotional state			Absence of abnormal behaviours	
Appropriate stockmanship	Good human-animal interactions	Stockperson skills	Stockperson skills	Stockperson skills	Stockperson skills
		Absence of negative handling methods	Absence of negative handling methods	Absence of negative handling methods	
		Appropriate handling facilities		Appropriate handling facilities	Appropriate handling facilities

4.2   Impact pathway analysis

The draft Impact Pathway is attached in Appendix 8.1 to demonstrate the linear representation of all the elements. For readability the individual elements of the pathway are presented in table format below (Tables 2 – 8). In addition, assumptions, risks and counterfactuals were established (Table 9).

Table 2. Inputs (what we invest)

Funding	• *Ext. govt, industry, private sector* • *University and research organization co-contribution*
Capabilities	• *Researchers and industry & govt partners with knowledge of red beef production systems, animal welfare* • *Data scientists (analytics, sensors and ML for supply chain and to automate monitoring and regulatory compliance)* • *Social scientists (incl. economists for value chain assessments)* • *BD and Expertise with stakeholder engagement* • *Comms*
Existing partnerships & collaborations	
Infrastructure (Plant and equipment)	• *Research facilities* • *Commercial partner properties* • *Data platforms/ management systems & measurement infrastructure*
Background IP	• *Much and varied and dependent on measurements and ways to implement that*
Existing Strategy/Plan/Project Portfolio	• *Existing livestock assurance programs, identification/ traceability and certification systems* • *Existing national and international standards, codes of practice, etc.*

Table 3. Activities (What we do)

Analysis of current state, assessment of options	• *Review existing relevant policy, standards, guidelines, and how they contribute to an objective measure of animal lifetime wellbeing* • *Identify/evaluate existing animal wellbeing systems, frameworks and tools worldwide incl. voluntary/mandatory* • *Identify the different entry points/use cases for end-users* • *Identify criteria: i) ready to be used; ii) seems suitable, needs some work, validation; iii) nice idea, need further R&D* • *Identify gaps in current data*

Research and development	*Design of R&D program informed by engagement and feedback from supply chain, i.e.:*
	• *Analysis of current state (as above)*
	• *Approaches:*
	  • *Identify and quantify most appropriate parameters and measures for lifetime animal wellbeing/Identify potential animal measures for further R&D - perhaps more D than R as R from a low base will consume significant resources for uncertain success in each instance*
	• *Data collection and sharing:*
	  • *Identify architecture of data system*
	  • *Developing protocols for digital data sharing including privacy-tech, interoperability and governance*
	  • *Developing new tools or approaches to digitise and automate monitoring across supply chains*
	• *Compliance (if certification is goal):*
	  • *Identify and test more flexible approaches to meeting current biosecurity, food safety, AW requirements of trade*
	• *Supply chain 'trust':*
	  • *Program of underpinning social science to centre R&D on users/all supply chain*

Establishing strong collaborative relationships and governance	• *Establish sub-committees and working groups* • *Undertake significant and ongoing engagement with commercial stakeholders/supply chain to understand needs/barriers and support uptake* • *Gauge consumer, industry acceptability (undertake willingness-to-pay, cost-benefit, consumer sentiment mapping (work of MLA with Good Meat, etc.)* • *Establish the of entity/body that manages trainings, data standards, governance* • *Establish governance protocols and responsibility* • *Establish expectations around monitoring and adhering to the program - i.e., audit process or similar* • *Develop & implements formal Comms, MEL plans*
Develop capability in research and partners	• *Develop training and tools to build understanding of LAWI and platform (e.g., producer roadshows) and confirm training providers*

Table 4. Outputs (Our deliverables)

World-class science and IP	• *Approaches:* • *MVP/Prototype LAW Index and metrics that contribute to lifetime animal wellbeing,* • *Innovation strategy to assist with longer term development* • *Structured and validated criteria for the scheme* • *Data collection and sharing:* • *Easily accessible, easy to use data platform that can account for current inputs such as existing compliance forms and data points* • *Technology to support digital supply chains platforms (e.g., integrated data, data storage system, potential automated sensor system to assess welfare, etc.)* • *Industry-owned IP that could be licensed/used by third parties* • *Peer-reviewed papers, reports, presentations (e.g., scientific validation of metrics to inform an objective descriptor; data reports to governing organisation)*
Capability/methods/approaches/prototypes	• *Completed capability framework that can support the delivery of the product* • *Process for identifying criteria to be incorporated into scheme (objective and independent of those developing criteria)* • *Methods to integrate animal wellbeing outcomes temporally* • *Supply chain/provenance technologies, platforms and procedures* • *Resources to support adoption of tool and change by producers - all modes (e.g., seminars and workshops to build initial understanding and train people tasked with oversight of underpinning platforms)* • *Online stock wellbeing calculator using the farmer's own data with links to supporting materials* • *Education tool for industry and consumers*
Communications, engagement and partnerships	• *Detailed engagement and comms plans* • *Network of partners and cooperative partnerships across the value chain ('early adopters')*
Strategy and policy	• *Map of standards/guidelines/regulations*
Monitoring, evaluation and learning	• *Measure of changes in animal wellbeing over time, incl. against a consistent benchmark*

Table 5. Short-term outcomes (the update or adoption of our work)

Ecosystem of partnerships for development	• *Advisory group/s and use case groups active around objective description of lifetime animal wellbeing (incl. industry 'reps', policy stakeholders, research orgs, etc.)*
Policy and strategy changes	• *Explicit support from peak bodies and development of corresponding policy positions* • *Alignment with existing policy/ standards and recommendations* • *Industry agreed strategy and end goal*
Partner/industry application	• *Acceptance around the concept is growing* • *Incentives are in place to support use of index by early adopters*
Capacity changes	• *Trials of MVPs based on existing data streams and technology across diverse stakeholders* • *Supply chain participants voluntarily testing index* • *Supply chain players trained and confident about using the tool/system* • *Upscaled investment in the science that provides for meaningful, cost-effective objective measures* • *Optimisation and/or integration of existing industry systems/platforms* • *Connectivity across supply chain is building*
Awareness and social engagement	• *Australian producers on board and accept that managing animal wellbeing is baseline requirement* • *Unified industry understanding and support of what objective wellbeing descriptors mean* • *Supply chain players actively promote the tool* • *Consumer awareness is building of the system*

Table 6. Medium-term outcomes (the update or adoption of our work)

Policy and strategy change	• *EU and UK accept the AUS approach as equivalence of their domestic measures of animal welfare* • *Industry is convinced that the parameters are the correct ones to be measuring*
Scaling capacity and application	• *Business model/s and fully functional capability framework established and being validated as to allow stream of benefits through supply chains* • *Robust data management system built (with automated data collection process and monitoring across supply chains)* • *Understanding of the management skills needed to maximise performance against the objective descriptor* • *Supply chain stakeholders actively participating in and providing necessary data inputs into objective descriptor (i.e., they can use it and do use it routinely)* • *Continuing refinement of parameters feeds into evolution of index and tools*
Commercialisation pathways	• *Supporting trading language, documentation pathways, audit mechanisms etc. to communicate and support credentials*
Social acceptance pathways	• *Acceptance by supply chain participants that animal wellbeing is a positive rather than defensive issue; change from 'minimum performance' to 'optimisation' mindset* • *Producers and supply chain partners actively work together to monitor and improve and report animal wellbeing information* • *Consumer confidence growing in the animal welfare standards of the system*

Table 7. Long-term outcomes (the update or adoption of our work)

Policy and strategy change	• *Policies/guidelines periodically reviewed and refined to address emerging issues*
Capacity and practice change at national scale	• *Large-scale, system-level application of developed tool(s), embedded in all supply chains (e.g., retailers using index as a baseline and going above and beyond to market an even higher level of welfare)* • *Supply chain players have detailed knowledge about the tool and are well train in its implementation*
Social acceptance pathway	• *Confidence in Australia producing the most trusted source of protein* • *Global animal welfare societies endorse Australian red meat welfare credentials based on update of index* • *Recognition that the animal wellbeing tool is viable and valuable to meet customer demands* • *Public understanding of what a wellbeing descriptor means and confidence in the animal wellbeing standards*
Commercialisation pathway	• *A brand for marketing is delivered* • *Potential new entity for monitoring and evaluation of the system*

Table 8. Impacts

Economic	• *Maintain and expand global market access, with Australian products sought for their quality and provenance* • *Red meat supply chains better connected and protected against damage from animal welfare issues* • *Productivity and efficiency gains (e.g., reduced costs, improved quality/grading, etc.) from animal welfare best practice through the whole red meat supply chain* • *Improved animal welfare*
Environmental	*Indirect/flow-on benefits with regard to smaller environmental footprint:* • *Potential reduction in use of chemical/hormone products for both therapeutic and non-therapeutic applications* • *Contribution to waste reduction and an associated reduction in environmental footprint in the sector* • *Northern pastures produce high value, environmentally friendly beef with sufficient profile to maintain the rural economy*
Social	• *Maintain access to high-quality, safe food options for consumers* • *Protection (and potential improvement) of rural livelihoods in red meat production, and associated wellbeing and protection of community cohesion* • *Knowledge, skills, and confidence gains within industry and the public around effective management of livestock*

Table 9. Assumptions, risks and counterfactuals.

Assumptions	• That the index provides a competitive advantage for Australia (it may not) • That sufficient $$ value can be realised to support industry adoption • Supply chain actors will be able to access tools/R&D outcomes (i.e., adoption & extension occurs at a large/wide scale) • Commitment for funding and capability building at scale • The industry is ready for change • The welfare metrics currently available or in development can adequately assess the lifetime wellbeing of an individual animal
Risks	• Long return on investment • Criteria may be imposed by others regardless of this work (without necessarily involvement of or consultation with the Australian red meat industry) • Digital divide and lack of connectivity mean that the benefits of digital technologies may be restricted to those areas/enterprises with good connectivity or with the resources (skills and money) to invest in improving connectivity • Legislation in data protection and ownership, privacy, Freedom of Information, and Right-to-Know • Higher administrative burden on supply chain to demonstrate AW credentials • Inability to meet consumer requirements (transparency, assurance) adversely impacts red meat market share • Widespread producer dissatisfaction • Finding that our livestock have low index value and difficult to change • Going forward with half-baked product that is difficult to change • The criteria that are identified or developed cannot adequately assure lifetime wellbeing in line with stakeholder expectations
Counterfactuals (What if we don't develop an objective descriptor of animal lifetime wellbeing)	• Competitor countries, commercial entities/third parties create their own systems and metrics (that may not be as objective, transparent, and science based), defining the rules of engagement, creating confusion and increasing the burden on industry. Leading the process and conversation allows us to have more certainty and control of outcomes. • Australia would have to meet trading partner or other animal welfare benchmarks which don't fit with Australian production systems. • Animal Wellbeing metrics and measures and benchmarks will be set by animal activists (rather than industry) and used for compliance rather than value creation. • Maintaining social licence is an industry wide challenge so a solution that includes the whole industry would be stronger than bespoke solutions. Certifications will likely articulate a higher welfare standard than current requirements and may leave those who don't elect to be certified as 'bad' or 'poor' or 'not desirable' which is not the case • Maintenance of status quo: • No change in short term, but other countries developing their own systems put pressure on Australia, which could then lose access to key markets, or be forced to adopt alternative systems not fit-for-purpose for the Australian context

4.3   Research and Development workshop

The results presented here are a collection of the perspective and views collected from workshop participants. David Beatty from MLA introduced the workshop. He described MLA's interest in exploring the concept of measuring lifetime wellbeing, possibly in index form, similar in concept to the role of Meat Standards Australia in describing eating quality. The CSIRO project is a scoping exercise. In the following the results are presented aligned with the agenda items (see Appendix 2).

4.3.1   Overview of scoping project and progress summaries

To set the scene and inform participants, CSIRO presented on the components of the project that have been completed which included: impact pathway analysis, global scan of welfare assessment systems and stakeholder interviews. The key messages that were distilled from components to guide the development of an approach to describe LAW were:

Impact pathway analysis

Impacts stakeholders envisage to achieve

- Overarching impact - improved outcome for the animals
- Facilitates the sustainability of the whole red meat supply chain

Envisaged long-term outcomes

- Large-scale, system-level application of developed tool(s), embedded in all supply chains
- Supply chain players have detailed knowledge about the tool and are well trained in its implementation
- Confidence in Australia producing the most trusted source of protein
- Global animal welfare societies endorse Australian red meat welfare credentials
- Recognition that the animal wellbeing tool is viable and valuable to meet customer demands
- Public understanding of a wellbeing descriptor and confidence in the animal wellbeing standards

The approach

- an evolving framework that continuously refines the system and enables continuous improvement
- flexibility in its application to reflect the scale
- easy to use

Critical elements for the success and scale

- Defining the scope and intent of an approach and considering unintended consequences and impacts
- Data landscape and infrastructure
- Positioning the approach in relation to existing legislation, regulation and guidelines is critical
- Early stakeholder engagement
- Education programs
- Producer support

Global scan of welfare assessment frameworks

General observations

- Not all schemes are transparent
- Many schemes are available
- Surplus to legislation
- Overlap in schemes
- Multi-species
- Indoor and pasture
- Voluntary
- 3rd party audited (annual)
- Certification label
- Based on Five Freedoms (from hunger and thirst, from discomfort, from pain, injury or disease, to express normal behavior, from fear and distress)
- Reviewed and updated

Principles of design of welfare schemes

- Good feeding
- Good housing
- Good health
- Appropriate behaviour
- Appropriate Stockmanship
- Animal vs herd/flock-based records
- Outcome based (yes/no) vs continuous record or score

Feedback from stakeholder consultation

- Respondents generally positive on the feasibility of an approach to describe lifetime animal wellbeing but a pragmatic, simple approach is preferred
- Drivers for a tool are
  - Complexity and number of current systems
  - Communicating to consumers
  - Transparency 'objective data not just take our word for it'
- Clarity of the purpose is key
- State vs national legislation
- Other countries import requirements (Market access)
- Customers are largely uninformed
- Welfare is influenced through the supply chain
- Supportive of building on existing schemes
- Difficulties
  - Accommodating the breadth of production systems and species
  - Data privacy and connectedness
  - Individual animal identification
  - Value proposition

4.3.2 Workshop Outputs

The workshop was designed to take participants through a thinking process where they visualised the ideal approach to describe LAW, what is currently possible and what is needed for an MVP and what are the research gaps to evolve what we can do now to the ideal approach. In the following section the outputs for the specific workshop sessions are summarised.

4.3.2.1 Vision for an unconstrained system and design principles

The guiding question for this session was 'Put yourself in 2030 and describe an ideal system we have for describing individual animal welfare' The feedback from the workshop is summarised in the following:

- In an unconstrained world, how would a lifetime wellbeing system function?
- What do you envisage from short-term MVP to comprehensive system long-term?
- Who is collecting the data?
- There are multiple end users, what are the primary applications it will serve?

The groups reported back, and the ideas put forward were synthesised as follows:

Design principles

- Integration
- Automation, electronic collection (reduces transcription errors)
- Targeted to user
- Centralised, industry-owned, independent oversight
- Periodic system review and adjustment
- Pays for itself, reward for participation minimal additional labour required
- Open to all
- Failure is the exception

Components

- Multiple data sources along data supply chain
- Data analytics, machine learning
- Continuous information – provides early signals on problems
- Robust animal identification, accuracy
- Goes beyond wellbeing, e.g. biosecurity
- Standardised definitions etc
- New animal indicators, e.g. neurobiological substrates
- Used by Brand Australia for market access
- Best practice and implementation – index, benchmarking
- Data available at point of sale and able to be used by individual brands
- Smart Tags

Purpose

- System informs decision-making
- Risk identification / feedback
- Auditing

Questions that remained unanswered but require consideration

- Comparison with MSA
  - There are bad results and good results from a LAW assessment, but there is no such thing as bad meat
  - We do not have a "gold-standard" (dependent variable) like in the MSA index
- Prefer to have several sub-scores e.g. nutrition, husbandry practices so e.g. farmers score well in some but have room to improve others
- Categorical gradings drive threshold behaviour
- Will the system mean that certain environments or systems are identified as intrinsically delivering poor welfare (e.g. because too hot)?
- How do we define trade-offs between e.g. short-term, acute (e.g. mulesing) and chronic (e.g. undernutrition) adverse experiences?
- Risk of alienation otherwise – 'can't ever improve because of my conditions'
- Identification of non-compliance raises legal issues

4.3.2.2. Existing data sources, capture and handling

The scene for the session was set by Integrity Systems Company. Key messages from the presentations were:

- ISC has a vision for the future integrity system that has many features in common with the system described in the first session of the workshop, e.g.:
- Automatic
- Real-time tracking
- Transparent
- 4 pillars: Livestock Production Assurance (LPA), National Vendor Declaration (NVD), National Livestock Identification System (NLIS), Livestock Data Link (LDL)
- LPA has 200k accredited Property Identification Codes (PICs)
- LPA has 7 program requirements
- Animal welfare is the only compulsory one
- Under this module, producers must have a copy of the Animal Welfare Standards & Guidelines (S&G), complete a training module and ensure staff are familiar with the S&G
- LDL enables the timely sharing of carcase and animal disease information – links carcase data from the NLIS, MSA and central animal health databases with analytical tools, benchmarking reports and the Solutions to Feedback library.

The guiding question for this session was 'Based on what we have now, how would you design a lifetime wellbeing system?' More specifically, they were asked to consider:

- What is a minimum viable product?
- What innovation is needed to source, analyse and aggregate currently available data?
- What are the short-, medium- and long-term priorities for system development?
- How do we handle data tracing across the supply chain?
- What are the trade-offs and risks?

What we have now (ie. relevant data and industry systems)

- Chemicals, treatments already captured
- Animal welfare benchmarking project
- Sheep Genetics could be used immediately to collect data
- LPA
- LDL
- NVD, eNVD even better
- NLIS
- Losses and mortalities
- A lot of information available at herd level
- Compliance data
- Australian AgriFood Data Exchange
- Lamb production (especially with early turnoff) is likely the most straightforward red meat production system, as lifetime is short and there are no or minimal transfers between enterprises
- Satellite / Remote data on pasture and condition score

What is needed in regard to data sources

- Extension of LPA Animal Welfare module
- Extension of LDL
- Centralise current electronic data e.g. from farm management software, and curate as a central database
- Upload to web-based app
- Need to understand animal welfare impacts of current data sources
- Connected industry platform
- Ease to add field in existing recording schemes (e.g. SheepGenetics)
- Improve recording on losses
- Build system on historic data
- Common platform for multiple accreditation systems
- Improve adoption of feedback (e.g. LDL)
- Benchmarking project is only on-farm, which is a gap – capture of data on transport needs to be addressed (e.g. time yarded, loaded, watered, unloaded etc)
- Inclusion of animal welfare measures related to fear/distress and normal behaviours

What is needed for supply chain application

- Start with producers before extending to retail
- Must have unique ID
- Stratify production systems, i.e. don't impose 'one-size fits all' approach
- How does the welfare descriptor transfer across at the point of sale (animal 'punished forever')
- Privacy and data access

4.3.2.3 Gap analysis

This session commenced with a presentation from Ian Colditz, CSIRO. Ian spoke about:

- Concepts of animal welfare and wellbeing
- Frameworks for assessment
- New measures
- Research issues

The guiding question for this session was 'What are the research gaps? What R&D is needed?' More specifically, participants were asked to consider:

- What activities ('D', i.e. development?) are needed to produce a 'defensible' MVP, and how far off is that?
- What are the longer-term R&D needs to progress the MVP to a model that:
- Is more meaningful / truly reflective of lifetime wellbeing
- Meets the principles we identified yesterday?
- What are your top 2-3 priorities?

Activities to produce a defensible MVP:

- Currently, we can generate snapshots of animal wellbeing in time but not lifetime animal wellbeing
- Although we can predict critical points for data collection and combine these into a 'trajectory' (or 'best practice index')

How do we know the trajectory reflects good LAW?

- Using existing platforms (NLIS etc), but with an understanding of their limitations
- Health is currently the primary indicator of wellbeing
- The Animal Welfare Benchmarking project has survey-generated data that could be plugged into the existing integrity systems
- Compliance with the standards and guidelines – provides a measure of minimal standards of animal wellbeing
- It is important to leave room for improvement in the grading so producers do not reach a threshold and then stop improving

- Hook tracking of lambs
- Scalability – can enterprises of all sizes reach best standards? Does scale confer advantage in being able to demonstrate superior LAW?
- Goats (wild harvested) – complex – to be considered later
- What about the animals not being recorded in the system, i.e. the mortalities within the system? How do they affect the LAW of individuals in the same cohort? What if mortalities are not recorded? How can recording of mortalities be improved?

Longer-term R&D needs

- Need for scoping of indicators of LAW – e.g. micro RNA, telomeres – look at human research
- What is the 'gold standard'?
- Animal preferences
- Discussion re qualitative behavioural assessment (QBA)
- Satellite images of the environment and suitability to livestock, e.g. heat, shade – could use to develop risk rating
- Relationship between mental health of human and animal
- Tech: sensors, agtech
- Human / animal interaction sensors – behaviour, context-specific (e.g. in yards)
- Quality of e.g. lambing paddocks, shade – change of environment over time
- Policy: advocate for updating and improvement of the standards and guidelines (but is this the right benchmark anyway?)
- Identify resilient animals – a lot of discussion around resilience vs robustness.

How to increase buy in and adoption (including design principles)

- Start with 'MVP' (based on the standards and guidelines), with everyone starting at the base tier and with defined criteria (animal measures etc) to upgrade – move over time to LAW measures on individuals, where animals of different status could be on the same farm, and an animal's status is adjusted as they move through the system
- Importance of extension / adoption
- Use structured, specifically designed behavioural change programs
- Auditing can be an education opportunity
- Identify drivers of change
- Articulate benefits of change (value proposition)
- Start with an audit of animal wellbeing measures that also deliver productivity or other benefits
- Standardise data management at the beginning of the project
- Ranking gold/silver/bronze for each value chain participant
- Maintain transparency on what is and is not included in the system as it develops over time – maintain integrity and trust in the system

4.3.4.4 Concept framework

One of the breakout groups proposed the framework below, which reconciles many of the broad discussion points that have been captured at the workshop. The framework could be used to create an MVP which evolves with further research and development. Currently, the potential model does not yet incorporate a temporal aspect that considers the description over a lifetime. The advantage of this model is that it satisfies different stakeholder requirements and can add to existing frameworks.

- Welfare / wellbeing priorities can be framed around the five freedoms, which would align with existing frameworks.
- Qualitative welfare/wellbeing measures (M1, M2…) – what underpins the priorities in relation to management, environment, health
- Quantifiable indicators / metrics (I1, I2,…) – existing data sources (LPA, LDL, SheepGenetics..), novel data sources
- Raw/Elementary data points (D1, D2, ….) – the underpinning data base that stores all the data
- Requirements, certificates (R1, R2, …) – wellbeing outcomes can be reported in the framework of the priorities, but the raw data can be drawn on for certification, risk management or any bespoke reporting model. This provides the opportunity to align and add to existing frameworks and/or align with international requirements.
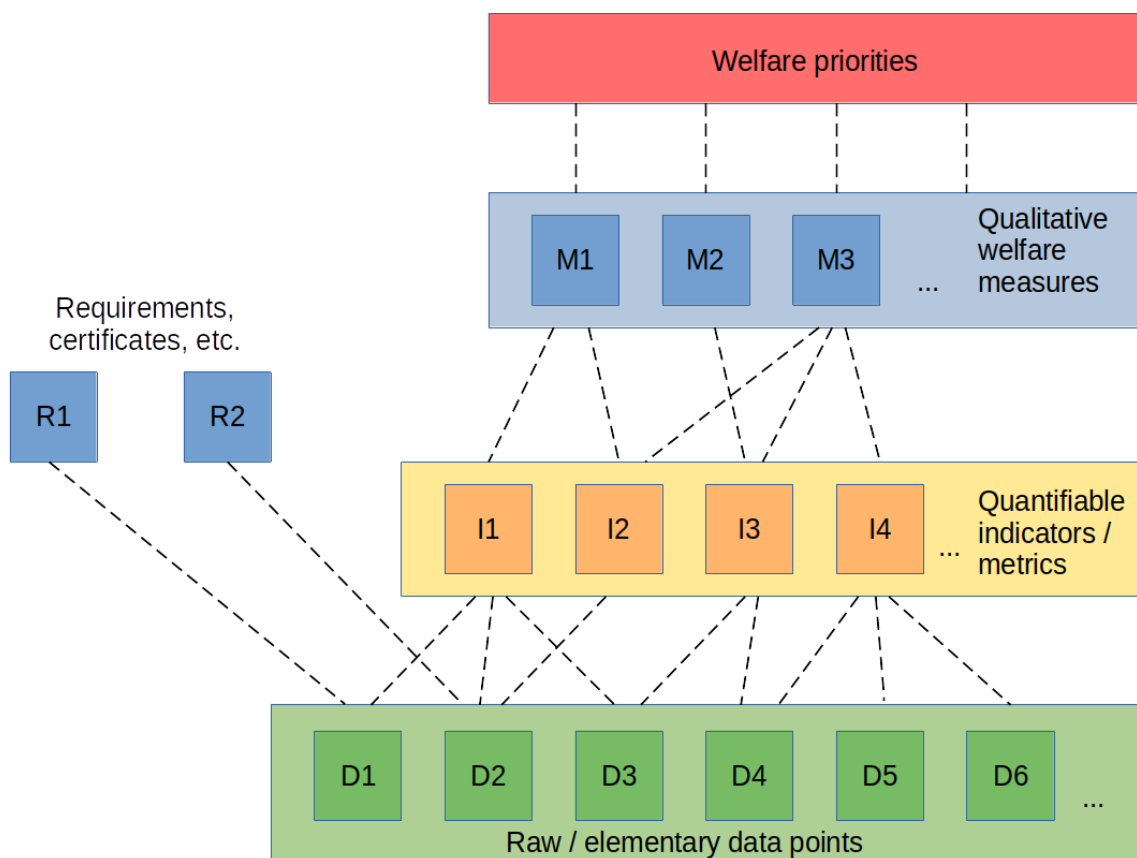
Figure 2. Concept framework.

4.4 Stakeholder feedback

4.4.1   Stakeholder survey approval and consultation summary

4.4.1.1 Approval

Ethical clearance for the activity "Understanding demand for a Lifetime Animal Welfare Index" (027/22) was granted for the period of 14/03/22 – 18/07/22 by the CSIRO Social and Interdisciplinary Science Human Research Ethics Committee (CSSHREC). The approved set of questions is listed in 3.1.3. The Participant Information Sheet and Consent Form provided to participants are provided in Appendix 8.1 1 and 8.2 respectively. CSIRO has collected and stored signed consent forms from participants.

Consideration of participant privacy is essential to obtain this ethical approval. As such it is important to inform all readers of this report that they have an ongoing obligation to ensure participant privacy. For this reason, all data is provided in an anonymised form. Some large organisations are identified in the report (to provide clarity around stakeholders interviewed during this activity) but not individuals from within those organisations.

4.4.1.2 Stakeholder consultation summary

Between April and June of 2022 seventy stakeholder contacts were made and >30 in depth interviews were conducted. The breakdown of industry sectors and numbers contacted/interviewed are shown in Table 10. The cattle and sheep producers were chosen to reflect the diversity of geographic location and enterprise type (breeding, backgrounding and finishing) found in Australia.

Table 10. Breakdown of stakeholders contacted and interviewed from different red meat industry segments.

Industry Segment	Examples	Contacted	In Depth Interview
Government	ABARES DAFF (Meat Exports Branch / Future Traceability)	19	5
Finance		5	2
Processor		3	1
Vets	(Office of Chief Vet)	5	2
Live export		1	0
Governance	Integrity Systems / Ausmeat	3	1
Industry Representatives	MLA / NFF / cattle Council / SALRC / NABRC / ASBF / SSF / ALFA / AWI	15	7
Retailers		2	2
Beef producer	N. Aus and S. Aus	10	7
Sheep producer	S. Aus	6	4
Feedlot		1	1
Totals		70	32

4.4.2   Stakeholder Feedback

The following is a summary of the responses to the survey questions. Distilling the various responses into key messages presented some challenges. The team has endeavoured to identify those responses where there was common ground as well as those which provided a more unique perspective to the specific questions.

4.4.2.1 Animal Welfare Credential Schemes

Feedback from questions 2, 3 and 4.
How are credential schemes in general (or animal welfare schemes) useful/valuable for the industry?

- Useful insurance if an accusation is made (by providing objective demonstration of what has occurred)
- Provide a direction for industry to improve (a magnetic north)
- Coalesce people to act in a desired manner / drive behavioural change within the industry
- Something for industry to celebrate and promote
- Provides a home for the next round of innovation
- Contribute to maintaining international market access

4.4.2.2 Familiarity with existing welfare schemes

Feedback from questions 2, 3 and 4.

What animal welfare schemes are you familiar with (domestic or international)? Schemes did not need to be solely focussed on animal welfare. The schemes identified and a link to further information of the scheme is provided.

- Livestock Production Assurance [Livestock Production Assurance (LPA) | Integrity Systems](#)
- Sustainawool [SustainaWOOL Integrity System moves the wool industry forward](#)
- National wool declaration [National Wool Declaration (NWD) | we know wool (awex.com.au)](#)
- Organic certification [National Standard for Organic and Bio-Dynamic Produce - DAWE](#)
- Flock care
- Northern Pastoral Group (Private standard)
- National Feedlot Accreditation Scheme [NFAS | AUS-MEAT (ausmeat.com.au)](#)
- Greenhams Never Ever [About – Livestock Integrity Solutions Australasia Pty Ltd](#)
- Red Tractor [Red Tractor Assurance | Assured Food Standards](#)
- JBS assured [JBS Farm Assurance - Aussie Beef](#)
- Global GAP [Global Gap | SMG (smg-aw.com)](#)
- Other private schemes driven by retailer or financier

4.4.2.3 Feasibility of a LAW approach

Feedback from questions 5, 6, 7 and 8.

Respondents were generally supportive of the idea of a LAW approach (believed that there was merit in assuring that welfare of a certain standard had been reached), and think that it could be done, although there was a broad range of thoughts about what a LAW approach might look like.

Concerns / Doubts

- An analogy provided was…You have to get the kids to school but does it matter if you drive the kids to school in a Ford or a Mercedes? The intent of this was that while a LAW approach might be needed there was a caveat about how far reaching (or complicated) such a system might be, and that this is likely to influence acceptance / adoption.
- Is a approach a single end of life measure or a combination of many measures from across the animal's life?
- Do single physiological markers exist that could be collected at end of life that provide an accurate assessment of welfare challenges an animal has faced?
- Current technologies cannot provide whole of life assessment from a single sample collected at a point in time.
- Difficulties in obtaining lots of on farm measures and linking the resulting data through to individual animals.
- Natural variation in responses. Where do thresholds exist and when do things become an issue?
- Sensors may provide a broader and objective measure of animal experience but uptake by industry is currently low.

4.4.2.4 Drivers for a LAW approach drivers and industry value

Feedback from questions 5, 6, 10 and 11.

Why would you implement a LAW approach and what is the value to your business of doing this?

- To ensure, and demonstrate, animal welfare
- A single accepted alternative to the complexity and number of current systems. Many of these systems are dictated by the destination of product and are driven by the private standards of importing retailers.
- A number of respondents felt that there was a gap in the market (for an animal welfare standard). Others who have implemented a private standard believe they now have this covered although it does come with a cost of administration that they could do without.
- To reduce paperwork of multiple systems
- To provide a broader range of target markets for product
- To ensure Australian product is regarded as premium
- To differentiate Australian product
- To ensure the system actually delivers animal welfare benefits

- A means of communicating between producers / processors / retailers and consumers (Addressing customer expectations around responsible sourcing)
- Benefits from transparency and objective data.
- Prefer 3rd party standards and not self-regulated (don't just take our word for it)
- Social licence
- Retailers would welcome not having to manage existing systems

4.4.2.5 Unstructured feedback – other considerations

Feedback from questions 4, 9 and 12.

- What problem are we trying to solve?
- State and Federal differences. Animal welfare is covered by state-based legislation that differs between jurisdictions. How can we standardise this? There may be some insights from the approach taken in generating NFAS, and the auditing of this system through AusMeat. May be difficult to create a federal credential and audit system.
- Animal welfare (State based) legislation is focussed on animal cruelty and producers typically operate at a level well beyond this standard
- Import country requirements and associated private standards from importers are a big driver
- No customer asks about welfare (sometimes health) because it is assumed that Australia has a high standard, and it is the reason they are already talking to us
- Welfare isn't all 'on farm'…what about roads and ports?
- Not starting from scratch / Support existing programs
- Existing 'guidelines' are about awareness not practice
- Who wants an animal that has 70% welfare treatment? A recurring thought is that any credential must be a categorised standard reached yes / no or good / better / best system
- What happens to animals or product not reaching a standard?
- Does it need its own logo or brand?

4.4.2.6 Marketing welfare schemes and operating above industry standard

Feedback from questions 10 and 11.

In this section the focus is stakeholders from within the Australian red meat supply chain using animal welfare claims to differentiate their product from others.

- Self-interested
- Differentiation leads to people throwing rocks
- Don't make claims above industry standard
- Some producers considering / already marketing around welfare

But perhaps this approach is useful at the country level to distinguish Australia from others.

4.4.2.7 Difficulties / Challenges of implementing a LAW approach

Feedback from questions 12 and 13.

A core question that emerged was, "How do we tick the same box (welfare certified) but ask different questions?" The intent of this question is to ask if it is possible to have a system that is flexible enough to provide a standard accreditation based on different measures in different regions. The reasoning behind this is an acknowledgement of the very different conditions and welfare risks animals face in Australia. Given this variation, how do we not unreasonably penalise or benefit certain producers based purely on their geographic location or type of production enterprise. It is an approach to bring flexibility to the system.

- The Deliverable / Narrative v compliance

Australia currently trades on a clean and green narrative. Not all claims that are made in this narrative are supported by existing objective compliance systems. The benefit of maintaining this approach is that it is already operational however, the downside emerges if challenged and a request for evidence to support claims is made.

- The Production Environment / Geographic Regions (North v South and East v West)

Australia is geographically diverse and cattle production systems have evolved to cope with this variation resulting in significant differences between the north (tropical and /or arid) and south (temperate). In general, animals produced in extensive northern systems have fewer interactions with producers, and face different challenges (related to disease, pest species, thermal stress, husbandry practices and feed / water availability) than do those raised in the south of the country. How does a single system account for this?

- The Animal / Beef v Dairy v Sheep

Animal breed is a source of variation for factors such as the need for feed and management.

- The System / Backgrounders v Breeders v Feedlots

Producers operate quite different enterprises in what is often a fragmented supply chain. Few producers are vertically integrated. Welfare risks differ between these operations.

- Equivalency between schemes / private standards

Australia exports >70% of the red meat produced. Maintaining or growing international market access is an important consideration for any credential scheme. Particularly important is the need to easily state how compliance with a domestic system translates to compliance, or otherwise, with international or private standards. This issue is termed equivalency. Animal welfare requirements differ between importing countries and even between different importers from the same country. How is harmonisation of the welfare standards achieved? In paper-based systems that often have different measurables how easy is it to develop a system that can address this challenge? Further, if these standards were to change how would a domestic system adapt to deal with this?

- Privacy / data availability for reports by different supply chain actors

Relevant production data must be made available for compliance checking and auditing of credential system. Access to collected data needs to be considered and managed. Data management systems must also be in operation that can be easily accessed and maintained to support system operation.

- Getting 50 cattle producers on board

Australia has tens of thousands of cattle producers of varying scale. Are all producers to be bound by this system or is it voluntary? Will producers of different scale be equally motivated to be involved?

- Unintended consequences of transparency (travel times)

A story was relayed around how Australia had developed a code of practice for cattle transportation. Discussion of this code with retailers in the EU raised concerns at the duration of Australian travel times (even though Australia thought it was doing a great job). It is possible that other areas might also raise unintended concerns but this may be less of a risk if systems are based on overseas performance measures.

- Staff training / turnover

The key message here is ensuring that a suitable workforce is available to implement any system.

- Demonstrate economic benefit

A key motivator of behavioural change is economic benefit. Do suitable test cases exist that show the advantages of changing practice? Alternatively, is the benefit delivered by preventing loss of market access or reduced social licence to operate?

- Supply and demand pricing often overwhelms any penalty scheme

It is possible to envisage market grids that provide premium prices for animals raised at a certain standard or penalise those that are not compliant? However, is such an approach effective in a supply and demand driven market, particularly during times of high demand.

- There is a perception we are doing something wrong

Like the concerns raised around unintended consequences there is a belief that increased transparency only increases the risk of public scrutiny and discovery of system breaches. The term welfare is often associated with an acknowledgement of the risks/challenges that animals face rather than as a positive about the care and quality husbandry that animals receive.

- Identifying individual animals

Is it possible to develop a system for individuals? Current approaches are based around herd, mob or flock reporting.

- Do strategies have animal benefits

It is often unclear if measurables of animal welfare / wellbeing have actually been demonstrated to deliver benefits to animals. It will be important to include information on this in the development of any system.

- Limiting source pool. Ensuring broad uptake to maintain supply at a standard to get retailers on board

Retailers and processors require certainty about the level of supply so that they can ensure supply to customers. If uptake of a system is low or slow then this might impact supply of product at the desired standard.

4.5   Cost-benefit analysis

4.5.1   Scope and Focus of an objective approach to describe lifetime animal wellbeing

In the context of the overall project and its components, the benefit and cost are defined by the assessment approach and the nature of measures included in the final lifetime wellbeing standard. (Figure 3)

For example, the measures may be categorised as.

1) Flock / herd level assessments
2) existing individual animal records
3) novel animal-based measures

The different measures or data sources could be included within an existing, or new animal wellbeing assurance standard / scheme. Design and implementation of a scheme based on existing methodologies will reduce the R&D cost but comes with the risk that these measures are not accepted by the market as demonstrable evidence of animal wellbeing status.
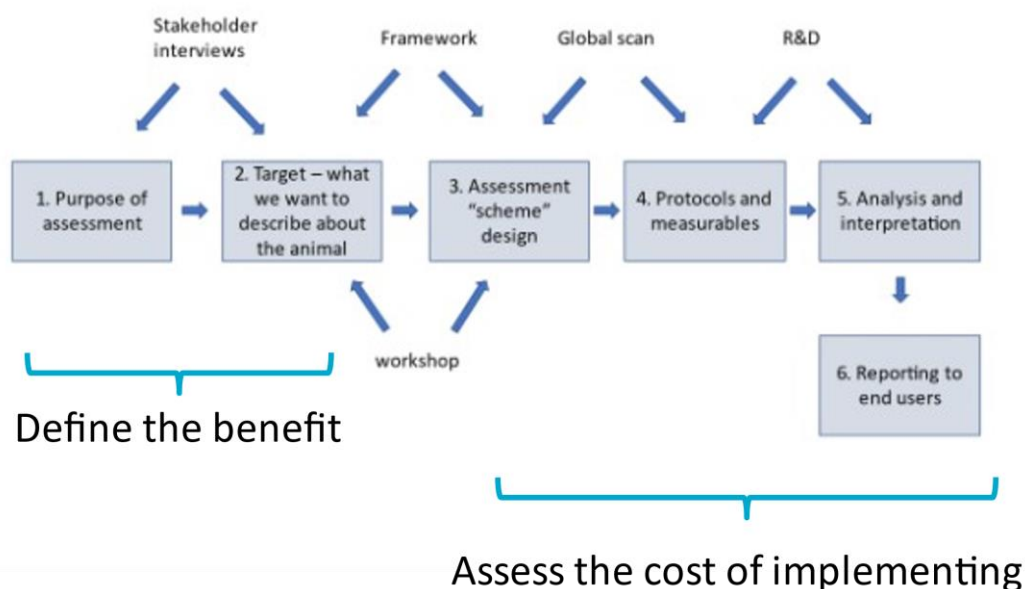

Figure 3. Development of an assessment approach to objectively describe lifetime animal wellbeing.

4.5.2 Benefits of an objective approach to describe lifetime animal wellbeing

The primary benefits of an objective approach to describe lifetime animal wellbeing that have been identified by stakeholder needs, views and aspiration are:

- Improved animal welfare- direct benefits to the animal
- Informs and enables continuous improvement in animal wellbeing at the enterprise and supply chain level
- Provides assurance to domestic stakeholders
- Provides assurance to international stakeholders

Leading to

- Improved market access
- Opportunities for market premiums
- Risk mitigation
- Improved productivity and efficiency

The above specified primary benefits are underpinned by interactions and multi-factorial drivers, which increases the complexity of the task to define economic, social, and environmental benefits of improved lifetime animal wellbeing through the supply chain. A simple calculation around premiums obtained in different international markets is shown in Appendix 1. This example also shows the assumptions that must be made to arrive at the resulting answer. Hence, the derived industry value is highly dependent on realistic assumptions. We believe that this topic should form a priority area for further research activity.

- Current animal wellbeing systems are assessed through participant knowledge and awareness of welfare guidelines. The next step of the pathway is to implement an approach that demonstrates the guidelines are being put into practice. The industry already has many approaches in place to assure animal wellbeing, but these are not reported in current systems, meaning that much of the existing good work is not communicated. Whether it is over the lifetime of the animal or at critical timepoints during its life, any evidence-based demonstration of improved animal welfare is directly beneficial to our production animals and helps to drive continuous improvement of the industry. This in turn is central to maintaining social licence and securing market access (existing and new markets). Estimation of the economic value of securing market access is feasible. However, to derive both the economic and social value from the maintenance of social licence for the red meat industry is far more challenging. Moreover, social licence is multi-factorial, and it is difficult to quantify the attribution of improved animal wellbeing to overall social licence (this may vary between markets e.g. Asian vs European markets).
- There are opportunities for market premiums through demonstration of higher animal wellbeing. This has been demonstrated in the Australian egg market with eggs from chickens kept in husbandry systems with higher animal welfare being sold at a higher price (Choice, 2015). However, it is evident and likely that higher animal wellbeing is not the only desirable product specification (e.g.; carbon neutral or regenerative agriculture as differentiators) and in addition, the demand of premium products fluctuates. Once again, quantification of the economic value will require an understanding of the specific attribution of animal wellbeing

to the market premium and different scenarios would need to be explored in a cost-benefit analysis to consider fluctuations in demand. In addition, a price premium derived from animal wellbeing credentials in the domestic market is likely to diminish over time as a demonstration of wellbeing becomes industry standard, triggering a situation in which those not complying with the standards are likely to be penalised.

- Improvements in animal wellbeing and livestock productivity are often considered separately but there are inextricable linkages between the two domains. For example, implementing strategies to improve lamb survival or to reduce the seasonal fluctuations in feed availability will directly benefit both.

A summary of cost and benefits that relate to the concept of animal wellbeing has been presented by Fernandes et al. (2021) and the complexities have been depicted in a tool for decision support. A draft calculation for the global premium attributable to animal welfare based on MLA information for exported product could amount to $6,388,512.80 per annum, which would be 0.07% of the total value of global export beef (Appendix 1). Defining an agreed method to derive this figure will be important for setting a benchmark value for animal welfare and monitoring the value change over time.
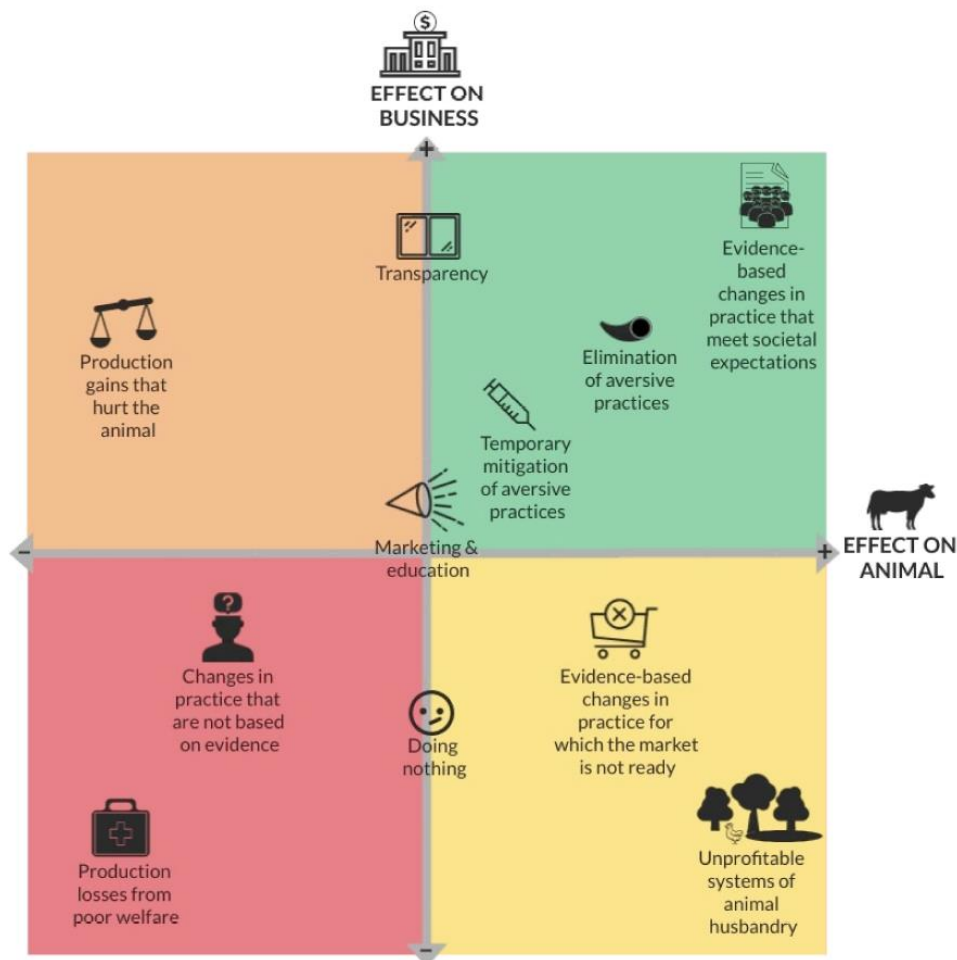

Figure 4. Decision tool for businesses considering changes in practice to improve farm animal welfare (by Fernandes et al. 2021).

4.5.3   Framework for a cost-benefit analysis

Tackling a cost-benefit analysis that explores benefit derived from social changes, such as animal wellbeing, is novel and not straightforward, as also noted by Fernandes et al. (2021). A cost-benefit analysis would require a suitable model that examines benefits and costs at the multiple levels (farm/enterprise, supply chain, whole industry) with the capability to consider social benefits. A small number of life cycle assessments have evaluated improvements in animal welfare (Scherer et al. 2018), but all used different and very specific scores to evaluate welfare. There is a clear gap and indeed, a novel opportunity to develop a life cycle assessment of animal wellbeing specific to the approach that will be developed for the Australian red meat industry.

The following framework is proposed to map the development of animal wellbeing assurance to ultimately achieve a determination of lifetime wellbeing against the perceived industry benefits (improved animal wellbeing, market access, market premiums, improved productivity), specific to the Australian red meat industry. It is recommended that this is undertaken as a staged development to enable the industry to evolve with the opportunities presented through the R&D but also to ensure that stakeholders needs are addressed (Table 11).

The **Baseline (BL)** represents what is achievable now and captures Livestock Production Assurance (LPA, mandatory), other existing industry data sources (such as NVD, NLIS) and different company-based welfare assurance systems (voluntary private standards), including recommendations and guiding principles from the Australian Beef Sustainability and Sheep Sustainability Frameworks (ASBF and ASSF), the National Feedlot Accreditation Scheme and Northern Pastoral group. Cost associated with BL include R&D cost to collate existing data sources and make them accessible whilst observing data privacy (see Milestone 6 Database and Governance) and implementation cost. Implementation cost will vary depending on the system type, which might be based on a single system or multiple of the above. Perceived industry benefits and the potential to improve animal wellbeing are minimal, but it does allow producers to demonstrate that they are implementing guidelines. However, the data could provide an industry situation assessment/benchmark for animal wellbeing and can serve to monitor and identify exceptional circumstances.

Welfare Benchmarking 2.0 represents a staged progression of deliverables that could form the basis of an industry program to improve lifetime animal wellbeing. It is also specifically designed to build on the current MLA investments in welfare benchmarking (WB) in the extensive beef and feedlot sectors. The primary goal of Welfare Benchmarking 2.0 is to generate outcome or animal-based measures of animal welfare. These could apply at specific times during the animal's life or ultimately, over the entire lifetime of the animal. The goal is designed to address the generally accepted paucity of validated animal-based measures within animal welfare assurance schemes.

The developmental objectives of Welfare Benchmarking 2.0 are:

1) Identify and validate current animal-based measures. The emphasis here is identifying practical parameters or measures that are currently applied at the herd (eg. weaning percentage) or preferably, the individual animal level.
2) Develop and validate new animal-based measures. The advances in automated remote or on-animal sensing technologies enable significant new opportunities to explore and generate new measures.
3) Develop and validate ambitious end-of-life measures as indicators of wellbeing over the lifetime of the animal, such as DNA methylation changes or identification of lifetime pain.

It is worth noting that measures under Welfare Benchmarking 2.0.3, the end-of-life measures themselves do not allow for continuous improvement because they serve as retrospective indicators. However, they might enable the development of predictive models that assist management decision that influence lifetime animal wellbeing.

The deliverables from each of the described stages are designed to build on existing welfare assurance systems e.g. company based welfare assurance or industry welfare benchmarking.

There are costs associated with R&D, commercialisation and adoption and implementation. The costs are increasing with increasing technical sophistication (scenarios 1 -3 of Welfare Benchmarking 2.0). Whilst the benefits for market access of Welfare Benchmarking 2.0 are assumed to remain constant, it is assumed that the increased cost from higher levels of sophistication are offset by increasing benefits in improved animal wellbeing, market premiums and improved productivity.

Table 11. Framework for a cost-benefit analysis of approaches to describe lifetime animal wellbeing with increasing sophistication.

Wellbeing Assurance	Costs#	Benefits			
		Improved animal wellbeing##	Market access	Market premiums	Improved productivity
Baseline (BL) • *LPA and other existing industry data sources*	*I*	*minimal$*	*No*	*+*	*No/minimal*
• *LPA + Company welfare assurance (including ABSF & ASSF metrics)*	*I*	*minimal$*	*+*	*+*	*No/minimal*
Welfare Benchmarking 2.0 1. BL + WB + validated existing animal-based measures (eg. weaning %)	R&D, C&A, I	+	++	++	+
2. BL + WB + validated existing and new animal-based measures	R&D, C&A, I	++	+++	++	++
3. 2 + lifetime animal wellbeing indicators	R&D, C&A, I	+++	+++	++	++

R&D – Research & Development, C&A – Commercialisation and/or Adoption, I – Implementation costs (capital and/or operational).

provides capacity to demonstrate change in animal welfare

$ without decision support tools

4.6   Database for delivery

4.6.1   Database requirements

Requirements for a database that underpins an industry approach to improve lifetime animal wellbeing include the gathering, connecting and storing of multiple records on individual animals throughout their life, whilst taking data privacy into account. The challenge is that animals may have changed ownership several times throughout their lifetime with data collected at various timepoints and in different locations. Consequently, this data may be present in multiple, disparate databases, each using different identifiers for individual animals. In addition, non-electronic compliance and declaration documentation may also supplement the animal's journey, particularly when animals move from one location to another. A database needs to be able to connect all these information sources. It also means that data ownership might change throughout an animal's life and data privacy needs to be provided, only allow access to data on a need-to-know basis.

Figure 5 demonstrates the various data collection points via the multiple assurance and verification systems currently active in Australia's red meat supply chain.
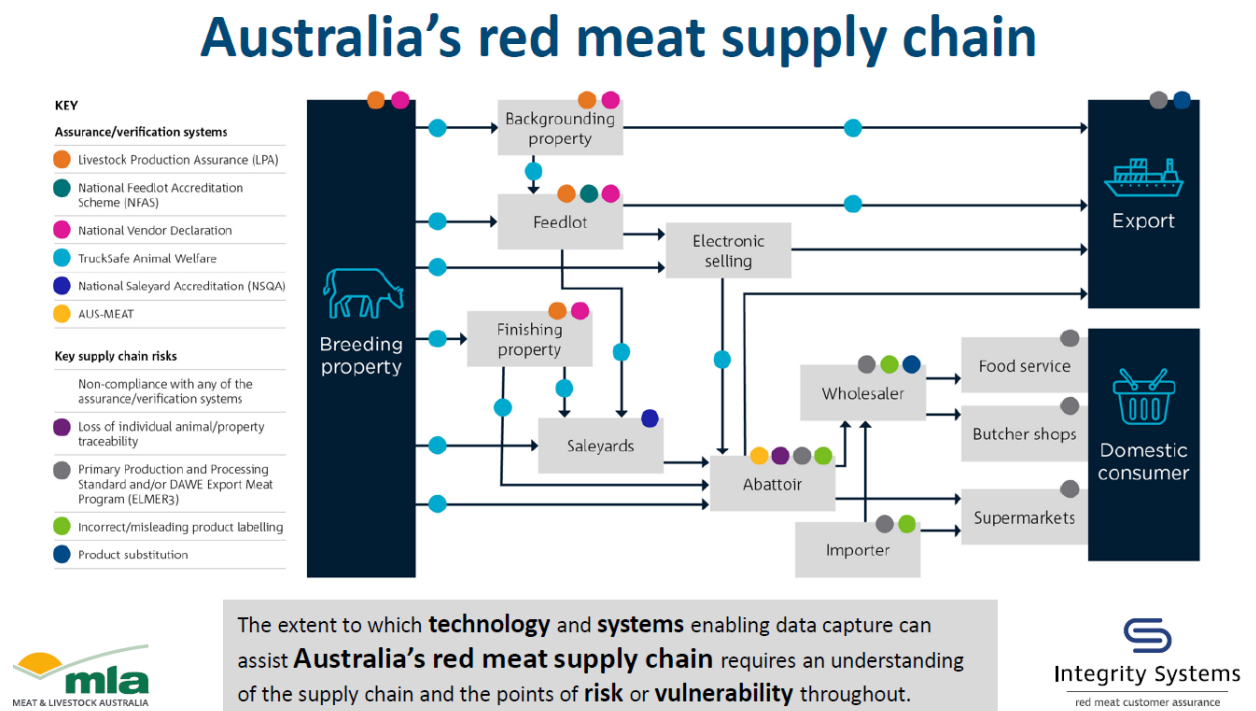
Figure 5: Model of data collection points in Australia's meat supply chain.

4.6.2   Data sources

In Milestone report 5, types of Livestock Wellbeing Assurance Programs were described, ranging from:

o   A baseline (BL) approach that represents what is currently achievable from existing industry data sources, including recommendations and guiding principles from the Australian Beef Sustainability and Sheep Sustainability Frameworks (ASBF and ASSF). It needs to be noted

that existing industry data has associated privacy and access restrictions and the database as described here assumes that industry data sources are accessible and can be linked. Industry data sources might include the following and within the Australian cattle industry, data may be available in multiple databases:

- NLIS (National Livestock Identification Scheme)
- NVD (National Vendor Declarations)
- LPA (Livestock Production Assurance)
- Trucksafe Animal Welfare
- National Saleyard Accreditation
- AUS-MEAT
- Breeding Farm production data
- Breedplan
- Backgrounding Farm production data
- Feedlot production data
- Weather data
- On-farm welfare assessment (e.g. Cattle Welfare Benchmarking)

o Welfare Benchmarking (WB) 2.0 represents a staged progression of deliverables that could form the basis of an industry program to improve lifetime animal wellbeing. These could be collected at specific times during the animal's life or ultimately, over the entire lifetime of the animal. The developmental objectives of Welfare Benchmarking 2.0 are:

1) Current animal-based measures. Existing practical parameters or measures applied at the herd (e.g., weaning percentage) or preferably, the individual animal level.
2) New animal-based measures. The advances in automated remote or on-animal sensing technologies enable significant new opportunities to explore and generate new data sources.
3) Ambitious indicators of wellbeing over the lifetime of the animal, such as telomere length or identification of a lifetime pain biomarker. These will be measures generated by a laboratory.

Table 12. Approaches to assess lifetime animal wellbeing with increasing sophistication as described in milestone report 5.

Wellbeing Assurance
Baseline (BL) - *LPA and other existing industry data sources* - *LPA + Company welfare assurance (including ABSF & ASSF metrics)*
Welfare Benchmarking 2.0
1. BL + WB + validated existing animal-based measures (e.g., weaning %)
2. BL + WB + validated existing and new animal-based measures
3. 2 + lifetime animal wellbeing indicators

The approaches as described in Table 12 might not eventuate in a consecutive manner. As noted earlier, industry data sources might be encumbered through privacy and access restrictions, which might prevent immediate integration for use in a wellbeing framework. Recognising this challenge

and the need to deliver an approach to industry as soon as possible, the timelines of data sources becoming available needs to be considered in layering the approach, e.g. the minimum viable product might include a mix of BL and Welfare Benchmarking 2.0.

4.6.3 Database model

The following database model describes the ideal scenario, assuming that all existing data sources described in the previous section are accessible and others, such as sensor-based data, are available for inclusion at a later point in time. Currently available data sources for BL have been gathered into multiple databases for multiple purposes but have not been designed to be integrated into a single system. A capable database would therefore need to be able to undertake the following:

- Gather the data from these multiple sources
- Interpret the data into an agreed and meaningful common language
- Sort and link the data to specific animals throughout their life
- Process the data via algorithms into metrics of wellbeing for the use by industry stakeholders.

A simple model of such a LAWI database network is given in Figure 6.
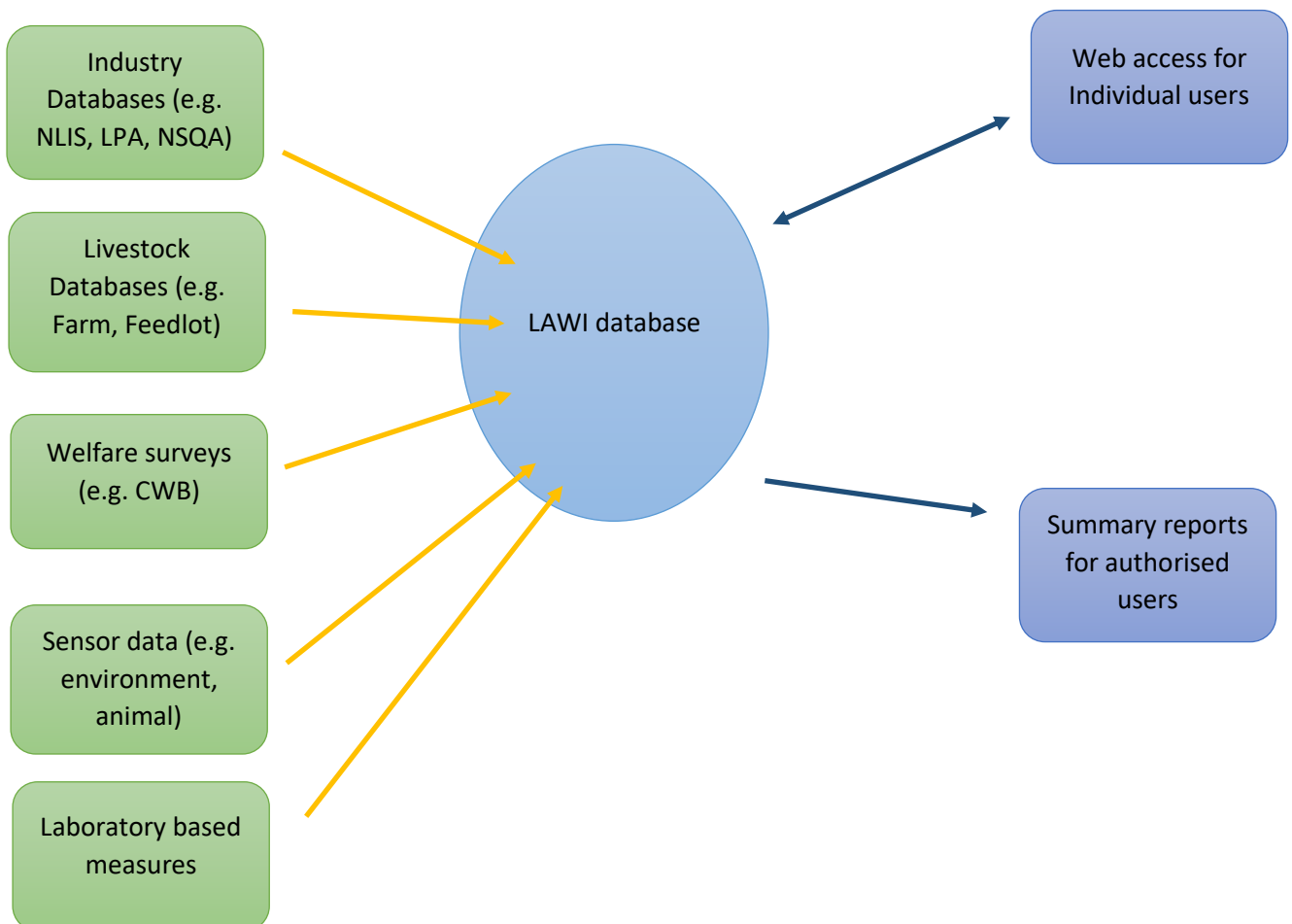
Figure 6: Simplified model of data flows in a national LAWI database

The model above shows the actual flow of data, but the process of initiating the transfer of that data could be done in one of two ways:

1. the database can "fetch" the data by asking the source database for the information

2. the source databases can initiate the action and "deposit" the data in the LAWI database

Which of the two methods is chosen, may vary depending upon the design of the source database. A flexible database needs to be able to cater for both data flow scenarios to not inhibit adoption unnecessarily.

4.6.4 Functionalities of a cloud-based platform

Over the last twenty years, databases have evolved from traditional in-house servers to remotely managed virtual servers, colloquially called the "Cloud". The Cloud consists of thousands of servers (Server farms) that are rented, as needed, to deliver all the hardware, operating systems and tools commonly used, such as SQL databases. The system implementor is then entirely freed of the need to purchase and maintain physical hardware, nor the supporting tools. Well known cloud providers include Microsoft's Azure, Google Cloud and Amazon Web Services (AWS). Cloud systems have many advantages including:

- Cost efficiency

  Only pay for what you need when you need it. Servers can be setup in minutes. The reliability and flexibility of modern cloud computing environments has been widely adopted because of the overall cost savings in managing these systems.

- Data Security

  Cloud systems are as secure as in house systems because managers have a wide variety of tools to manage access via the internet. They are populated with the same operating systems (typically Windows and Linux) that are used by in-house systems, if needed. In addition, applications, such as SQL databases, are available as a service in the cloud, without the need to setup such systems manual.

- Flexibility

  Access is typically via a web browser. Therefore phones, tablets, PC's or Apple devices all have access, without the need to download an App. Device Apps, such as phone or PC, can still be created for the cloud if needed.

- Scalability

  More computing power or more storage can be almost instantly enabled if needed to meet demand.

- Disaster recovery

  Automatic backups are readily enabled with a cloud solution, whether local, to another server on the continent or across the world.

- Easy manageability

  Very little expertise is needed to manage cloud infrastructure because the service providers have simplified that process with comprehensive built-in systems with easy-to-use dashboards.

- Simple software upgrades

  Included within the Cloud subscription, Operating Systems and databases are automatically updated by the cloud provider, a task usually managed by IT specialists with in-house servers. Custom applications such as the LAWI database and LAWI web interfaces can likewise reside in a single, central location, thus simplifying the rollout of upgrades to those.

4.6.5   Prototype monitoring system, the example of Cattle Welfare Benchmarking (CWB)

Here we exemplify the requirements and characteristics of a database that might underly an program to objectively describe lifetime animal wellbeing, here with a focus on the collection of on-farm data.

Due to be completed in early 2023, MLA have funded the development of a pilot system to monitor on-farm management practices with the aim to encourage producers to improve welfare outcomes with suggested improvements via benchmarking against industry best practice.   With the limited resources available for database development, it was decided to build a database using the pre-existing "Livestock Information Platform" (LIP), a cloud-based database technology previously built jointly by CSIRO and ABRI. See the following section for more information about LIP. This system is currently in active use with 18 participating pastoral cattle producers.

Within the LIP framework, the decision was taken to implement the CWB database as a single LIP database, to simplify the collating of results by the administrators. Each of the participating users were then granted access to the database, but only permitted to create and access their own data. LIP's built-in security prevents those users from accessing the data of other users, however they are free to add or edit their own data. Only the administrators can see all the data.

LIP has a variety of useful built-in capabilities that allow software builders to build cloud-based databases economically. These include:

• An "Application Programming Interface" or API. This is a software technology that allows access to LIP via a single "front door". API's are widely used and familiar to software developers. The LIP API vets all access attempts for authorisation against the data requested.

• A standard username and password access requirement.

• Secure containment of databases so that they are only accessible to database owners unless the owner grants permission to other LIP users.

• Flexible level of permissions granted to other users for access to the database, table or table column.

• Other users can be granted permission to read, edit, or append new data.

• Both structured data and unstructured file or image storage is available in LIP.

• LIP includes capability to send emails.

• LIP uses Microsoft's SQL database as the principal tool to store structured data.

• LIP is housed in Microsoft's Sydney based Azure data centre.

• Managed on an ongoing basis by the University of New England's Agricultural Business Research Institute (ABRI).

A model of the database structure for the CWB is as follows:

CWB is a complete functioning system. Major modules include:

- A web interface to allow users to enter data
- Users can receive "instant" feedback via the web interface
- Users can receive "benchmark" PDF reports via email when available
- Administrators can collate and analyse welfare risk via a Windows administrator's tool
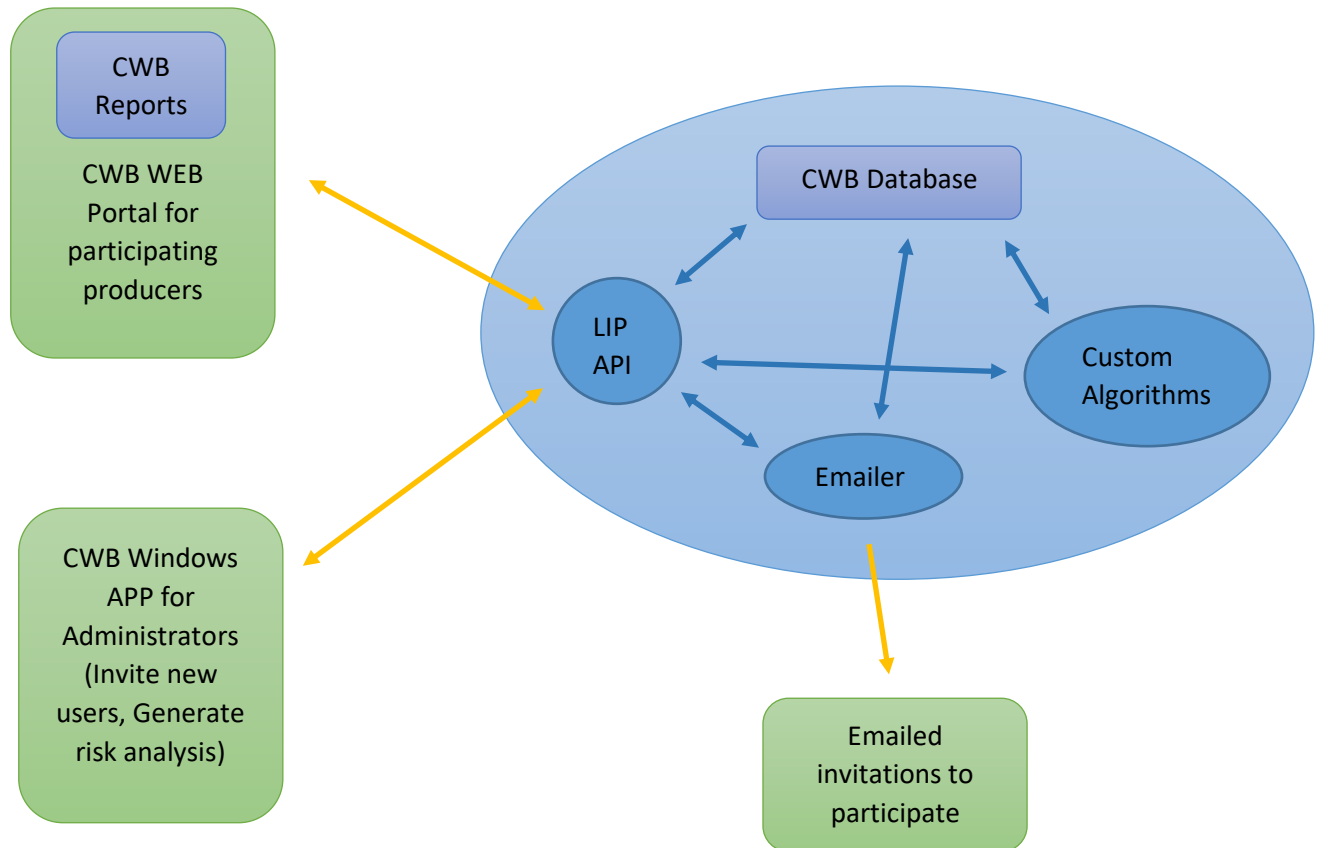
Figure 7: Dataflows within the CWB system.

The CWB is a very comprehensive survey based around practices for each property. Each year, the property manager answers questions (see Figure 8 for a snapshot), complemented by questions relating to each yarding event. Once completed the participants can produce an instant annual survey report (see Figure 9 for a snapshot) which will flag their responses against industry best practice using familiar traffic light (Red/orange/yellow/green) colours to highlight areas of improvement.

Figure 8: A Snapshot of part of the "Water" tab in the Annual Survey section of the Cattle Welfare Benchmarking web application.

Annual Survey Report

The categories assigned below are based on the Australian Animal Welfare Standards and Guidelines for Cattle. Categories may be based on welfare state (i.e. what the animals are experiencing) or welfare risk (i.e. the chance of welfare being impacted if something goes wrong) depending on the type of data entered.

State categories: Good, Adequate, Room for improvement, Immediate action required
Risk categories: Low risk, Moderate risk, Increased risk, High risk

Property: newprop

Survey Year: 2022

Water

Standard 2.1 A person in charge must ensure cattle have reasonable access to adequate and appropriate feed and water.

Access to water

Cattle water access is missing some information.

Water source monitoring frequency

`Increased risk` Troughs checked every few weeks.

`Increased risk` Dams/static water checked every month.

`Increased risk` Creeks/rivers/flowing water checked less often than monthly.

Water should be checked at least every few days to ensure it has not been contaminated even if there is a sufficient contingency period. Contamination of water may reduce intake and can cause illness or disease.

Guideline 2.13 states that where water quality is known to be variable, it should be monitored regularly for harmful substances and managed to protect cattle welfare.

`High risk` Some or all water courses were checked less frequently than their contingency period. This puts welfare at significant risk if water supply is interrupted.

Standard 2.1 A person in charge must ensure cattle have reasonable access to adequate and appropriate feed and water.

Guideline 2.14 states that water infrastructure should be inspected and maintained to allow effective provision of water in a reasonable time.

Feed

Standard 2.1 A person in charge must ensure cattle have reasonable access to adequate and appropriate feed and water.

Figure 9: A Snapshot of the Annual Survey Report in the CWB web application.

4.7   Program governance

Effective governance is essential to an industry program around lifetime animal wellbeing. It is central to the accountability of the program and to ensure the interests and needs of the multiple stakeholders are met.

At this early point in time of developing a program, only suggestions can be made on potentially underpinning governance structures. An industry program to improve lifetime animal wellbeing will move through different phases of technological maturity and industry delivery:

1) Research and Development
2) Implementation and Adoption
3) Management and Operations (including database management)

There are several formal governance models that could be applied and there may be specific governance considerations that are required for each of the different phases of the program. The preferred governance model will ultimately be contingent on size and scope of the program and the different program components and phases to delivery. The transition from research through to implementation and adoption may require a different governance approach. Similarly, the governance of the implementation/adoption and management/operations phases may differ depending on whether the Program is centrally managed via an industry entity or implemented and managed through company-specific welfare assurance schemes.

4.7.1   Research and development

Several governance models could be applied during the R&D phase and the choice will depend on multiple factors such as the quantum of R&D co-investment, funding sources and the process for R&D proposal evaluation and selection. One model with some precedence is a joint industry (including funding agencies) and research partner oversight committee. This type of model would seem well suited and appropriate for the Lifetime Animal Wellbeing Program.

It will be important to ensure there is balanced representation without the committee becoming too large. An independent chairperson and/or executive officer is recommended. Whilst specific Terms of Reference will be developed, the primary responsibility of the program governance committee is managing the execution and delivery of the research, development and adoption.

The combined representation from research and industry partners ensures fair assessment of research proposals that meet the needs of industry. However, vested interest from representatives on the committee must be managed with a strong focus on creating benefit to the Program.

Once there is clarity about the composition of the R&D of the program, the discovery process of converting the research outputs into industry impacts must be given priority as this will inform and shape the governance of the subsequent phases of the program. Using an impact pathway as an underpinning framework facilitates the development of key performance indicators that enable the decision making to manage risk.

4.7.2   Implementation and adoption

A research and development phase will continue to be aligned with the implementation and adoption phase. Therefore, the governance mechanism from the previous phase would remain to ensure transparent decision-making processes about new and ongoing research components to benefit the Program. For the implementation and adoption phase it is important to consider influencing factors and barriers to adoption and whole life cost of the program. Arashabi et al. (2021) developed a concept governance framework in a different context, but they demonstrate that governance structures and membership of these structures can facilitate implementation and adoption by addressing stakeholder barriers and motivation for adoption and implementation. Implementation and adoption and management and oversight phases need to have monitoring and evaluation processes to ensure the envisaged impacts of Program are being met.

4.7.3   Management and operations

The purpose of a committee that manages and overseas operations of the program is to ensure the alignment and the ongoing benefit of Program components, including database operations, to the overall strategic goal of the Program. Monitoring is based on key performance indicators to overall progress. The committee also serves as an escalation point for major operational risks and disputes that might occur in the R&D committee.

4.7.4   Potential governance models

The appropriate governance model is dependent on the funding arrangement for a Program to deliver an approach to improve LAW to industry, referred to the following as "The Program". In the following, legal requirements have not been considered. Here we describe two models 1) Mission-like organisation led program with partners 2) MLA led through MLA Donor Company. All governance models require clear terms of reference.

Mission-like model (research organisation led)

Description

In the development phase of the Program would be governed and informed by a Steering Committee (lead organisation only; governance and decision-making), Science Committee (Program Research Pillar leads, impact experts; technical input), and External Reference Group (MLA, DAFF, industry bodies; advisory role) with standing membership. Other groups or individuals can be invited to contribute on a temporary basis to provide key input and support. Governance arrangements might be developed further in the process.

The **Steering Committee** includes representatives from the lead research organisation. It is a decision-making body for the direction of the Program and expenditure of funds. The chair of the committee is held by a senior person of the research organisation.

The role of the **Science Committee** is to integrate the Program's science for impact by developing proposals for consideration by the steering committee.

An **External Reference Group** would include industry representatives and partners who play an advisory role to the Program. This focus of the External Reference Group is to ensure alignment of the Program with industry priorities. The members of the external reference group and provide a mechanism of high-level coordination of key stakeholders and provide direction to the program. Representatives advocate on behalf of the Program.

Risks Assessment

- To achieve industry adoption and implementation it is key to avoid a fragmentation of industry and research and development. This risk is mitigated by providing a governance structure that has representatives from both, including a mechanism, the Steering Committee to escalate decisions if required.

- There is a risk for the reputation of partners. It is key to appoint an executive officer who will ensure governance excellence and transparency.
- Conflict of interest. However, by having an approval mechanism for funding that is driven by the Program partners rather than the research providers, emphasis is placed to drive Program priorities.

Partnership model (MLA led)

Description

Throughout the lifetime of Program, it would be governed by a Management Committee (MLA and partner representatives; governance and decision-making), Science Committee (Program area leads; technical input), and External Advisory Committee (industry bodies; advisory role) with standing membership. The membership of the Management Committee can be extended with new partners coming on boards.

The **Management Committee** includes representatives from each of the supporting partner organisations of the Program. It is a decision-making body for the direction of the Program and expenditure of funds. The chair should be an independent person. The Management Committee needs to be supported by an Executive officer.

The role of the **Science Committee** is a mechanism for Research Pillar leads with a wider group of science leaders from the Program to identify and integrate science priorities for impact. By reviewing project progress and assessing new proposals for fit into the impact strategy of the Program.

An **External Advisory Committee** would include industry representatives and partners who play an advisory role to the Program. This focus of the External Reference Group is to ensure on the alignment of the Program with industry priorities.

Risk Assessment

- To achieve industry adoption and implementation it is key to avoid a fragmentation of industry and research and development. This risk is mitigated by providing a governance structure that has representatives from both.
- There is a risk for the reputation of partners. It is key to appoint an executive officer who will ensure governance excellence and transparency.
- Conflict of interest. This is the largest risk where the approval of funding and new proposals sits with the organisations that provide the funding.

Other models

Other options for governance with board arrangements would be appropriate if the program is funded as a Cooperative Research Centre or as a Joint Venture.

5   Conclusion

Early in the project, it emerged that the initial idea of exploring a lifetime animal wellbeing index (LAWI) might not meet industry stakeholder needs and the scope was opened up to alternatives, such as modular approaches that enable early delivery of a minimum viable product (Baseline Livestock Wellbeing Assurance Program). Due to the pivot in design thinking, the proposed program is referred to as "Livestock Wellbeing Assurance Program". Key for adoption and to guide the design of the Program, is the establishment of a clear value proposition for stakeholders. The deep exploration of R&D and stakeholder needs highlighted that the complexity of the ambitious Program to describe lifetime animal wellbeing in the red meat industry and requires further discussion, now that an initial design is being proposed.

5.1 Key findings

The overall project goal was to scope an objective approach to describe lifetime animal wellbeing.

The objective of the project was to understand:

- Stakeholder needs
- Use cases
- Existing animal welfare frameworks
- Existing data sources
- The knowledge gaps….what is the underpinning R&D required
- Value proposition -> cost / benefit

The following provides a summary of the key findings/conclusions of the project components that were instrumental in shaping the design and scope of a Livestock Wellbeing Assurance Program.

Impact pathway analysis

Key messages that will guide the development of the scope and delivery:
- The overarching impact is the improved outcome for the animals, with other economic, social and environmental outcomes being secondary flow-on impacts.
- An approach to objectively describe lifetime animal wellbeing is unlikely to generate a long-term competitive advantage for an individual industry stakeholder but will facilitate the sustainability of the whole red meat supply chain.
- Ideally, the approach:
   o Is an evolving framework that enables continuous improvement
   o Is flexible in its application to reflect the scale and diversity of production systems
- Critical elements for the successful delivery and scale of implementation of an approach to objectively describe lifetime animal wellbeing.
   o Defining the scope and intent of an approach and considering unintended consequences and impacts (narrative vs industry perceptions and realities)
   o Data landscape and infrastructure
   o The approach needs to align with and build on existing legislation, regulation and guidelines is critical
   o Early stakeholder engagement

Global Scan

Welfare assessment is complex with many facets to consider when objectively quantifying an individual's welfare state. Wellbeing encompasses more positive aspects and currently there are few well-validated, on-farm, objective measures to assess cattle and sheep wellbeing. The global scan indicated that there is a plethora of schemes out there internationally, but few schemes include direct on-animal measures, likely due to the historic difficulty in objectively and feasibly doing this. Any scheme developed for Australian conditions would have to be to account for highly variable nature of livestock production in this country. This is standard requirement for anyone developing a new scheme in that it must be tailored to suit a certain country/environment/production system. No certification scheme tracks individual animals over their lifetime and currently this would be challenging to achieve but as a goal, but if this can be achieved, it would set the Australian industry apart in the global context.

Stakeholder survey

Key messages require careful consideration in the context of the design and implementation of a future welfare standards/assurance systems:

- Support for a Wellbeing Assurance Scheme exists but was not unanimous
- A Wellbeing Assurance scheme might be used to distinguish Australian product from that originating in other countries, or domestically to ensure a welfare standard has been reached.
- A recurring thought is that any welfare standard must be categorised such as a yes / no or good / better / best system.
- Clear options for managing animals or product not reaching standard must be in place
- Harmonisation of the multiple welfare standards that exist across country and from private origin is required.
- Equivalency of a domestic standard to international or private standards needs to be considered.
- The diversity of welfare risks found within the Australian production system was routinely identified as a hurdle for developing an industry standard.
- Clarity is required around a standard based on a single measure, or an aggregation of multiple measures, reported from across an animal's lifetime.

One possible framework that emerged as a possible prototype in several interviews was a modular animal welfare system. Producers would select the standard/module (with associated performance metrics) most relevant to their enterprise. An animal welfare standard would then be achieved by compliance with any one of the different modules. Such a system could be linked to existing data systems and third-party review processes in order to demonstrate animal welfare outcomes.

R&D workshop

The concept of a lifetime description of animal wellbeing is a challenging proposition. The background information on stakeholder needs and existing frameworks highlighted the complexity. As a result, the discussion was focused on broad high-level concepts and most of the outcomes were a collection of qualitative comments that relate to components of a potential approach/framework to describe lifetime animal wellbeing.

Key messages from workshop:

- A data platform that allows bespoke information to be extracted for various use cases is the key requirement
- A minimum viable product currently can only provide a snapshot of wellbeing at certain times in an animals' life, data connectivity is required to reflect the wellbeing trajectory throughout an animals' life
- Moving from a description of wellbeing to positive outcomes through more complex on-animal measures, possibly informed by sensors

Summary of key principles for the development of a Livestock Wellbeing Assurance Program

- The global scan demonstrated that existing frameworks relating to animal welfare and wellbeing vary widely in purpose and use case (voluntary participation for progress tracking to compulsory participation for auditing and assessment). Depending on the purpose, different levels of data aggregation (e.g raw data points or metrics) can underpin the offering to end users. It also showed that these frameworks had varying levels of success, which needs to be considered in the context of the development of similar frameworks for Australia. The LAW program should enable the industry to transition from awareness about how to achieve good animal wellbeing to evidence-based demonstration of welfare/wellbeing outcomes. This is central to any of the multiple use cases for welfare/wellbeing assurance systems
- The size and complexity of the program will determine the quantum of investment required but this must be balanced against the actual and potential benefits
- There needs to be a clear value proposition for stakeholders (premium / market access / risk/continuous improvement), including a definition which proportion of this benefit is attributable to wellbeing? This also includes quantifying the non-economic value of improvements in animal welfare.
- Needs to demonstrate that Australian producers already operate above enforceable welfare standards and regulations to create and build consumer and market trust

5.2 Benefits to industry

The primary impact of a Livestock Wellbeing Assurance Program would be the improved wellbeing outcomes for the animals, with other economic, social and environmental outcomes being secondary flow-on impacts. An approach to objectively describe lifetime animal wellbeing is unlikely to generate a long-term competitive advantage for an individual industry stakeholder but will facilitate the sustainability of the whole red meat supply chain.

6   Future research and recommendations

6.1   The way forward – Livestock Wellbeing Assurance Program

The exploration of the current red meat supply landscape, with respect to welfare assurance schemes and stakeholder needs, has provided principles to guide the concept for design and implementation of a Livestock Wellbeing Assurance Program. The existence of knowledge gaps and missing detail is acknowledged, but these should not prevent initiation and design of the Program. Indeed, these gaps should become the focus of a supporting research and development plan. The development and implementation of the proposed program should be phased to optimise existing and future investments and increase adoption. The proposed Livestock Wellbeing Assurance Program is applicable to both sheep and cattle.

6.1.2   The objective

The overarching objective for a Livestock Wellbeing Assurance Program is to enable industry to transition from awareness of animal welfare guidelines to evidence-based demonstration of welfare/wellbeing outcomes. The Livestock Wellbeing Assurance Program has the potential to become the unifying entity for existing welfare standards, guidelines, and legislation. As such, it provides a means for the red meat industry to communicate certainty around animal welfare to the community, consumers and internationally. To address the diversity in individual stakeholder needs, flexibility in the application of the program is quite important. To that end, the choice of specific modules of wellbeing metrics can vary but the core principle is that each metric is scientifically verified.

6.1.3   Scope and recommended design

The proposed industry Livestock Wellbeing Assurance Program can be established using animal measures routinely collected by industry but brought together and reported on following the development of key enabling technologies. Industry familiarity with the measures should promote early adoption, while phased development enables the optimisation of past and future investments, by utilising measures and systems already in operation but providing scope for enhancement as new and credible measures are validated. Successful delivery would enable both current and bespoke Welfare/Wellbeing Assurance schemes providing the opportunity to assure a minimum standard but also allow product differentiation when required. To achieve this in practice will be highly challenging and complex. An overarching roadmap to guide the phased development of a Wellbeing Assurance scheme is presented in Table 13 that builds on three key elements of the Livestock Wellbeing Assurance Program:

- Data Platform
    - connects, integrates and standardises existing and future data from different sources and at different scales
    - enables interrogation at different scales (business and industry level) providing opportunities for benchmarking and evidence-based demonstration of continuous improvement
- Enabling technologies
    - the development of new quantitative capacity to measure/predict animal welfare outcomes

- - - o new measures and metrics
    - o validation of new metrics of positive wellbeing outcomes
    - o automation of measurement and data capture
- Implementation and adoption
  - o new analytical platforms to provide predictions of animal welfare outcomes and the opportunity for remedial action when required
  - o tools for data interpretation and decision making
  - o domestic and international market analysis and value attribution to wellbeing
  - o whole supply chain modelling of cost benefit, including social impacts

Table 13. Phased development of an industry Welfare Assurance Program.

Wellbeing Assurance	Components	Phase		Benefits	Capacity /Opportunity
Baseline (BL)	• *LPA and other existing industry data sources* • *LPA + Public/private welfare assurance (including ABSF & ASSF metrics)* • *Future Feedback*	*Where we are now*		• *Continuous improvement of welfare and remedial action* • *Enables product differentiation*	*Increasing capacity to deliver evidence-based welfare outcomes*
Wellbeing Assurance	*BL + validated existing animal-based measures (eg. weaning rate, growth)*	*Phase 1*		• *Strengthens market and consumer trust*	*Increased opportunity to collect positive welfare outcomes*
Wellbeing Assurance Plus	*BL + WA + validated existing and new animal-based measures*	*Phase 2*		• *Improved productivity* • *Enables risk mitigation and drive opportunities*	*Moving from risk mitigation to assessing opportunities*

A Baseline system (Where we are now)

The baseline system is designed to draw on existing industry data sources, available through Livestock Data Link (LDL) and other sources, allowing rapid delivery of a first-generation Welfare Assurance data platform. This is the first step to enable the collection and reporting of qualitative and quantitative welfare outcomes. Importantly. it provides entry points for different stakeholders. However, this first step is a big undertaking and will require a considerable amount of investment.

The deliverables from such a baseline system would assist; Producers to understand the level of wellbeing in their animals and to identify opportunities for improvement, Processors and retailers to start working with their producers on creating a narrative for product differentiation.

Existing data sources might include:

- National Livestock Identification Scheme (NLIS)
- National Vendor Declarations (NVD)
- Livestock Production Assurance (LPA)
- National Feedlot Accreditation scheme
- Trucksafe Animal Welfare
- National Saleyard Accreditation

- AUS-MEAT
- Breeding Farm production data
- Breedplan
- SheepGenetics
- Backgrounding Farm production data
- Feedlot production data
- Weather data
- On-farm welfare assessment (e.g. Cattle Welfare Benchmarking)

Not all data will be useful, and measurements must be validated for their relevance and their capacity to describe negative or positive welfare outcomes. The Livestock Wellbeing Assurance Program will enable and augment existing public/private welfare assurance schemes with quantitative objective and connected data sources that can readily feed into the existing frameworks to enhance the existing schemes. This approach has the advantage of tapping into already agreed welfare metrics and connecting to existing systems that are familiar to industry, assisting adoption and already accounting regional diversity.

The Baseline will provide an assessment of wellbeing retrospectively (after data collection) at some time points in an animal's life. Further time points can be augmented in the following phases of development to arrive at a more comprehensive description of lifetime animal wellbeing. Key elements of development would be the connection and integration of existing and future data sources building a flexible platform that can be populated and interrogated at different scales, whilst data privacy is observed.

Animal wellbeing alone may not be a sufficient driver for the establishment of a data platform, but on the opportunity also exists to connect into existing investments by MLA e.g Australian AgriFood Data Exchange and Future Feedback. Considering the large scope of the task, a strategic and planned approach needs to be taken.

Wellbeing Assurance and Wellbeing Assurance Plus (Phase 1 & 2)

Wellbeing Assurance and Wellbeing Assurance Plus represent the staged progression of deliverables that improve the Baseline system. They continue to build on the current MLA investments eg. welfare benchmarking in the extensive beef and feedlot sectors and the data platform developed in the Baseline system. The primary goal of the Wellbeing Assurance Phases is to generate scientifically verified outcome or animal-based measures of animal wellbeing. These could apply at specific times during the animal's life or ultimately, over the entire lifetime of the animal. The goal is designed to address the generally accepted paucity of validated animal-based measures within animal welfare assurance schemes. Whilst moving from Wellbeing Assurance to Wellbeing Assurance Plus, technology that underpins data capture increases in sophistication and enables the description not just of negative outcomes but a differentiated account of positive wellbeing outcomes. The underlying approach increases in complexity and sophistication from Wellbeing Assurance to Wellbeing Assurance Plus, but the level of complexity in application, e.g. on-farm data collection processes, decreases, enhancing the opportunities to objectively and easily describe lifetime wellbeing. As described in the Baseline System, the deliverables from each of the phases of development are designed to build on existing welfare assurance systems e.g. private/public based welfare assurance or industry welfare benchmarking.

The developmental objectives of the Wellbeing Assurance and Wellbeing Assurance Plus are:

- Identify and validate current animal-based measures. The emphasis here is identifying practical parameters or measures that are currently applied at the herd (eg. weaning %) or preferably, the individual animal level (growth, reproductive outcomes).
- Develop and validate new animal-based measures. The advances in automated remote or on-animal sensing technologies enable significant new opportunities to explore and generate new measures.
- Develop and validate ambitious end-of-life measures as indicators of wellbeing over the lifetime of the animal, such as DNA methylation changes or identification of lifetime pain. (It is worth noting that the end-of-life measures themselves do not allow for continuous improvement because they serve as retrospective indicators. However, they might enhance the development of predictive models that assist management decision that influence lifetime animal wellbeing.)

Implementation and adoption

Early stakeholder engagement and co-creation of the approach is key to successful implementation and adoption. Two critical research pillars have been identified to ensure broad implementation and adoption in industry of the deliverables of the described phased concept:

1) To formulate a value proposition of a Wellbeing Assessment Program, a detailed understanding of the value of the benefits (see Table 12) to industry stakeholders (economic and social) and the attribution of value to animal wellbeing in the domestic and international market is required. Whole of supply chain modelling and insight analyses would provide important information on the drivers of value,
2) In the Baseline system, analytical platforms and tools are required for stakeholders to interpret their data. Tools to provide prediction of animal welfare outcomes, data visualisation and decision making will enhance the uptake and agency in decision making to improve and enhance wellbeing outcomes.

In conclusion, the overarching principle to deliver a pragmatic flexible approach defines the recommended scope and design of a Livestock Wellbeing Assurance Program more succinctly. A phased approach will enable the delivery of tools to industry early and evolve in sophistication, automation and positive wellbeing outcomes for animals.

6.1.4   Modular deliverables

Modular access to the deliverable of a Wellbeing Assessment Program provides the highest level of flexibility to stakeholders in the implementation and is designed to maximise adoption. This will empower industry stakeholders to take ownership of shaping the deliverables to their own needs. Private/public frameworks for the assessment of animal wellbeing already exist, end user specific access to modules allows stakeholders to improve their existing framework and shape the product to their needs.

- For example, Producers, processors or supermarkets might build their own brand based on animal wellbeing credentials. To be able to differentiate their product, they need to be able to "mix and match" metrics to build their brand.
- Data sources can be accessed to describe animal wellbeing to match international frameworks to gain or maintain market access

A key aspect of the modular approach is that the credentials are not used in isolation to create a commercial advantage, but that it needs to be ensured that it demonstrates robustness in terms of animal welfare assurance, improving wellbeing outcomes for animals. Therefore, alignment with frameworks such as the five freedoms needs to be considered as part of the modular access.

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8   Appendix

8.1   List of workshop participants for impact pathway analysis

Aaron Ingham	CSIRO	Principle Scientist – Phenomics
Sonja Dominik	CSIRO	Project lead
Drewe Ferguson	CSIRO	Scientist Meat quality and welfare
Dana Campbell	CSIRO	Senior Scientist - Welfare
Katie Ricketts	CSIRO	Senior Scientist - Sustainable agricultural transformation
Moira Menzies	CSIRO	Project manager
David Beatty	MLA	Group manager productivity and animal wellbeing
Michael Laurence	MLA	Program Manager Animal Wellbeing
Hayley Robinson	ISC	Program Manager – Research and Insights
Scott Cameron	MLA	Global insights and strategy
Josh Anderson	MLA	International Business Manager
Renelle Jeffry	MLA	Program Manager – Sustainability Portfolio
Catherine Golding	MLA	Business development manager
Louise Holding	Supply chain/Producer	Project Director No Fear No Pain Initiative Harvest Road
Ann Backhouse	DAWE*	Meat Market Access section, Export Standards Branch
Ian Rogan	SALRC	Chair SALRC
Darryl Barbour	DAWE	A/g Assistant Secretary for the Meat Exports Branch
Andrew Fisher	University of Melbourne	Chair Of Cattle And Sheep Production Medicine Veterinary Clinical Sciences
Mark Inglis	JBS	Livestock SA JBS
Naomi Wilson	AACo	Head of Environment and Sustainability
Alan Tillbrook	University of Queensland	Professorial Research Fellow Center for Animal Science, Managing Director of The Animal Welfare Collaborative
Andrew Blinco	OBE Organics	General Manager Operation OBE Organics
Valeska	MLA	Regional Manager for South East Asia
Ross McKenzie	OBE Organics	Livestock Coordinator OBE Organics
Belinda Dexter	Australian Lamb Company	CFO at the Australian Lamb Company
Sabine Schmoelzl	CSIRO	Principle Scientist - Phenomics
Stephen Baker	Rabobank	Head of quality asset management

*note that DAWE is now DAFF

8.2 Draft impact pathway

Describing Lifetime Animal Wellbeing | DRAFT Impact Pathway V0.2

Impact Statement: (TBD)

PARTICIPATION: Who we need to reach across the various parts of the pathway?

| Government: Federal and State Agriculture (DAWE; ILSC, DPIs etc.); Current industry corporates and bodies (MLA, ISC, Research Councils, ALC, JBS, AACo, OBE Organic, etc.); Research partners (CSIRO, universitie, etc.) | Australian Agriculture Departments and their Ministers; Australian Chief Vet and state and territory counterparts. Current industry corporates and bodies (AMIC, CCA, SPA, ALEC, ALFA); Advisory groups (RACs, Research Councils); processors, transporters, wholesalers, retailers (domestic and export), consumers; Animal welfare advocacy organisations, NGOs; Rural lending orgs | Federal gov. (e.g. DAWE); State gov. (regulators); Local councils, Land owners and red meat producers; Rural lending organisations; MLA; large scale producers (AACo, NAPCO, CPC, etc.), influential producers, breed societies, Advisory groups (RACs); Rural insurers; Research Councils; ILSC; AgTech companies; Tech companies; Live export and processors; Farm advisors; Animal Health Companies; Industry 4.0 Providers; Consumers; Export markets, WWF, RSPCA and other groups with social licence interests; Domestic & international Private investors; Financial institutions; Strategy/policy development partners: MLA/RMAC/ AMIC/CCA/SPA/ALEC/ALFA, with DAWE, CSIRO, universities& other research orgs | Red meat industries, wider public & consumers, regional communities, government |

Years 2022 – 2026 | **Years 2023– 2030**

INPUTS
What we invest

Funding
- Ext. govt, industry, private sector
- University and research organization co-contribution

Capabilities
- Researchers and industry & govt partners with knowledge of red beef production systems, animal welfare
- Data scientists (analytics, sensors and ML for supply chain and to automate monitoring and regulatory compliance)
- Social scientists (incl. economists for value chain assessments)
- Expertise with stakeholder engagement
- BD and Comms

Existing partnerships & collaborations

Infrastructure (plant & equipment)
- Research facilities
- Commercial partner properties
- Data platforms/ management systems & measurement infrastructure

Background IP
- Much and varied and dependent on measurements and ways to implement that

Existing Strategy/Plan/Project Portfolio
- Existing livestock assurance programs, identification/ traceability and certification systems
- Existing national and international standards, codes of practice, etc.

ACTIVITIES
What we do

Analysis of current state, assessment of options
- Review existing relevant policy, standards, guidelines, and how they contribute to an objective measure of animal lifetime wellbeing
- Identify/evaluate existing animal wellbeing systems, frameworks and tools worldwide incl. voluntary/mandatory
- Identify the different entry points/use cases for end-users
- Identify criteria: i) ready to be used; ii) seems suitable, needs some work, validation; iii) nice idea, need further R&D
- Identify gaps in current data

Research & development
Design of R&D program informed by engagement and feedback from supply chain, i.e.:
- Analysis of current state (as above)
- Approaches:
  o Identify and quantify most appropriate parameters and measures for lifetime animal wellbeing/Identify potential animal measures for further R&D - perhaps more D than R as R from a low base will consume significant resources for uncertain success in each instance
- Data collection and sharing:
  o Identify architecture of data system
  o Developing protocols for digital data sharing including privacy-tech, interoperability and governance
  o Developing new tools or approaches to digitise and automate monitoring across supply chains
- Compliance (if certification is goal):
  o Identify and test more flexible approaches to meeting current biosecurity, food safety, AW requirements of trade
- Supply chain 'trust':
  o Program of underpinning social science to centre R&D on users/all supply chain

Establish strong collaborative relationships & governance
- Establish sub-committees and working groups
- Undertake significant and ongoing engagement with commercial stakeholders/supply chain to understand needs/barriers and support uptake
- Gauge consumer, industry acceptability (undertake willingness-to-pay, cost-benefit, consumer sentiment mapping (work of MLA with Good Meat, etc.)
- Establish the of entity/body that manages trainings, data standards, governance
- Establish governance protocols and responsibility
- Establish expectations around monitoring and adhering to the program - i.e., audit process or similar
- Develop & implements formal Comms, MEL plans

Develop capability in research and partners
- Develop training and tools to build understanding of approach and platform (e.g., producer

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OUTPUTS
Our deliverables

World-class science & IP
- Index:
  o MVP/Prototype approach and metrics that contribute to lifetime animal wellbeing,
  o Innovation strategy to assist with longer term development
  o Structured and validated criteria for the scheme
- Data collection and sharing:
  o Easily accessible, easy to use data platform that can account for current inputs such as existing compliance forms and data points
  o Technology to support digital supply chains platforms (e.g., integrated data, data storage system, potential automated sensor system to assess welfare, etc.)
- Industry-owned IP that could be licensed/used by third parties
- Peer-reviewed papers, reports, presentations (e.g., scientific validation of metrics to support objective descriptor; data reports to governing organisation; etc.)

Capability/methods/approaches/prototypes
- Completed, flexible, agile, and evolving capability framework that can support the delivery of the product in diverse contexts and at different scales
- Process for identifying criteria to be incorporated into scheme (objective and independent of those developing criteria)
- Methods to integrate AW outcomes temporally
- Supply chain/provenance technologies, platforms and procedures
- Producer adoption related training resources
- Online stock wellbeing calculator using the farmer's own data with links to supporting materials
- Education tool for industry and consumers

Communications, engagement and partnerships
- Detailed engagement and comms plans
- Network of partners and cooperative partnerships across the value chain ('early adopters'

Strategy and Policy
- Map of standards/guidelines/regulations

Monitoring, evaluation and learning
- Measure of changes in animal wellbeing over time, incl. against a consistent,

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OUTCOMES
The uptake or adoption of our work

Short Term Outcomes

Ecosystem of partnerships for development
- Advisory group/s and use case groups active around objective descriptor (incl. industry 'reps', policy stakeholders, research orgs, etc.)

Policy & strategy alignment
- Explicit support from peak bodies and development of corresponding policy positions
- Alignment with existing policy/ standards and recommendations
- Industry agreed R&D strategy and end goal

Partner/industry application
- Acceptance around the concept is growing
- Incentives are in place to support use of index by early adopters

Capacity changes
- Trials of MVPs based on existing data streams and technology across diverse stakeholders
- Supply chain participants voluntarily testing index
- Training and learning system for supply chain is developed
- Upscaled investment in the science that provides for meaningful, cost-effective objective measures
- Optimisation and/or integration of existing industry systems/platforms
- Connectivity across supply chain is building

Awareness & social engagement
- Australian producers on board and accept that managing AW is baseline requirement
- Unified industry understanding and support of what an objective descriptor means
- Supply chain players actively promote the tool
- Consumer awareness is building of the tool and its function in the supply chain

Medium Term Outcomes

Policy & strategy change
- Trading partner acceptance of objective descriptor as equivalence of domestic measures of animal welfare
- Industry is convinced that the parameters are the correct ones to be measuring

Scaling capacity & application
- Business model/s and fully functional capability framework established and being validated as to allow stream of benefits through supply chains
- Robust data management system built (with automated data collection process and monitoring across supply chains)
- Understanding of the management skills needed to maximise performance against the index
- Supply chain stakeholders actively participating in and providing necessary data inputs into index (i.e., they *can* use it and *do* use it routinely)
- Training partners and systems are identified, and approach is piloted
- Continuing refinement of parameters feeds into evolution of index and tools

Commercialisation pathways
- Supporting trading language, documentation pathways, audit mechanisms etc. to communicate and support credentials

Social acceptance pathway
- Acceptance by supply chain participants that animal wellbeing is a positive rather than defensive issue; change from 'minimum performance' to 'optimisation' mindset
- Producers and supply chain partners actively work together to monitor and improve and report animal wellbeing information
- Consumer confidence growing in the animal welfare standards of the system

Long Term Outcomes

Policy & strategy change
- Policies/guidelines periodically reviewed and refined to address emerging issues

Capacity & practice change at national scale
- Large-scale, system-level application of developed tool(s), embedded in all supply chains (e.g., retailers using index as a baseline and going above and beyond to market an even higher level of welfare)
- Supply chain players have detailed knowledge about the tool and are well train in its implementation

Social acceptance pathways
- Confidence in Australia producing the most trusted source of protein
- Global animal welfare societies endorse Australian red meat welfare credentials based on update of index
- Recognition that the animal wellbeing tool is viable and valuable to meet customer demands
- Public (esp. consumer) understanding of what an objective descriptor means and confidence in the AW standards

Commercialisation pathways
- A brand for marketing is delivered
- Potential new entity for monitoring and evaluation of the system

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IMPACTS
Benefits to eco, environ, soc

Economic
- Maintain and expand global market access, with Australian products sought for their quality and provenance
- Red meat supply chains better connected and protected against damage from animal welfare issues
- Productivity and efficiency gains (e.g., reduced costs, improved quality/grading, etc.) from animal welfare best practice through the whole red meat supply chain
- Improved animal welfare

Environmental
Indirect/flow-on benefits with regard to smaller environmental footprint:
- Potential reduction in use of chemical/hormone products for both therapeutic and non-therapeutic applications
- Contribution to waste reduction and an associated reduction in environmental footprint in the sector
- Northern pastures are resilient to climate variability and produce high value, environmentally friendly beef with sufficient profile to maintain the rural economy
- Reduction in the rate of land quality decline or a decrease in the area of lands which are degraded.

Social
- Maintain access to high-quality, safe food options for consumers
- Protection (and potential improvement) of rural livelihoods in red meat production, and associated wellbeing and protection of community cohesion
- Knowledge, skills, and confidence gains within industry and the public around effective management of livestock

8.3   LAWI Participant Information Sheet

Research Participant Information Sheet

Use case and value proposition for an objective approach to describe lifetime animal wellbeing through the red meat supply chain

Project overview

You are invited to take part in a project that will evaluate the scope and delivery mechanism for an objective approach to describe lifetime animal wellbeing through the red meat supply chain. This is a collaborative project between CSIRO and Meat and Livestock Australia (MLA), funded by MLA. The project will develop a business case for the development of approaches to describe lifetime animal wellbeing. Perspectives of stakeholders are sought on how they would use such information, perceived impediments to achieve impact, characteristics that make application more feasible and the value that such an approach might create for their business or in industry more generally, domestically and globally .

What does participation involve?

Participation in this study will involve taking part in an interview that will take approximately 60 minutes. All interviews will be conducted by CSIRO researchers and will take place via videoconference (or phone if a video is not possible) at a convenient time. The interview will cover the following topics:

1. Your role in the red meat supply chain.
2. The value that an objective approach for the description of lifetime animal wellbeing would create for your business / the broader red meat industry
3. Your perceptions of the challenges for a potential implementation

We will also gather some demographic information about the people who participate in the study (e.g. gender, occupation). This information will remain anonymous.

Risks and benefits

Aside from giving up your time, there are no foreseeable risks associated with participating in this study. Whilst your participation in this project may not benefit you directly, your participation will assist developing an approach that will create benefit in the red meat industry

Withdrawal from the research project

Participation in this study is completely voluntary and you do not have to take part. Your decision whether to participate will not affect your current or future relationship with the researchers or anyone else at CSIRO. If any topic is raised during the interview that you prefer not to discuss, you only need to tell the interviewer and the topic will not be pursued. Similarly, you are free to stop the interview at any time. In this case, any information you have provided will not be included in the study results. If you wish to withdraw after the interview has finished, simply notify the researchers listed below and your interview data will be destroyed. You may withdraw from this study at any time up until the publication of the final outputs.

CSIRO Australia's National Science Agency

8.4   LAWI Consent Form

Research Participant Consent Form

Understanding demand for a Lifetime Animal Welfare Index

Dear Participant

Please review the information below and sign if you agree to participate in this research project

I _____ acknowledge that:

- I have agreed to participate in the above project being **conducted by CSIRO**.
- I have been **provided with information** about the project and had any questions regarding my participation and any associated risks and benefits answered to my satisfaction.
- I understand my participation in the research will involve **a 60 minute interview**.
- I have been provided with **contact details** of the researcher and understand that I can contact them at any point during the study. I have also been provided with the contact details of an independent ethics officer at CSIRO should I wish to raise any concerns or complaints about the conduct of the research.
- I understand that my participation in the project is entirely **voluntary** and that I am **free to withdraw** my participation at any time and without having to provide a reason for my withdrawal.
- I understand that I may also ask for part or all of the information provided by me to be removed from the study **up until the publication of the final outputs** without penalty or explanation.
- I understand that the interview will be **recorded** (written notes) for reference purposes to help ensure accuracy of the data.
- I understand that the **information I provide** for this research will be used for the **following purposes**:
    - to produce reports, scientific papers and conference presentations
    - to inform industry and policy makers' future decisions and activities
    - to provide input into future CSIRO research on community perspectives about climate change impacts
- I understand the information will be treated **confidentially** and I will **not be identified** in any publications resulting from the study. Information provided by me will be **stored securely** by the CSIRO.

Name:_____ Signature:_____ Date:_____

We thank you for your agreement to participate in this research

CSIRO Australia's National Science Agency

8.5   List of workshop participants

Name	Field	Organisation
Mark Hutchinson	Research	University of Adelaide
Sonja Dominik	Research	CSIRO
Caroline Lee	Research	CSIRO
Drewe Ferguson	Research	CSIRO
Dana Campbell	Research	CSIRO
Jessica Monk	Research	UNE
Hannah Salvin	Research	NSW DPI
Kim Bunter	Research	AGBU
Danila Marini	Research	CSIRO
Linda Cafe	Research	NSW DPI
Nick Van Beest	Research	Data61
Moira Menzies	Research	CSIRO
Aaron Ingham	Research	CSIRO
Lauren Hemsworth	Research	University of Melbourne
Jeremy Skuse	Research	Consultant
Amanda Doughty	Ag tech - Research	Allflex
Dominque Blache	Research	UWA
Theresa Collins	Research	Murdoch
Michael Laurence	Industry	MLA
David Beatty	Industry	MLA
Ali Small	Research	CSIRO
Scott Williams	Facilitator	Consultant
Sharon Dundon	Industry	MLA
Sabrina Lomax	Research	University of Sydney
Tracy Sullivan	Industry	vet and president of the Australian Cattle Veterinarians
Irene Sobota	Industry	Integrity Systems Company
Wayne Pitchford	Research	University of Adelaide

8.6   R&D workshop Agenda

Lifetime Animal Wellbeing R & D Workshop
Stamford Sydney Airport. 27 – 28 April 2022.

Workshop Goals

To scope and identify R&D needs to enable the development of a framework to assess lifetime animal wellbeing in livestock (cattle and sheep).

Background

Livestock producers, livestock industry managers and supply chain actors are increasingly under pressure to demonstrate and validate strong commitments to animal welfare and ethical treatment. The pressure to provide robust animal welfare data and information stems from a range of influential actors including investors, regulators, multinational traders, animal advocacy and welfare groups, retailers and consumer groups.

For businesses that produce, trade or sell livestock and their products, the measurement of animal wellbeing presents opportunities for mitigating brand and social license risk, but it also presents market opportunities to build trust in the supply chain for differentiating products based on assurance of higher animal welfare standards.

Australia's red meat industries are taking a proactive approach to the risks and opportunities around verifying animal welfare. This includes commitments to the application of "world class animal health, welfare, biosecurity and production practices" which was central to the livestock focussed priorities listed in Red Meat 2030 (Red Meat Advisory Council 2019). This is also supported in MLA's Strategic Plan 2025: "To become the trusted source of the highest quality protein the focus should be on product quality and product attributes, including animal health, welfare and environmental credentials".

The assessment of livestock wellbeing over the lifetime of an individual animal and its delivery as a tool to end-users is both highly challenging and complex. It is difficult to define in the first instance, will likely be introduced in a staged manner and it can be constantly evolving due to its multifaceted nature. There are multiple drivers of influence including geographical, environmental and temporal effects that will impact the welfare experience of an animal over its lifetime. Emphasis on objectivity in the assessment of welfare is paramount. Addressing this problem requires an understanding of the complexity, interconnectedness, trade-offs and recognition of the requirements of the various stake holders along the supply chain.

There is a strong need for standardised, objective information in order to define animal wellbeing. Capturing wellbeing throughout an animal's life is very ambitious and challenging, due to the requirement for an efficient and pragmatic but not over simplified approach that drives industry application and adoption. Notwithstanding this, the development and application of a "Lifetime Animal Wellbeing Index (LAWI)" is ultimately central to growing consumer and market trust in Australian red meat products. As a precedent, Meat Standards Australia (MSA) has demonstrated that it is possible to capture multiple inputs
over the life of an animal and convert these (post-slaughter) into a simple verifiable index that quantifies and conveys eating quality to the consumer. Moreover, this innovation has been internationally recognised highlighting Australia's global leadership in meeting consumer and retailer needs. Similarly, a LAWI that accounts for the physiological and behavioural changes and adaptations that reflect animals' wellbeing throughout their lifetime will provide a vehicle for continuous improvement to improve both the on-farm and pre-slaughter animal experience and underpin growth in consumer trust and global market access.

Agenda Day 1
9.00 Welcome and workshop introduction   *Scott Williams*

Overview of scoping project and progress summaries
9.05 Project overview and impact pathway analysis   *Sonja Dominik*
9.35 Global scan of welfare assessment frameworks   *Dana Campbell*
10:00 Feedback from stakeholder consultation   *Aaron Ingham*
10.30 Questions and discussion   *Scott Williams*

11.30 Visioning session:
Put yourself in 2030 and describe an ideal system we have for describing individual animal welfare.
Breakout session in groups
Key questions
In an unconstrained world, how would a lifetime wellbeing system function?
What would it look like – from short term product to the Rolls Royce system long term?
Who is collecting the data?
There will be multiple end users but what are the primary applications it will serve?

1.15 Mapping out existing data capture across the supply chain – where are we now?
                                        Irene Sobota
1.40 Existing data sources, capture and handling. Where are we now and where to next?
Based on what we have now, how would you design a lifetime wellbeing system.
Breakout session in groups
Key questions:
Short-, medium- and long-term development of an approach?
How would you integrate the information?
What innovation is needed to source, analyse and aggregate the data?
How to handle data tracing across the supply chain?
What are the trade-offs and risks?

3.30 Report Back
4.00 Wrap up and Finish
5.30 Pre-dinner drinks followed by dinner from 6pm

Agenda Day 2

8.30 Assessing lifetime animal wellbeing   *Ian Colditz*
9.00 What are the research gaps? What R&D is needed?
The R&D gaps will add to the mapped-out information from the previous session.
Break out session in groups

Key questions
What current measures are available to accurately reflect lifetime animal wellbeing?
What new measures are needed?
How feasible is an objective approach in tracking animal welfare?

11.00 Continue R&D gap session
12.00 Report back
1.00 Wrap up and finish

8.7 Draft calculation of the value of wellbeing to the total value of global export beef.

A draft calculation based on information obtain from Josh Anderson (MLA).

Prices and Assumptions

- *China purchases 172,191 T of meat from Australia at an average price of $9.74 / kg*
- *This is a $0.36 premium / kg based on global sales figures, but includes chilled and frozen product*
  - *Frozen 148,041 T at $8.86 / kg ($1.34 / kg premium)*
  - *Chilled 24,150 T at $15.16 / kg ($0.81 / kg premium)*
- *The assumption is that frozen product represents bulk commodity and chilled product as premium, where consumers would be more likely to be interested in quality credentials like welfare status.*
- *In a recent CSIRO survey of retailers and consumers in China 8% (Vietnam 0%) of participants stated that their purchasing decision was influenced by animal welfare.*
- *The figure of 8% was applied across all countries identified here.*

Calculations of value of wellbeing of global beef export (based on chilled product only)

China premium

24,150,000 kg x $0.81 / kg = $19,561,500

Applying a similar approach for other countries paying above global average.

Korea premium

40,202,000 x $0.34 = $13,668,680

USA premium

53,774,000 x $0.79 = $42,481,460

Taiwan premium

5,117,000 x $0.81 = $4,144,770

> *Global total premium $79,856,410*

Then 8% (consumer decision that are influenced) of $79,856,410 global premium may be attributable to animal welfare considerations.

> *Global premium attributed to wellbeing = $6,388,512.80 per annum.*

Total global beef export value = 959,162,000 kg x $9.39 / kg = $9,006,531,150

Wellbeing benefit / Total value = $6,388,512.80 / $9,006,531,150 x 100 = 0.07%

8.8   Global Scan

Objective: *Deliver a comprehensive and extensive global scan and evaluation of frameworks and methodologies that assess animal welfare/wellbeing for sheep and cattle, to act as a foundation for the development of this LAWI to understand the regional opportunities, the challenges and benefits to industry implementation when the information is interpreted in an Australian context. Linkages with other sustainability frameworks, e.g. carbon and biodiversity, will be acknowledged and captured.*

1)   Introduction – what is welfare and how can we objectively measure it?

1.1 What is welfare?

A systematic approach to describing what animal welfare is and how it can be measured commenced in the UK in the 1960s in response to public concern over "factory farming". The Brambell (1965) report into the welfare of intensively housed livestock concluded that "Welfare is a wide term that embraces both the physical and mental well-being of the animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence available concerning the feelings of animals that can be derived from their structure and functions and also from their behaviour." The committee recommended that all farm animals should be given sufficient space so that without difficulty they can "stand up, lie down, turn around, groom themselves, and stretch their limbs." The recommendation became known as the Five Freedoms and was subsequently refined by UK Farm Animal Welfare Council to include Provisions as to how Freedoms might be met:

- Freedom from hunger and thirst—achieved by readily accessible fresh water and a diet to maintain full health and vigour.

- Freedom from discomfort—achieved by appropriate shelter with a dry, restful lying area, and temperature within an acceptable range of tolerance.

- Freedom from pain, injury, and disease—achieved by prevention or rapid diagnosis and treatment.

- Freedom from fear—achieved by conditioning animals to their surroundings and avoiding situations that cause stress.

- Freedom to express normal patterns of behaviour—achieved by the provision of room to move, things to do and the company of their own kind.

Mellor and colleagues (Mellor and Beausoleil 2015; Mellor 2017) developed a similar framework based on Five Domains for describing the scope of physical and mental activities of the animal that the authors proposed encompass the concept of animal welfare. The Five Domains model provides a stronger focus on the mental experiences of the animal than the Five Freedoms model by viewing four physical/functional domains (Nutrition, Health, Environment, Behaviour) as inputs that generate the fifth domain (Mental experience) which in turn represents an integrated welfare outcome (Webster 2016).

"animal welfare means the physical and mental state of the animal in relation to the conditions in which it lives and dies."

(World Organisation for Animal Health, OIE)

In parallel with the development of these frameworks, debate ensued in the new science of animal welfare as to what actually constitutes good animal welfare. Fraser (2008) suggested "that animals should *feel well* by being free from prolonged or intense fear, pain and other unpleasant states, and by experiencing normal pleasures; that animals should *function well* in the sense of satisfactory health, growth and normal behavioral and physiological functioning; and that animals should *lead natural lives* through the development and use of their natural adaptations." Broom (1986) provided a synopsis of welfare as "the state of the animal as regards its attempts to cope with its environment". More recently Dawkins (2008, 2021b) has suggested welfare is "health and what animals want". The World Organisation for Animal Health draws these concepts together to say **animal welfare means the physical and mental state of the animal in relation to the conditions in which it lives and dies**. A consolidated version of Fraser's description of welfare is widely adopted as a tripartite model in which welfare entails biological functioning, mental (affective) states, and natural living (Figures 1 and 2). Each of these aspects of the animal's life need to be fulfilled for the animal to be in a state of good welfare. Nonetheless, the aspects are not entirely independent; mental (affective) experiences for example are part of biological functioning, and vice versa (Hemsworth *et al.* 2015). On the other hand, healthy biological functioning does not guarantee positively valenced affective experience, and vice versa (Williams 2021). For example, an aging cow may experience positive affective experiences from suckling and grooming her calf yet be in a poor physical state due to seasonal conditions and the debilities of advancing age.
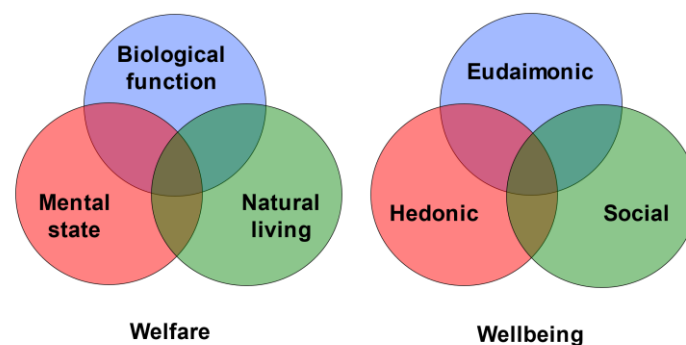
Figure 1. Welfare is described by a tripartite model with aspects of biological functioning, mental state. Wellbeing is described as combining eudaimonic, hedonic and social aspects. Strong similarities exist between the two models.

Figure 2. Two frameworks for describing welfare are provided by the Five Freedoms model and the Five Domains model.

1.2 What is wellbeing?

The concept of animal welfare has its heritage in biology. Wellbeing, in contrast, draws its heritage from philosophy. From at least the time of the ancient Greek philosophers, humans have wondered what it means to have "a good life" (Appleby and Sandöe 2002; Ryff *et al.* 2021). Continuing from these early writings to the present day, two prominent aspects of a good life are described as eudaimonia and hedonia. Eudaimonia describes the capacity of the human or animal to express agency, function well, fulfil biological potential and express mastery over its environment (Nordenfelt 2011; Ryff *et al.* 2021; Williams 2021). This contrasts with hedonia which describes pleasant (positively-valenced affective) mental experiences (Ryff *et al.* 2021; Williams 2021). Social interactions (connectedness) are sometimes described as a third aspect of wellbeing (Williams 2021). These three aspects of wellbeing can be summarised as "doing", "feeling" and "interacting". It is obvious that the tripartite model of animal welfare and the three-factor model of wellbeing bear very strong similarities (Figures 1 and 3).

'wellbeing can be summarised as "doing", "feeling" and "interacting".'

An alternative parsing describes three aspects of human and animal wellbeing as perfectionism, desire fulfilment and hedonism (Appleby and Sandöe 2002). In this construction, perfectionism describes the fulfilment of an objective list of biological functions, while desire fulfilment and hedonism are two aspects of the subjective mental experience of feelings. A materialist view of

biology understands preferences and hedonic experiences to be grounded in (neuro-)physiological and behavioural activities, and to serve a functional role in the fulfilment of the biological potential of the animal (a view termed hedonic perfectionism). Nonetheless, feelings emerge as a system property of the activity of (neuro-)physiological and behavioural activities and have a subjective quality that cannot be reduced to the mere description of the constituent physical activities. As a consequence, from a philosophical perspective, the feelings that attend desire fulfilment and hedonism attain value as an aspect of wellbeing that is not adequately captured by current measures of biological functioning. As described below, rapid advances in analysis of biological function are creating opportunities for more quantitative assessment of the affective dimension of mental experience. Perfectionism and eudaimonia align closely with biological function and natural living in the tripartite model of animal welfare (Figure 1). An outline of the relationships between the concepts addressed by animal welfare and wellbeing is presented in Table 1.
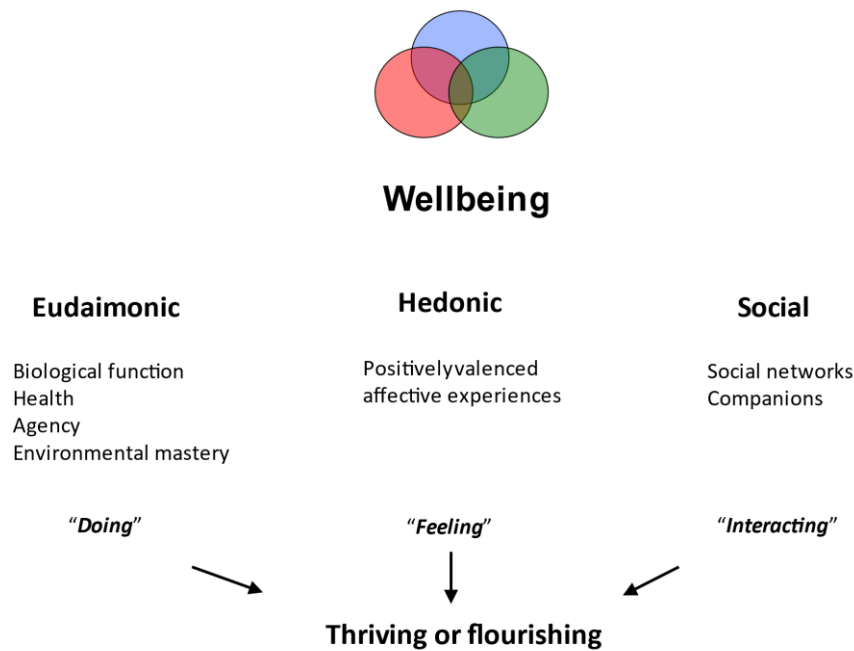
Figure 3. In the three-factor model of Wellbeing, eudaimonic, hedonic and social wellbeing combine in the positive outcome of thriving or flourishing

Table 1. A map of the relationships between concepts addressed by animal welfare and wellbeing

Animal Welfare (following Fraser 2008)		Wellbeing			
		Humans (following Appleby and Sandöe 2002)	Animals	Alternative model (following Williams 2021)	
Feel well	Free from prolonged or intense fear, pain and other unpleasant	Hedonism	Pleasure, suffering	Hedonia (feeling)	Positive affect

	states, and by experiencing normal pleasures	**Desire fulfilment**	Preferences	**Social wellbeing** (interacting)	Positive social function
Lead natural lives	Development and use of natural adaptations	**Perfectionism**	Natural living	**Eudaimonia** (doing)	Fulfilling inherited and develop-mentally acquired potential
Function well	Satisfactory health, growth and normal behavioral and physiological functioning		Fulfilling functional potentials		Environmental mastery
					Agency

In early discussions of the concept of animal welfare it was often considered that for practical purposes welfare and wellbeing could be considered synonymous concepts (e.g. Duncan and Dawkins 1983). When a distinction is drawn, the difference is usually seen to lie in the scope of animal experience addressed by the two concepts. Welfare, it is suggested, covers the full spectrum from bad to good experience whereas the focus of wellbeing is on the positive experiences of the animal's life that enable it to thrive and flourish (Yeates and Main 2008; Webster 2021; Williams 2021; Colditz 2022). Webster (2021) describes the distinction in the following terms: "Welfare describes the physical and mental state of an animal across the whole spectrum from very good to very bad. Well-being describes a state within the range of satisfactory to good and must therefore be the aim of good husbandry." The pragmatic approach adopted here is to draw insights from both heritages without pursing pedantic distinctions that might only serve to impede progress towards the goal that animals lead good lives. The most important shared insight is the concept that animals can attain as state of "positive" welfare/wellbeing.

1.3 What is positive welfare/wellbeing?

The initial focus of assessing welfare and improving husbandry was on minimising exposure of animals to harms and deprivations (Broom 1986). Any harm can compromise wellbeing while none is individually necessary for an animal to be in a state of poor welfare (Figure 4). It was recognized that above and beyond the absence of harms and deprivations animals could have experiences that promote positive mental states, the development of capabilities (competencies) to cope with their environment, positive health and a thriving physiological status (Ryff *et al.* 2004; Boissy *et al.* 2007;

Yeates and Main 2008; Yeates 2011; Mellor 2016; Lawrence *et al.* 2019; Rault *et al.* 2020; Williams 2021; Colditz 2022). These positive experiences have been drawn together in the concepts of "quality of life" (Reid *et al.* 2022), a "life worth living" (Yeates 2011; Mellor 2016; Webster 2016) and a "good life" (Rowe and Mullan 2022). In the welfare tradition, positive aspects are described as pleasant mental (i.e., positively-valenced hedonic) experiences (Boissy *et al.* 2007; Yeates and Main 2008). The concept of wellbeing makes an important contribution to this field by recognising that eudaimonic biological functioning and environmental mastery are also important (non-hedonic) aspects of positive experience (Rault *et al.* 2020; Ryff *et al.* 2021; Williams 2021; Colditz 2022) rather than merely providing an indicator of the absence of harms. Positive welfare/wellbeing is not encompassed by a single experience or mental state of the animal. In contrast to harms where any harm is sufficient to compromise welfare/wellbeing, for the animal to experience positive welfare/wellbeing it needs to express a suite of biological functions and mental experiences, all of which may be necessary and none of which is alone sufficient to deliver a positive state (Figure 4). This dichotomy in influence between harms and benefits has implications for the assessment and scoring of animal welfare.
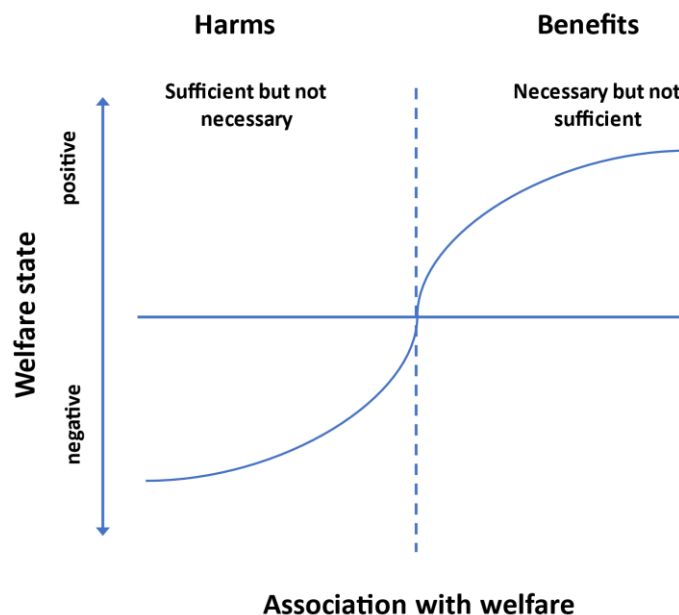
Figure 4. Any individual harm can be sufficient to diminish welfare but none is individually necessary for the animal to have a poor welfare state. In contrast, many functions of the animal contribute to a positive state of wellbeing, however none is alone sufficient to confer wellbeing to the animal. The point of inflection between positive and negative welfare does not lie at a location equating to a fixed sum of benefits but is determined by the occurrence of harms.

1.4 How is welfare assessed?

From the above account it follows that welfare is an abstract conceptual construct that describes an integrated whole-of-animal state encompassing physical and mental experiences. This abstract character creates a problem as "welfare" is not accessible for direct measurement in the way that, say, bodyweight can be measured. The measurement of hidden characters - also termed hidden constructs or latent variables - is a familiar problem in psychometrics, sociometrics and econometrics (Reid *et al.* 2022). Biological functions of the animal such as morphological,

physiological, immunological, reproductive, behavioural and some mental activities can be directly measured as proxies for welfare, yet despite objective measurement of these proxies, the welfare state of the animal remains an inferred condition (Figure 5). Thus, a gold standard measure of the welfare state of the animal is not available (Scott *et al.* 2001). This leads to terminology which describes welfare as "assessed" not measured, and the practical measurements made on animals in the field as "indicators" rather than "measures" of welfare. Inevitably some looseness in this terminology occurs in the literature. The utility of proxies for assessing welfare is iteratively refined through experimentation and application in the field.
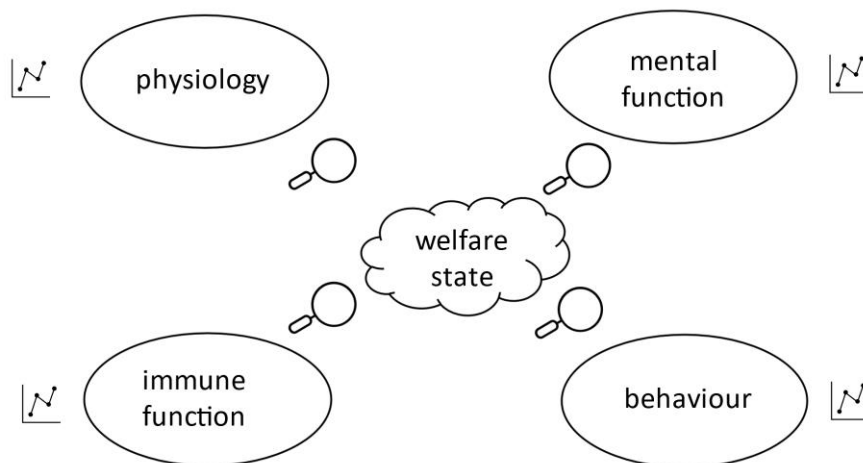
Figure 5. The welfare state of the animal is hidden from direct measurement. It is inferred from objective measurements made on physical and mental activities of the animal which provide indicators of the underlying welfare state.

1.5 What is measured to assess welfare?

A standard approach to the assessment of welfare is the quantification of inputs and animal-based outcomes in the domains of importance described in the Five Freedoms or Five Domains frameworks.

Inputs, also often termed resources, measured in welfare assessment schemes can include:

- Attributes of the abiotic environment such as access to water, appropriate climatic conditions

- Attributes of the biotic environment such as appropriate feed, social company, novelty, protection from predators and toxins (e.g. toxic plants)

- Attributes of the built environment such as bedding, shelter, yard design, truck design, sale yard design

- Attributes of the management environment such as stock person training, skills, attitudes, husbandry practices, use of preventative and therapeutic medicines, access to veterinary

support, euthanasia policies and practices, the production chain (e.g. breeder property, sale yard, backgrounding, feedlot)

- Attributes of the animal such as its genetic (e.g. polledness, heat tolerance) and phenotypic (e.g. temperament) suitability to the production system; experience of and response to training practices such as yard weaning in the southern beef industry and tailing in the northern beef industry

- Regulatory framework in which the industry operates such as individual animal identification, traceability, welfare standards and regulations, occupational health and safety regulations, agvet chemical regulations, epidemic and exotic disease preparedness, other operator compliance regulations that help safeguard animals against exposure to harms

- Risk assessment protocols to tailor inputs to the minimisation of inherent hazards/harms at the individual enterprise level

The measurement of inputs aims to ensure provisions are in place to minimise the risk of exposure to harms. Inevitably this approach can lead to an ever increasingly fine-grained catalogue of the inputs needed to address the specific circumstances of individual enterprises. Inputs are based on their predicted potential to avoid harms and optimise outcomes, thus animal-based measures of actual outcomes can complement input measures in welfare assessment schemes.

Outcomes measured to assess welfare can include

- Self-care indicated by self-grooming, coat cleanliness, use of aids such as shelter, stand-off pads and automated backrubbers

- Production variables such as growth rate, condition score, age at joining, joining weight, age at weaning, weaning weight, calving rate, weaning rate, condition at culling, longevity (age at culling)

- Health variables such as conformation, comportment, injuries, incidence of diseases, death rates, need for euthanasia, predation, need for preventative and therapeutic treatments

- Behavioural variables such as positive and negative social interactions, feeding patterns, lying behaviours, activity levels and patterns, distance travelled, stunning box behaviours

- Mental state variables such as choices, eye white, ear postures, vocalisations, cognitive activities

- Physiological variables indicative of metabolic and stress status, heart rate variables, telomere length, hair cortisol, hair nitrogen isotope ratios, endocrine levels, DNA methylation patterns, microRNA profiles, body temperature, longitudinal variation in wool fibre diameter (sheep)

- Immune functions such as immune competence, acute phase proteins

- Integrated animal measures such as "qualitative behavioural assessment"

- Post-mortem variables indicative of pre-mortem injuries, subclinical infections, resolved infections (e.g. liver scaring), performance of carcass characteristics against genomic predictions

Some welfare assessment schemes such as WelfareQuality® explicitly map input and outcome measures to individual Freedoms and Provisions (Botreau *et al.* 2007).

An alternative framework has been developed for assessing a "good life" (Rowe and Mullan 2022). The focus in this framework is on the provision of opportunities for the animal to live an enriched life. The framework aligns closely with the concept of wellbeing outlined above without drawing explicit links to eudaimonic, hedonic and social wellbeing. The Framework is presented in Table 2 redrawn from Rowe and Mullan (2022). It takes an input approach based on assessment of resource needs rather than an outcome approach based on animal measurements. The Good Life framework aligns more closely with the Five Domains framework than the Five Freedoms framework (Table 3).

Table 2. Twelve resource needs are identified under five "Good Life" opportunities within a generic framework proposed to describe what all species of farm animals need in order to have a "good life".

Good Life opportunity	Resource need
Comfort	Comfortable physical environment
	Comfortable thermal environment
	Safe environment
Pleasure	Food enrichment
	Play opportunities
	Breeding and nurturing opportunities
Confidence	Positive experiences with people
	Positive social interactions
Interest	Enriched environment
	Enhanced learning opportunities
Healthy life	Management policy for positive health
	Breeding for positive welfare
	Promoting a natural body type (telos)

Table 3. A map of the relationships between the assessment areas addressed by the Five Freedoms, Five Domains and Good Life frameworks.

Five Freedoms		Five Domains		Good Life	
Freedom from thirst, hunger and malnutrition	By providing ready access to fresh water and a diet to maintain full health and vigour	**Nutrition**	Water		
			Food		
Freedom from discomfort and exposure	By providing an appropriate environment including shelter and a comfortable resting area	**Environment**	Comfort	**Comfort**	Comfortable physical environment
			Physical features		Comfortable thermal environment
					Safe environment
Freedom from pain, injury, and disease	By prevention or rapid diagnosis and treatment	**Health**	Disease	**Healthy life**	Management policy for positive health
			Injury		Breeding for positive welfare

			Function		Promoting a natural body type (telos)
Freedom from fear and distress	By ensuring conditions and treatment which avoid mental suffering	**Mental State**	Emotions	**Interest**	Enriched environment
			Agency		Enhanced learning opportunities
			Pleasures	**Confidence**	Positive experiences with people
Freedom to express normal behaviour	By providing sufficient space, proper facilities and company of the animal's own kind	**Behaviour**	Behaviour rewards		Positive social interactions
				Pleasure	Food enrichment
			Behaviour expressions		Play opportunities
					Breeding and nurturing opportunities

1.6 Measurement and interpretation of animal-based outcomes

From the perspective of animal welfare, every day in the life of an animal matters. This creates a problem for welfare assessment. Schemes that make animal measurements at infrequent timepoints can only provide a snapshot in time of the welfare status of the animal (Webster 2016; Keeling *et al.* 2021). Furthermore, snapshot measures generate cross-sectional data. For cross-sectional data, the benchmark used to assess whether an individual is "normal" is derived from normative statistics of the population (Veissier *et al.* 2011). For instance, a cortisol measure of an individual that falls say two standard deviations above the group mean might be interpreted as indicating the individual is stressed. Yet the genetic constitution of the individual may lead to its resting cortisol concentration being much higher than the group mean and the event that raises its concentration further from the group mean may represent only a minor deviation within the animal's own biology. Thus, measuring performance of the individual against group benchmarks only provides a coarse-grained indication of the status of the individual. Biology is built on individual variation. Every animal differs in its personality (temperament) and in its physical and mental functioning. A portion of the between-animal variation in day-by-day measurements persist across time as a consistent difference of the individual from others in its group. This source of variation underlies the common practice of fitting of "animal" as a random factor in time series (repeated measures) analyses. Longitudinal data collected for example by sensor technologies enables estimation of the pattern that is consistent for the individual and can provide a fine-grain indication of when performance of the individual deviates from its individual norm. The limitations of cross-sectional data are most apparent for measurement of dynamic biological activities such as production, physiological, immunological, behavioural and mental variables. Scores such as coat condition measured on an ordinal scale can often be more reliably assessed against group norms. So significant is the disjunction between assessments made at the individual level and the group level that it is recognized by statisticians that drawing individual-level inferences from group-level statistics constitutes an "ecological fallacy" which can lead to

misleading or incorrect inferences regarding individual behaviour. A statistical relationship observed at a population level may not hold for any of the individuals (Heino *et al.* 2021).

The problem of cross-sectional data is well-recognized as a limitation of welfare assessment schemes (Webster 2016; Keeling *et al.* 2021) and has generated interest in the development of whole-of-animal integrated measures. Two approaches to the development of integrative measures (that are not entirely independent) have been pursued. The first approach is to look for functions or activities of the animal that integrate its diverse physiological, immunological, behavioural and mental attempts to cope with its environment into a single welfare indicator. "Mental state" in the Five Domains model (Mellor and Beausoleil 2015) and positively-valenced (hedonic) affective experience in the positive welfare model (e.g. Lawrence *et al.* 2019; Duncan 2020) have been suggested to provide just such an integrative indicator of welfare. Limitations of hedonic affective experience for describing the totality of welfare are recognized in the three-factor model of wellbeing described above. Nonetheless, an integrative measure that captures even part of the mental experience of the animal would be extremely valuable and consequently a huge international research effort is investigating methods for quantifying the hedonic state of the animal as an indicator of positive welfare (Keeling *et al.* 2021) (Box 1).

Box 1.

How are feelings assessed in animals?
Affective experiences and feelings are dynamic states that are continuously present yet can change from moment to moment (emotions) or persist for hours and days (moods). The affective state of the animal is thought to emerge from central processing in the brain of sensory inputs associated with physiological activities in internal organs and sensory inputs from the external environment. Self-report of a person's felt experience provides the gold standard for assessing affective states in humans. In animals, proxies based on mental, behavioural and physiological activities are measured as indicators of affective state. For example, heart rate increases whereas variability in the time interval between consecutive beats (a measure of functional complexity) decreases in negative affective states such as fear. Other indicators include the startle response to surprise, position of the ears, muscle contractions in the face (grimace), vocalisations, area of the white of the eyes (sclera), blood flow to skin, muzzle and eyes, demeanour of the animal, and mental functions such as decisions made when faced with ambiguous cues. Changes seen in these physiological, behavioural and mental activities can occur in a range of affective states that can be positive or negative. For example, heart rate can increase in a positive state of anticipation of a reward and during exercise as well as during negative states associated with fever, fear or pain. Consequently, changes need to be interpreted within the context of the conditions the animal is experiencing in order to infer the affective state. Studies of (neuro-)physiological activity in the brain and peripheral tissues in humans also fail to identify diagnostic fingerprints that are reliably associated with particular affective states. This does not mean that affective experiences are not real. Rather, it suggests that a diversity of physiological, behavioural and mental activities can attend any particular positive or negative experience and conversely that a diversity of positive or negative experiences can attend any particular physiological, behavioural or mental activity. Positive states have proved to be more difficult to measure than negative states. The strong emphasis on positive experiences as an aspect of positive welfare has stimulated much research into new indicators of positive affect. For a recent review of indicators of positive affective states in cattle see Keeling *et al.* 2021.

At first blush, the nebulous character of an affective state seems at odds with the "concrete" character of a physiological activity such as growth. Body mass can be measured reliable with scales and the change in body mass over time can be calculated to estimate growth rate. Growth, then, seems to be a concrete characteristic of the animal. On closer consideration, however, growth can be understood to be a very complex state, and its component parts are not easily described by any single measure of body mass. Indeed, growth can only be estimated by comparison of body mass with a prior record. The relative (allometric) rate of growth of components of the body such as muscle, fat, connective tissue, bone, and organ mass changes with age and is influenced by diet, genetics, prior nutritional experience (e.g. compensatory growth), infection status, reproductive status and so on. It has taken many decades of research to develop equations that can predict with high accuracy the relative mass (and commercial value) of carcase components from growth rates calculated from a series of body mass measurements, which all need to be interpreted in the context of age, nutritional status, genetics, and so on. Thus, growth and affective state share the characteristic of being states that are embedded within and emerge from the biophysical activities of the animal occurring in the context of prevailing environmental conditions. Neither can be dissected from a carcase and put on display in an anatomy museum, which is true of other states such as homeostasis, body temperature, and evolutionary fitness. States, then, are the dynamic outcome of underlying biophysical processes observed at a point in time. Studies on the assessment of affective states are still at a relative early stage on the pathway towards high prediction accuracy. Nonetheless, substantial progress has been made in the last decade in developing quantitative methods for assessing affective states in farm animals, including cattle. While most experimentation on developing these methods has been undertaken in research settings, there is also progress being made towards quantifying affective states in pasture fed cattle on commercial properties.

The second class of integrative biological measures are "iceberg indicators". Iceberg indicators are characteristics of the animal that have been found to be highly sensitive to loss of stability of biological functions of the animal and hence provide early warning signals of current or impending poor welfare. Examples include vocalisations in newborn chicks (Herborn *et al.* 2020), haematological variables in sheep exposed to endemic gastrointestinal parasite infections (Hernandez *et al.* 2020) and vocalisations in the stunning box (Grandin 1998).

The second approach to the development of whole-of-animal measures moves beyond a "compartment" model of welfare to interrogate the underlying "structure" of biological functions. The Five Freedoms, Five Domains and Good Life frameworks can be described as compartment models in that they divide biological functions into categories (e.g. feed and water, comfort, physical integrity, mental integrity, behavioural integrity). The compartments are grounded in mechanistic models of how animals work, for example by fulfilling needs and expressing biological activities. Assessment of welfare is then undertaken by measurement of activities within each compartment. The "structural" approach adopts the black box model that is commonly adopted in quantitative genetics. When applied to quantitative genetics, the black box approach assumes knowledge of underlying biological mechanisms is not a pre-requisite for measurement of traits and their subsequent application in breeding programs. Of course, knowledge of mechanisms and the contribution of genes to those mechanisms can improve description of traits and prediction of breeding values (Mackay *et al.* 2009). When applied to animal welfare, the black box approach does not rely on knowledge of the activity of host response pathways in order to interpret the significance of changes in biological functions as indicators of welfare (Wagner *et al.* 2021). Once again, knowledge of underlying mechanisms helps with interpretation but is not necessary. Perhaps not

surprisingly, then, the structural approach is being rapidly developed by quantitative geneticists (amongst others) through statistical analysis of deep phenotypes from longitudinal data sets generated by sensor technologies.

The structural approach is grounded in resilience theory (Scheffer *et al.* 2018). Three of the principal characteristics of stable systems are the **uniformity of trajectories** (Berghof *et al.* 2018; Iung *et al.* 2019) such as growth rate and daily milk yield, **periodicity of biorhythms** (Scheibe *et al.* 1999; Wagner *et al.* 2021) such as body temperature and daily feeding activity, and **complexity of networks** (Asher *et al.* 2009; Miller *et al.* 2020; Heino *et al.* 2021) such as social interactions. Deviations from these three patterns increases as the capacity of an animal to cope with everyday fluctuations in its environment decreases (Scheffer *et al.* 2018). Statistical methods for analysing these three characteristics of biological systems have been developed and validated in large datasets in dairy cows (Elgersma *et al.* 2018; Van Dixhoorn *et al.* 2018; Adriaens *et al.* 2020; Poppe *et al.* 2020; Poppe *et al.* 2021a; Poppe *et al.* 2021b; Sun *et al.* 2021; Wagner *et al.*, 2021; Friggens *et al.* 2022), pigs (Putz *et al.* 2019; Revilla *et al.* 2019), chickens (Berghof *et al.* 2019), sheep (Nunes Marsiglio Sarout *et al.* 2018) and goats (Mengistu *et al.* 2017; Abdelkrim *et al.* 2021). Poorer uniformity, periodicity and complexity indicate poorer current wellbeing and are predictive of poorer health outcomes and poorer longevity. The analytical methods provide measures of the functional stability of the animal at a systemic level and can lack diagnostic specificity for identifying deprivations at the compartment level (Figure 6) (Wagner *et al.* 2021). In principle, appropriate variables could be chosen to provide sufficient specificity for activity of individual compartments to be addressed. Indeed, these variables could include indicators of positive affective (hedonic) experience (Dawkins 2021a). The "structural" approach is under intensive investigation in humans in the study of "affect dynamics" via smart sensor worn by the individual (e.g. Wampfler *et al.* 2022). Although studied in detail in other farm animal species including sheep and dairy cattle, the methods for assessing the structure of biological functions have not yet been applied to beef cattle and are not yet sufficiently well validated for application in a beef cattle welfare assessment scheme. As the methods rely on (notionally) continuous data collection from individual animals, analyses detect deviation from what is normal for the individual rather than the group, and hence avoid the "ecological fallacy" and enable precision welfare assessment for the individual animal. These developments are mentioned here to highlight a potential "threat" (and concurrent opportunity) to welfare assessment schemes as described below.
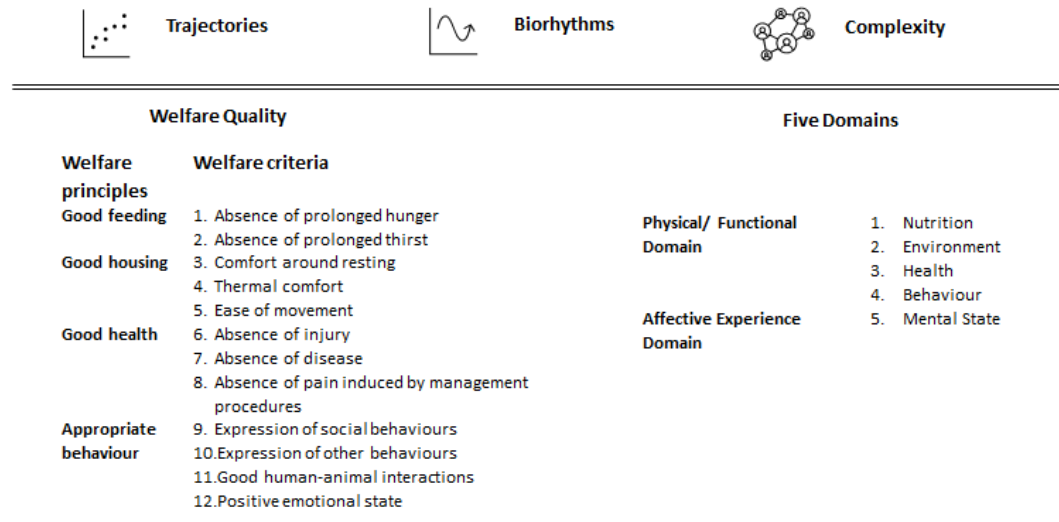
Figure 6. Three parameters of stability in biological functions of the animal are the uniformity of trajectories such as growth rate, periodicity of biorhythmic variables such as body temperature, and complexity of activities such as social interactions. These parameters provide systemic measures of positive biological functions. When parameters deviate from normal, they can lack specificity for identifying deficiencies within the biological compartments described by WelfareQuality (Freedoms model) or Five Domains model. Analysis currently relies on longitudinal datasets. For a review see Colditz (2022) https://psyarxiv.com/w6a3k/.

1.7 Scoring welfare

The essential character of individual types of resources in providing opportunities for wellbeing (Figure 4) is considered in the animal welfare literature to mean that resources are non-fungible (Veissier *et al.* 2011). That is, the availability of one resource, for example positive social interactions, cannot substitute for a deficiency in another resource, such as a comfortable physical environment. The essential character of resources has implications for construction of any index to benchmark individual enterprises and to quantify progression at the enterprise and industry levels over time. Traditionally within the compartment approach to describing and assessing welfare, criteria are developed within each category (compartment) to designate a range of within-category scores, then scores are reported for each category rather than aggregated to a single total value. In more nuanced terms, positives do not cancel negatives (Sandøe *et al.* 2019), however, two positives are better than one and hence positives can in theory be summed to give a measure of the degree of positive wellbeing. To provide context for an aggregate positive score, it is necessary to also describe deficiencies and harms such as absence of effective analgesia for painful husbandry procedures (Figure 4).

Structural analyses of biological functions can be performed over short periods such as daily or over long periods such as a year or a whole lactation and can generate a single value for each animal that falls on a continuous scale for the period of evaluation. These analyses hold the potential to provide a much finer-grained indicator of welfare than can be achieved with scoring systems employed in current compartment model welfare assessment schemes. As noted above, the measures usually lack diagnostic specificity for the causes of disturbance in function (Wagner *et al.* 2021). Nonetheless, rhythm disturbances performed over short intervals such as a day can flag the

occurrence of events for investigation by a stockperson. Negative and positive factors combine in their influence on biological functions, and these influences are integrated through homeostatic processes to generate a continuous measure of functional normality. Further work is needed to determine whether deviations from normality in the structure of biological functions can provide a measure of the relative severity of the affective (feelings) dimension of insults such as painful husbandry procedures performed without effective analgesia and diseases (see Wagner *et al.* 2021 and Sun *et al.* 2021 for preliminary investigations of these questions in dairy cattle). "Biological functions" in this context include mental functions and affective experiences, as well as behavioural and physiological functions. Box 2 provides a real-world example of analysis of biorhythms in dairy cows for assessment of welfare as reported by Wagner *et al.* 2021.

Box 2.

Real-world example of analysis of biorhythms for the assessment of welfare in dairy cows.

Wagner *et al.* 2021 describe detection of welfare events from the analysis of behavioural activity data determined from individual animal locations within dairy barns. A variable called "activity level" was estimated by applying predetermined weights to the time an animal spent in various locations within the barn based on communication between an animal-borne transponder and a base station once per second. Circadian patterns in behavioural activity level were then analysed. Data were sourced from historical records from 4 farms representing more than 120,000 cow*days. Initial studies examined a suite of methods for analysis of time series data including traditional machine learning methods (K Nearest Neighbours for Regression (KNNR), Decision Tree for Regression (DTR), MultiLayer Perceptron (MLP), Long Short-Term Memory (LSTM), as well as the Bag Of SFA Symbols (BOSS), Hierarchical Vote Collective Of Transformation-based Ensembles (Hive-Cote), Dynamic Time Warping (DTW), Fully Convolutional Network (FCN) and Residual Network (ResNet) algorithms. The authors settled on a Fourier transform-based method to detect changes in the circadian activity rhythm, which they termed 'Fourier-Based Approximation with Thresholding'. Abnormalities in the circadian pattern of behavioural activity level were validated against stockperson records of cow health including accidents, lameness, oestrus, calving, mastitis, rumen acidosis, other diseases, mixing, other disturbances and inflammation caused by intramammary injection of bacterial endotoxin. The method detected abnormal rhythms associated with 95 % of health and reproductive events. Rhythm abnormalities were detected up to 35 hours before stockperson recording of the occurrence of events.

The study illustrates several important points.
1) Disturbance in the circadian pattern of behavioural activity was highly sensitive for detecting compromised welfare and reproductive events such as oestrus and calving
2) Disturbance in the circadian pattern of behavioural activity level provided a generic measure of compromised welfare that lacked diagnostic specificity for identifying the cause of disturbance. This is in accord with the description of "structural" measures of biological function as providing holistic measures of wellbeing that represent the integrated biological function of the animal.
3) Sensor data was not decomposed into basic behavioural activities such as resting, standing, walking, and eating for subsequent interpretation within an ethological model of normal dairy cow behaviour. Thus, detection of disturbances did not rely on a normative model of behavioural activity with parameters such as resting time of 12 – 14 hours per day, feeding time 30 – 90 minutes per day and so on.

4) Detection of abnormalities was based on deviation from the prior circadian pattern in behavioural activity level expressed by each individual. Thus, the method provides individualised assessment of welfare, an approach termed idiographic analysis.

5) Data extraction was tailored to the sensor system available to the researchers. While developmental work may be required for extraction and validation of an appropriate behavioural activity level variable from other sensor technologies (e.g. triaxial accelerometers), the underlying concept of biorhythm analysis should be applicable to other technologies for quantifying behavioural activity level.

6) Physiological variables such as body temperature may also be amendable to biorhythm analysis for detection of compromised welfare as illustrated by the work of Van Dixhoorn *et al.* 2018.

7) Structural analysis of biological functions for assessment of wellbeing needs to be combined with other methods when it is important to know the cause of a welfare-related event.

8) Disturbance to circadian rhythm in behavioural activity level can provide a flag for the stock person to investigate the cause of the disturbance.

9) Historical sensor datasets, when annotated with individual animal health and management data, can be used for development of methods for structural analysis of biological functions as an indicator of wellbeing.

Biorhythm analysis as an indicator of welfare is a topic attracting increasing attention. Other studies in sheep and cattle include (Scheibe *et al.* 1999; Nunes Marsiglio Sarout *et al.* 2018; Van Dixhoorn *et al.* 2018; Palacios *et al*. 2021; Casey *et al.* 2022).

1.8 Potential threats to welfare assessment schemes

The historical perspective taken in this introduction helps illustrate that the concept of what animal welfare is and how it can be measured are both evolving and are not owned or controlled by any cohort of stakeholders (Sandøe and Jensen 2012). Ongoing developments could pose a threat to any welfare assessment scheme. The threat here includes 1) the potential for confusion amongst producers and consumers arising from the description of new dimensions of welfare and new aspects of animal biology that lie outside the familiar dialogue around welfare, and 2) the introduction by third parties of new proprietary tools for example based on sensor technologies for assessment of "welfare". On the other hand, confusion and competition already exist. In any event, new phenotypes being identified by application of resilience theory to longitudinal datasets can support legitimate claims for new breeding strategies to improve welfare, and new conceptual frameworks for interpretation of sensor data can support new claims for real time precision welfare assessment and management. The opportunity is to have a welfare assessment scheme that can embrace such methodologies and apply them to data streams already held by industry as technologies mature.

Another development that will impact the welfare landscape is genomic prediction. In accord with the concept of "precision medicine" in humans, precision livestock farming achieved through data driven and digitally-supported animal management (Dawkins 2021a) is enhanced by combination with genomic prediction (Schillings *et al.* 2021). In this scenario, genomic predictions of phenotype could be tailored to the environment in which the animal is managed and provide an individual-animal (predicted) baseline against which to compare actual biological performance as measured by sensor technologies. High accuracy has already been achieved in genomic predictions of finishing weights and carcase characteristics for feedlot cattle (Alexandre *et al.* 2021). A predicted

performance trajectory has utility when it is not possible to measure actual performance trajectory at high frequency such as daily body weight in the feedlot. In combination, genomic prediction and real-time measurements enable precision welfare assessment and management.

These technological developments can underwrite a (future) goal of optimal wellbeing:

The red meat industries embrace management practices and animal genetics that ensure the minimisation of harms and the availability of the physical, social and developmental resources that are necessary for the animal to optimise its wellbeing. These provisions and actions enable the animal to express its inherited and developmentally acquired potential for healthy physical, mental, behavioural and social functioning in an ever-changing environment, as revealed through intra-individual normativity of performance trajectories, biorhythms and complexity of biological system functions.

Similarities and differences between Welfare and Wellbeing are summarised in Table 4.

Table 4. An outline of the concepts of Welfare and Wellbeing

Heritage	Biology	Philosophy
Precepts	"Drives" arising from needs and wants generate behaviours and mental states in support of biological functions. Deprivations, and physical and psychological insults cause suffering. Positive environmental engagement can cause positive affective states	Animals have the potential to develop competences that enable physical and mental fulfilment through harmonious environmental engagement
Construct	**Welfare**	**Wellbeing**
What is it?	The physical and mental experiences arising from engaging with the environment	Fulfillment of potential for environmental mastery, purpose, pleasure, and connectedness achieved through engaging with the environment
Model	Physical functions, mental state, natural living	Eudaimonia, hedonia, social wellbeing
Frameworks	Five Freedoms, Five Domains, Good Life	Doing, feeling, interacting (connecting)
Assessment schemes	e.g. WelfareQuality®, AssureWel, RSPCA Assured	None are explicitly aligned yet with the three-factor model of wellbeing. The Good Life Framework implicitly adopts many of these concepts without articulating them within the three-factor model
What is measured?	Availability of resources to enable fulfilment of freedoms. Physical and mental outcomes to determine	Provisionally, the "structure" of physical, behavioural and mental activities (trajectories, rhythmicity,

		complexity) to determine whether harmonious environmental engagement is being achieved
Temporal focus	Events (e.g. marking) and moments in time (e.g. snapshot surveys)	Long-term to whole-of-life
Commonalities	Role of positive experiences in generating a positively valenced hedonic affective state	
Biological outcomes	Health and having what the animal wants	Fulfilment of the individual's potential to express positive health and a thriving mental and physical constitution
Status in the academic literature	Shovel ready	Needs conceptual and methodological development for application to beef cattle and sheep
Note	The fairly rigid disciplinary interpretation of the concepts presented here should not discourage a more relaxed use of "wellbeing" to describe the focus of the assessment protocol under development in this project	

1.9 Is there a single definition of welfare or wellbeing?

The dance of ideas as to what welfare and wellbeing are and how they can be measured described above illustrates that the concepts are evolving and any attempt to reduce them to a single definition applicable to all situations is fraught. None the less, at a practical level, welfare and wellbeing are defined by the indicators that are measured and, conversely, practical definitions can provide a guide as to what should be measured to assess welfare (Appleby and Sandöe 2002). For example, according to the World Organisation for Animal Health (OIE) code for terrestrial animals, **animal welfare means "the physical and mental state of an animal in relation to the conditions in which it lives and dies**." A condition on this definition can be seen by its limitation to terrestrial as opposed to aquatic animals.

This introduction helps describe the landscape in which a project for developing a new index for assessing lifetime wellbeing needs to operate in order to have international credibility. From a top-down perspective, proposed measures need to be operationalised within a framework that articulates a conceptual construct of wellbeing. From a bottom-up perspective, new measures can be developed, for example from analysis of sensor data, which inform our understanding of how animals function, which in turn can inform the concepts of what constitutes wellbeing. Advances can be made via both bottom-up and top-down initiatives (Figure 6).
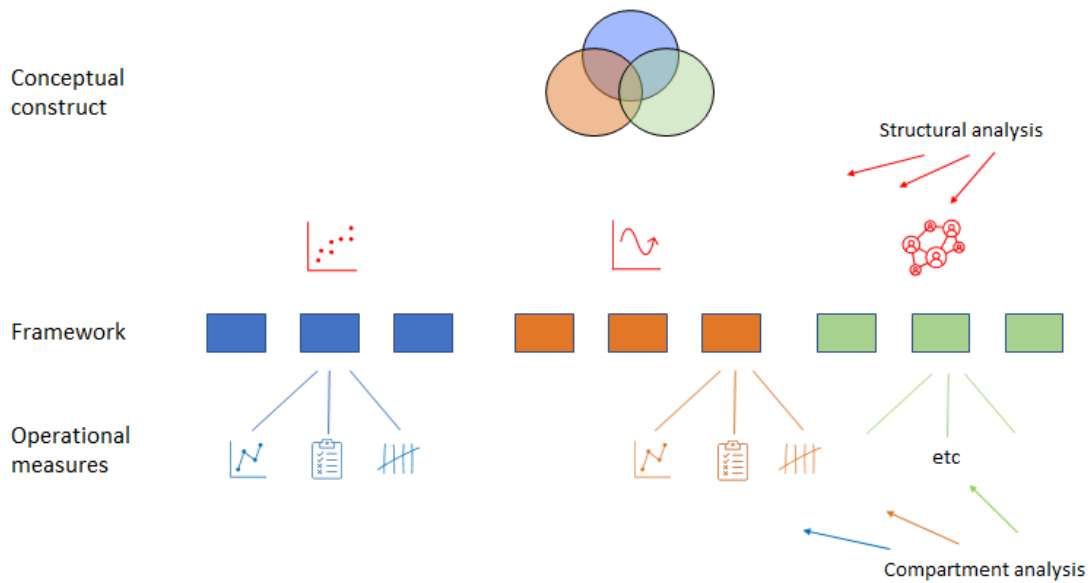
Figure 6. In a top-down approach, a conceptual construct of welfare or wellbeing is articulated through a framework that describes compartments or categories that encompass components of the conceptual construct. An assessment scheme is composed of a suite of operational measurements, for example covering input resources, management practices and animal outcomes, within each compartment described here as "compartment analysis". An alternative assessment strategy is to undertake structural analysis of biological functions that provide integrated measures of the functional integrity of the animal described here as "structural analysis". In a bottom-up approach, new measurement technologies (for example structural analysis of biological functions capture via sensor technologies) can reveal new aspects of biological function that inform the conceptual model of wellbeing.

1.10 Summary of welfare and wellbeing

Welfare and wellbeing describe the physical and mental state of the animal in relation to the conditions in which it lives and dies. Good welfare occurs 1) when animals *feel well* by being free from prolonged or intense fear, pain and other unpleasant states, and by experiencing normal pleasures; 2) when animals *function well* in the sense of satisfactory health, growth and normal behavioural and physiological functioning; and 3) when animals *lead natural lives* through the development and use of their natural adaptations. Five Freedoms, Five Domains and Good Life are three detailed frameworks that describe the conditions that need to be met for animals to have good welfare. Assurance schemes employ a suite of measures to assess the extent to which criteria described in these frameworks are satisfied.

Initial concern about welfare focused on minimising harms and deprivations. Above and beyond the absence of harms and deprivations, animals can have experiences that promote a thriving physiological and mental status. Many types of harm and deprivation can compromise welfare and no single type is necessary for welfare to be compromised. On the other hand, many types of

physical and mental experiences contribute to positive welfare and no single type is sufficient to ensure positive welfare is experienced by the animal. Welfare assurance schemes need to measure the occurrence of harms associated with poor welfare and the occurrence of benefits associated with good welfare. The presence of benefits is not sufficient to cancel the impact of harms.

Welfare is a whole-of-animal state that is hidden from direct measurement. Welfare is assessed by measuring proxies from which the state of the animal is inferred. Thus, objectively measured proxies provide *indicators* of welfare rather than *measures* of welfare. These proxies can include 1) inputs and resources, 2) management practices and skills, and 3) physical and mental outcomes expressed by the animal. This last category of animal-based measures is usually aligned with each of the compartments of an assessment framework to assess to what extent each criterion of welfare is fulfilled. Some new methods of analysis currently under development can provide holistic indicators of the extent to which biological functioning of the animal is normal; however, these methods lack diagnostic specificity to indicate the probable causes of abnormality when it occurs. Thus, these methods can provide an indicator of positive welfare but lack specificity to identify the causes of poor welfare within each category of a framework. When validated for beef cattle, these methods will extend our current capability to assess welfare.

Every day of the life of every animal matters. By necessity, current assurance schemes reply on survey samples taken on a subset of animals at infrequent intervals. Farm records and post-mortem data can provide additional information to help fill gaps between sampling points. Continuous monitoring of animals, for example by sensor technologies, will enable a more complete description of the welfare of each animal across its whole life.

Every animal differs in its physical and mental functions, as revealed for example by differences between individuals in their temperament, metabolic rate and feed efficiency. Deviation from what is normal for the individual provides the true baseline for describing its welfare. Individual animal monitoring combined with genomic prediction of each individual's potential holds the promise of "individualised" real-time precision welfare assessment and management across the life of each animal.

2) Assurance schemes available globally (feedlot, extensive beef and sheep)

2.1 Search methodology

To identify international beef assurance schemes an online Google search was conducted using terms of 'beef cattle welfare assurance', 'beef animal welfare certified', 'welfare assessment scheme beef', 'beef animal welfare assurance', 'beef cattle welfare assurance South America', 'feedlot welfare assurance', and feedlot welfare assurance USA'. A list was comprised of all schemes that were identified during the online search. Many of these schemes covered multiple agricultural animal species and thus also included standards for sheep. Additional existing welfare assurance schemes for sheep were identified, using the search terms 'sheep welfare scheme', 'sheep welfare label' and 'animal welfare labelling'. The PDF files of the specific assessment schemes/criteria that were used were downloaded, or URLs saved for any scheme that did not have a file to download. For schemes that were not available online, contact was made with the assurance provider to request a copy of their scheme providing a brief background on why the request was being made. Given the difficulty in knowing if all schemes had been identified or not during online searches (there is no central point that lists international assessment schemes for beef cattle/sheep welfare), individuals who are known to be involved with assessment schemes (research institutions or NGOs) were contacted directly via email for their input. They were supplied with the list of previously identified schemes to confirm whether there were any schemes they knew of that were missing. Via this method, several more schemes were identified and added to the list. Once a collection of over 30 schemes had been collated that spanned across the UK, EU, US, Canada, and New Zealand, the standards were examined, and tables compiled to summarise the general information.

2.2 Results of global scan – what do the schemes measure?

Below is the list of assurance schemes that were identified during the online search and liaison with international experts in the area. The links to the online website or downloadable standards are included as well as indication of schemes that were identified but their standards were not publicly available. For each scheme that was available, a range of general information about the scheme was compiled as listed in the Table 5 below to summarise overarching origins, goals and implementation of the scheme. A selection of 5 schemes for beef cattle were identified that were internationally recognised, and/or frequently or widely used, and/or highly outcome-based (i.e., animal-based measures), and/or applicable to Australia. These schemes comprised Welfare Quality® (EU), Red Tractor (UK), GAP (Global Animal Partnership, USA), RSPCA Assured (uses AssureWel for animal-based indicators, UK), and a recently developed scheme for NZ extensive pasture-based cattle systems. Using these schemes, a second table was created that summarised the general areas of welfare that are covered under each scheme's guidelines (Table 6).

List of international welfare assurance schemes for beef and sheep

- Welfare Quality: http://www.welfarequalitynetwork.net/en-us/reports/assessment-protocols/

- AssureWel: http://www.assurewel.org/beefcattle.html; http://www.assurewel.org/sheep.html

- University of California at Davis: Cow/calf assessment: https://www.ucdcowcalfassessment.com/

- Bord Bia: https://www.bordbia.ie/globalassets/bordbia.ie/farmers--growers/farmers/qas/document-libraries/sblas-pdfs/sustainable_beef_and_lamb_assurance_scheme_standard.pdf, refers to FAWAC animal welfare code: http://www.fawac.ie/publications/animalwelfareguidelines/

- GAP: https://globalanimalpartnership.org/standards/beef; https://globalanimalpartnership.org/standards/sheep/

- Red Tractor: https://assurance.redtractor.org.uk/contentfiles/Farmers-6832.pdf?_=636656002697091706

- Soil Association (SA) https://www.soilassociation.org/

  sa-gb-farming-_growing-standards.pdf (soilassociation.org)

- Quality Meat Scotland (QMS) QMS Cattle & Sheep Assurance Scheme | Quality Meat Scotland (qmscotland.co.uk)

- RSPCA Assured/Freedom Foods RSPCA welfare standards for beef cattle - RSPCA; https://science.rspca.org.uk/sciencegroup/farmanimals/standards/sheep

- NZ Assessment Scheme: presented in research paper. Part 1: https://www.mdpi.com/2076-2615/10/9/1597; Part 2: https://www.mdpi.com/2076-2615/10/9/1592

- Assured British Meat (ABM) uses the Red Tractor Scheme.

- Animal Welfare Approved: Certified Animal Welfare Approved by AGW food label. (agreenerworld.org)

- Certified Humane - A Project of Humane Farm Animal Care. Our Standards - Certified Humane

- NCBA (National Cattleman's Beef Association): https://www.ncba.org/producers/feedyard-audit (uses BQA standards)

- BQA (Beef Quality Audit) https://www.bqa.org/Media/BQA/Docs/cchg2019.pdf

- NAMI (North American Meat Institute): https://animalhandling.org/producers/guidelines_audits

- AHA (American Humane Association): https://certifiedhumane.org/our-standards/

  https://www.americanhumane.org/app/uploads/2021/08/Beef-Cattle-Audit-Tool-1.pdf,

  https://www.americanhumane.org/app/uploads/2021/08/Beef-Cattle-Full-Standards-.pdf

- American Grassfed Association | americangrassfed : AGA Grassfed Ruminant Standards - American Grassfed Association

- Food Alliance: Food Alliance - Sustainability for Food and Agriculture : Livestock Producers - Food Alliance

- National Cattle Feeder's Association: Welcome | National Cattle Feeder's Association (nationalcattlefeeders.ca) Microsoft Word - PAACO-Assessment_Guide_ver8_Feb18.docx (nationalcattlefeeders.ca)

- Verified Beef: Home | Verified Beef Production Plus

  VBP_On_Farm_Food_Safety_Self-Assessement_V_2.5_April_2017.pdf (verifiedbeef.ca)

VBP_Producer_Manual_combined_V_1.6_and_V_7.8_Feb_13_2019.pdf (verifiedbeef.ca)

- Pasture for Life - https://www.pastureforlife.org/certification/the-pasture-for-life-standards/: PfL-Standards-Version-4.3-Feb-2022.pdf (pastureforlife.org)

- Label Rouge – collection of 16 books for beef welfare/production summarised in a research paper: https://www.sciencedirect.com/science/article/pii/S1751731121002007; Part 2: https://pubmed.ncbi.nlm.nih.gov/32906782/

- GAWA About us – Global Animal Welfare Assurance (gawassurance.org)

- Scottish Organic Producers Association (SOPA)

- AHDB (Agriculture and Horticulture Development Board) Home | AHDB

- Eigenkontrolle Tiergerechtheit' (acronym: EiKoTiGer)

- Bio Austria: https://www.bio-austria.at/ https://www.thuenen.de/en/ol/projects/cattle-husbandry/feasibility-of-animal-welfare-indicators-in-on-farm-self-assessment/

  On-farm self-assessment of animal welfare (thuenen.de)

- AsureQuality: Meat – AsureQuality

- Progressive Beef Progressive Beef

- Cultivate – Poland (https://foodworks.pl/en/livestock/cultivate-cattle-farming-system

- BoviWell – France (https://hub.bovine-eu.net/search/boviwell-a-french-tool-to-measure-and-communicate-animal-welfare-on-beef-farms) A French scheme based on Welfare Quality principles

- Beter Leven - https://beterleven.dierenbescherming.nl/english/ (based on comparable, existing schemes such as RSPCA Assured label from the RSPCA in the UK and Label Rouge in France) Calves - Beter Leven keurmerk Zakelijk (dierenbescherming.nl)

- USDA Organic | USDA: Organic Livestock Requirements.pdf (usda.gov)

- Sheep Welfare Scheme (Irish farmers association); https://www.ifa.ie/sheep-welfare-scheme/ The Sheep Welfare Scheme provides €10 per ewe to farmers for undertaking actions to make a positive contribution to flock welfare.

- Animal Welfare INTEROVIC Spain (AWIS): AW label covering only sheep was created in Spain upon initiative of the interbranch organisation Interovic https://www.interovic.es/awis-en covers animal welfare on farm, during transport and at slaughter.

- Animal Protection Denmark https://www.dyrenesbeskyttelse.dk/en covers animal welfare on farm, during transport and at slaughter for multiple species including beef, sheep and lamb.

- "Better Animal Welfare" ("Bedre Dyrevelfærd"), a Danish government animal welfare label https://bedre-dyrevelfaerd.dk/servicemenu/english/ covers animal welfare on farm for calves and beef.

- KRAV (Sweden) https://www.krav.se/en/ covers animal welfare on farm, during transport and at slaughter for multiple species including calves, beef, sheep and lamb.

- Sigill Kvalitetssystem AB (subsidiary of the Federation of Swedish Farmers) https://www.svensktsigill.se/ public-private partnership. Covers animal welfare on farm and at slaughter for multiple species including calves, beef, sheep and lamb.

- https://www.tierschutzlabel.info/ (Germany) The animal protection label "Für Mehr Tierschutz" from the German Animal Welfare Association ("For more animal welfare") covers animal welfare on farm, during transport and at slaughter for multiple species including beef.

- Bienestar Animal (Welfair) (Spain) https://www.animalwelfair.com/en/ Covers animal welfare on farm and at slaughter for multiple species including beef, sheep and lamb. Based on Welfare Quality scheme

Table 4: Summary of parameters across different international assessment schemes

Scheme	Country of origin	Scope (welfare only?)	Species Focus	Framework	Assessment frequency	Type of farm	Auditing	Assessment outcomes	Participation (voluntary/compulsory)
UC Davis Cow/Calf Health and Handling Assessment	USA	Welfare only	Designed for breeding cows/heifers, (can be used for any cattle)	Doesn't explicitly state	Annual or as often as a producer would like	Pasture	No auditor	No clear outcome	Voluntary
American Humane Certified™	USA	Welfare only	beef, bison, swine, layers, turkeys, dairy goats, dairy cattle, broilers	Five Freedoms	Annual (unless issues are present that prevent certification) but producers must supply records for daily inspection of all animals for indoor housing, at least weekly inspection of all animals in extensive settings. Auditor aims to score all animals when on site during inspection.	Pasture, feedlot, indoor housing	3rd party audited (producer supplies records)	American Humane Certified	Voluntary to become Humane Certified
Bord Bia/SBLAS (Sustainable Beef and Lamb	Ireland	Welfare, food safety, sustainability	beef, lamb	FAWAC (Farm Animal Welfare Advisory	18-month visits, producer needs to supply	Pasture, indoor	3rd party audited (producer	Bord Bia quality mark	Voluntary to become Bord Bia accredited

Assurance Scheme)				Council) based on the Five Freedoms	records to the auditor		supplies records)		
Pasture for Life	UK	Welfare, sustainability, product quality	cattle, sheep, goats, bison, water buffalo, deer	Five Freedoms (welfare outcomes are based on AssureWel)	Annual (unless issues are present that prevent certification) but producers must supply all records for the 12-month period. Auditors may assess animal-based outcomes during their certification visits. Unclear how many animals they will assess. Producer needs to supply herd level records.	Pasture (indoor over winter as required)	3rd party audited (producer supplies records)	Certification Mark	Voluntary to be certified
NCBA (National Cattleman's Beef Association)	USA	Welfare only but NCBA have sustainability goals as well)	beef	Doesn't explicitly state	Unclear (Farm protocols, BMPs, SOPs to be updated annually)	Feedlots	3rd party audited (producer supplies records)	BQA certified	Voluntary to be certified
BQA (Beef Quality Assurance)	USA	Welfare only	beef	Doesn't explicitly state	Unclear, maintaining standards should be part of daily care	Ranch/feedlot	Unclear	BQA certified through online or in-person	Voluntary to be certified

								training course	
NAMI (North American Meat Institute)	USA	Welfare only	beef, sheep, pigs	Doesn't explicitly state (written by Temple Grandin)	Annual 3rd party (Recommended weekly internal audits)	Slaughter facilities	3rd party audited	NAMI certified	Voluntary to be certified
AGA (American Grassfed Association)	USA	Welfare, sustainability	beef, bison, sheep, dairy cattle, goat, lamb, pigs	Doesn't explicitly state: Animal welfare assessed based on written herd health plan preferably in consultation with a vet, or a separate auditing process through a different animal welfare certification program.	12-15 months	Pasture	3rd party audited	AGA certified	Voluntary to be certified
Label Rouge	France	Welfare and sustainability	beef, lamb, laying hens, broilers, pigs, ducks, geese	Doesn't explicitly state	Annual?	Pasture, indoor	3rd party audited	Label Rouge certified	Voluntary but standards are government regulated
Red Tractor	UK	Welfare, food safety, sustainability	beef, lamb, pork, dairy cattle, broilers,	Doesn't explicitly state	12-18 months (daily checks required for outdoor livestock, twice	Pasture and indoor housed (and transport)	3rd party audited (producer	Red Tractor Certified	Voluntary to be certified

			ducks, turkeys		daily for indoor-housed livestock)		supplies records)		
GAP (Global Animal Partnership)	USA	Welfare only but NCBA have sustainability goals as well	beef, bison, broilers, dairy cattle, goats, laying hens, sheep, pigs, turkeys	3 overlapping circles (health and productivity, natural living, emotional wellbeing)	15 months	Pasture and indoor and transport	3rd party audited (producer supplies records)	GAP certified with different levels of certification (stars) indicating improved welfare with more stars	
RSPCA Assured (Formerly RSPCA Freedom Foods)	UK	Welfare only	beef, dairy cattle, laying hens, pigs, dairy cattle, sheep, salmon, trout, ducks, turkeys, broilers	Five Freedoms	Annual	Pasture and indoor	RSPCA assessors (producer supplies records)	RSPCA Assured label	Voluntary to be certified
QMS (Quality Meat Scotland)	Scotland	Welfare and soil (?)	beef, sheep, pigs	Five Freedoms	Annual	Pasture and indoor	3rd party audited (producer supplies records)	QMS certified	Voluntary to be certified
AWA (Animal Welfare Approved)	USA	Welfare and sustainability	beef, dairy cattle, laying hens, pigs, dairy goats, dairy sheep, sheep, ducks, turkeys,	Doesn't explicitly state	Annual	Strictly pasture	Audited by an AGW auditor	AWA certified	Voluntary to be certified

			broilers, geese, bison						
Humane Farm Animal Care	USA	Welfare	beef, broilers, laying hens, dairy cattle, all goats, sheep, dairy sheep, pigs, turkeys, bison, red deer	Five Freedoms (based on the RSPCA guidelines)	Annual	Pasture and indoor	3rd party audited	Humane Certified	Voluntary to be certified
Welfare Quality	EU	Welfare only	beef, dairy cattle, veal calves, pigs, broilers, laying hens	Five Freedoms	Doesn't state	Pasture and indoor (developed for intensive production systems)	Developed as a scheme to be used by others	Developed as a scheme to be used by others	Developed as a scheme to be used by others
AssureWel	UK	Welfare only	beef, dairy cattle, pigs, broilers, laying hens, sheep		Depends on the auditing company	Pasture and indoor	Developed as a scheme to be used by others	Developed as a scheme to be used by others	Developed as a scheme to be used by others
Sheep Welfare Scheme (Irish farmers association)	Ireland	Welfare only	sheep	Requires farmers to go beyond basic mandatory standards and undertake targeted actions selected from a menu of options (for either Lowland	Annual	Pasture	Irish farmers association	scheme to enhance AW in the national sheep sector	Voluntary; if farmer opts out they are unable to re-join

			flock or Hill flock)						
Animal Welfare INTEROVIC Spain (AWIS)	Spain	Welfare only	sheep, lamb, goat,	International codes or standards EU legislation or guidance Private rules	Not provided	Pasture	Independent auditors/ announced	Single tier design	Voluntary to be certified
Animal Protection Denmark ("Anbefalet af Dyrenes Beskyttelse")	Denmark	Welfare only	laying hens, broilers, turkeys, dairy cows, beef, pigs, sheep, lamb, ducks, geese	EU legislation or guidance National legislation or guidance	Not provided	Pasture	Independent auditors/ announced	Single tier design	Voluntary to be certified
"Better Animal Welfare" ("Bedre Dyrevelfærd")	Denmark	Welfare only	broilers, calves, dairy cows, beef, pigs	Private rules	Not provided	Pasture	Label's own auditors and independent auditors/ unannounced	3 tier design (hearts)	Voluntary to be certified
KRAV	Sweden	Welfare + Climate, Biodiversity and Social responsibility	laying hens, broilers, turkeys, calves, dairy cows, beef, pigs, sheep, lamb, goat, rabbit, ducks, geese, fish	International codes or standards EU legislation or guidance National legislation or guidance Private rules	Not provided	Pasture	Independent auditors/ announced	Single tier design	Voluntary to be certified
Sigill Kvalitetssystem AB	Sweden	Welfare only	laying hens, broilers, calves, dairy cows, beef,	National legislation or guidance Private rules	Not provided	Pasture	Independent auditors/ announced	4 tier design (hearts)	Voluntary to be certified

			pigs, sheep, lamb, fish						
"For more animal welfare" ("Für Mehr Tierschutz")	Germany	Welfare + Authenticity, Traceability, Origin	laying hens, broilers, dairy cows, beef, pigs	Private rules	Not provided	Pasture	Independent auditors/ unannounced	2 tier design (Same logo with different information)	Voluntary to be certified
Bienestar Animal (Welfair)	Spain & Sth America	Welfare only	laying hens, broilers, turkeys, dairy cows, beef, pigs, sheep, lamb, goat, rabbit	International codes or standards EU legislation or guidance National legislation or guidance	Not provided	Pasture	Independent auditors/ announced	Single tier design	Voluntary to be certified
Beter Leven keurmerk	Netherlands	Welfare only	laying hens, broilers, turkeys, calves, dairy cows, beef, pigs, rabbit	EU legislation or guidance National legislation or guidance Private rules	Not provided	Pasture	Independent auditors/ unannounced	3 tier design (stars)	Voluntary to be certified

Table 5: Summary of general welfare areas across 5 selected schemes

General Welfare Parameters	Welfare Quality	Red Tractor	GAP	RSPCA Assured (uses AssureWel)	NZ Cow-calf Model
Good Feeding	Absence of prolonged hunger	Sufficient food and feeder space	Sufficient food and feeder space	Sufficient food and feeder space	Absence of prolonged hunger
	Absence of prolonged thirst	Sufficient water and drinker space	Sufficient water and drinker space	Sufficient water and drinker space	Absence of prolonged thirst
		Clean food and water	Clean food and water	Clean food and water	
Good Housing	Comfort around resting	Safe and clean	Pasture access	Safe and clean	Ease of movement
	Thermal comfort	Appropriate lighting	Safe and clean	Thermal comfort	Absence of hazardous objects / terrain
	Ease of movement	Thermal comfort	Thermal comfort, weather protection	Appropriate lighting	Access to shade
		Appropriate social groups	Ease of movement	Ease of movement	
		Ease of movement	Enrichment	Enrichment	
Good Health	Absence of injury	Absence of injury	Absence of injury	Absence of injury	Absence of injury
	Absence of disease	Absence of disease	Absence of disease	Absence of disease	Absence of disease
	Absence of pain induced by management procedures	Absence of pain induced by management procedures	Absence of pain induced by management procedures	Absence of pain induced by management procedures	Absence of pain induced by management procedures
			Good body condition	Good body condition	
			Step 5, no body alterations		
Appropriate Behaviour	Expression of social behaviours	Housing facilitates normal behaviour	Housing facilitates normal behaviour, including play, grooming, resting	Expression of social behaviours	Expression of social behaviours
	Expression of other behaviours		Housing facilitates normal social behaviours	Expression of other (normal) behaviours	Expression of negative behaviour
	Positive emotional state			Absence of abnormal behaviours	
Appropriate Stockmanship	Good human-animal interactions	Stockperson skills	Stockperson skills	Stockperson skills	Stockperson skills
		Absence of negative	Absence of negative	Absence of negative	

		handling methods	handling methods	handling methods	
		Appropriate handling facilities		Appropriate handling facilities	Appropriate handling facilities

It is acknowledged that not every international scheme was captured during the search; several schemes have websites and certification labels, but their actual assessment methods are not publicly available, and several schemes within Europe are not readily available in English. However, across the schemes that were assessed, several patterns emerged and thus conclusions are able to be drawn without including every scheme.

There are a lot of different certification schemes and labels available. It has often been stated that it must be confusing for the consumer and this global scan endeavour validates this observation. While some countries have relatively widely known certification schemes that are broadly applied (e.g., Red Tractor in the UK), across the US there are a multitude of different labelling schemes that focus on animal welfare to varying degrees (e.g., GAP, Humane Certified, AWA, American Grassfed Association) and, thus, may require the consumer to make judgements on which scheme they support during their product choice decisions. There is also overlap within the certification schemes as some use similar assessment protocols, e.g., Soil Association and RSPCA Assured use AssureWel. The schemes do not replace any government regulations on animal welfare and are predominantly voluntary to join. Most schemes result in a certification label that is awarded following application to the scheme and independent 3rd party auditing. Certification labels are renewed typically annually and any producer that fails an audit is revisited to check for improvements where required, or ultimately removed from the scheme for continual non-compliance. There are some instances where the auditing is conducted by employees of the certification label (e.g., AWA, RSPCA Assured).

Most schemes are based on, or appear to be based on the Five Freedoms if not explicitly stated and typically have protocols developed for multiple livestock species (e.g., GAP, RSPCA Assured). The schemes are typically listed as being founded on science, having been compiled based on consultation with experts in animal welfare, and are regularly updated as new evidence emerges to optimise animal welfare assessment with scientific consultative committees (e.g., GAP). Predominantly, the certification schemes focus on resource-based and management-based factors within their guidelines and auditing processes. There are few schemes that appear to have the auditors take measurements on the animals, where instead the auditors will view records across the year that report on animal health measures together with a general visual assessment of animals on the property. The traditional focus on resource-based and management-based factors as measurements of animal welfare is recognised as potentially failing to actually measure what is happening to the animal. This motivated the development of protocols such as WelfareQuality and AssureWel where the measures are more outcome-based and focus on animal indicators. Both WelfareQuality and AssureWel were developed to be used as part of certification labels (e.g. RSPCA Assured uses AssureWel for its animal-based measures) and have a wide usage in animal welfare research as well. The AssureWel standards recommend assessing a sample of 20 random animals, or the whole group depending on the measure and thus the auditor needs to have close contact with animals during the inspection process.

Across all the assessment schemes identified, the measures of animal welfare are herd level based and no scheme was identified that tracks lifetime welfare of the animal. The Pasture for Life scheme, for example, does provide QR codes on the product labelling that allow consumers to track the animal their meat came from: https://www.pastureforlife.org/trace-your-meat/, however, the

information displayed is general https://www.pastureforlife.org/tracks/?tracks_id=1412B16. Similar QR code options are available for Cape Grim beef produced in Tasmania: https://www.capegrimbeef.com.au/traceability.html and the GoodBeefIndex in the UK: https://www.goodbeefindex.org/about/authentication. While producers are encouraged and/or required to do daily inspections of their animals and keep detailed records, the certification scheme processes do not facilitate detailed tracking of each individual. There is a protocol developed for assessing lifetime animal welfare that was originally designed for laboratory primates but has been tested on livestock species in an experimental setting. This is not widely used but highlights that this is an idea that has previously been considered. https://nc3rs.org.uk/crackit/animal-welfare-assessment-grid-awag

While some schemes have a single certification mark (e.g., Red Tractor, American Humane Certified), other schemes have graded systems where animal welfare is higher with increasing levels of the schemes indicated by how many stars (e.g. GAP 5-star rating scheme, Beter Leven 3-star rating scheme). WelfareQuality was developed so that measures could be aggregated into scores to provide rankings of how good the status of the animals' welfare is following assessment. However, overall many schemes have been developed to safeguard animal welfare and ensure no suffering and mistreatment or poor health that would compromise ethical responsibility of animal management and food safety. This aligns with the general history of animal welfare research and the current state of knowledge on animal welfare assessment methods with increasing interest in positive animal welfare (e.g. Rowe et al., 2021 and the pursuit of Higher Animal Welfare through the GAWA Alliance) and optimising farming conditions to ensure a high quality of life beyond just eliminating negative experiences.

3) Relevance to the Australian context

While there are a multitude of schemes available internationally, the schemes were also created with international conditions in mind. Thus, not all schemes have relevance to the Australian context. This may be the relevance of specific animal-based measures that are not applicable to Australian cattle such as high incidences of lameness that are seen more in indoor-housed cattle, housing requirements that are not feasible such as requirement of shade which is not always possible in the Northern Beef industries, or assessment of pasture access, which is not necessary, given cattle are not intensively indoor-housed as they are elsewhere internationally. Certain management specifications may also not be relevant/feasible such as requirements for daily close inspection of animals at pasture for smaller grazing properties, or twice daily inspections for animals housed inside. However, this is a limitation that has been recognised in the recent development of other schemes specific to certain countries where the basic framework of a previously validated scheme and list of measures has been adopted and then adapted to ensure relevance to the context being assessed. Thus, it would be expected that any type of welfare assessment scheme developed for Australia would be modified to suit the conditions present in this country. For example, Racciatti et al. (2022) have recently published the process they went through to develop a scheme relevant for cattle welfare in feedlots in Argentina. They utilised existing schemes such as WelfareQuality® as well as other relevant published literature, and consultation with experts to compile a set of relevant measures that were then refined and validated on commercial feedlots to ensure a resulting scheme

that was applicable to the conditions being assessed. A similar process was applied to develop a set of measures relevant to extensive pasture-based beef cattle systems in New Zealand (Kaurivi et al., 2019; Kaurivi et al., 2020a,b) and this process of adaptation of an international scheme to local conditions has also been recently applied within Australia to develop welfare assessment protocol for livestock transported by sea (Dunston-Clarke et al., 2020). Whether creating a new assessment scheme from the ground-up or modifying an existing one, measures will need to be adapted to ensure relevance to Australia.

4) Current standards in Australia and existing data streams

4.1 Existing livestock data streams

Livestock producers in Australia face a plethora of compliance frameworks. The most important of these is the Livestock Production Assurance (LPA) scheme which is operated by Integrity Systems. The LPA supports the adoption and adherence of the Australian Animal Welfare Standards and Guidelines for cattle, sheep and goats and provides a mandatory learning module on animal welfare. Livestock transactions and movements are recorded including declaration of withholding periods due to veterinary drug treatments. Other program requirements include property risk assessments, safe and responsible animal treatments; stock foods, fodder crops, grain and pasture treatments; preparation for dispatch of livestock and biosecurity. Individual components of the program feed into different record systems. Records remaining on farm include biosecurity plans which contain records of veterinary drug use and treatment and animal health management. At the point of sale, National Vendor Declarations are required which capture recent drug treatment only if within the withholding period of the medicine.

Livestock transportation is also regulated by the Australian Trucking Association through its independently audited quality assurance programs TruckSafe and TruckCare. The program includes a module on Animal Welfare built around the quality assurance principles contained in international standards and also uses hazard analysis of critical control points. The module is supported by the Australian Livestock and Rural Transport Association (ALRTA) through its national animal welfare policy, endorsing the 'Fit-to-Load' policy developed by MLA and the ALTRA Guide for Safe Design of Livestock Loading Ramps and Forcing Yards'. TruckCare is a voluntary accreditation system for livestock transporters that is primarily focussed on animal welfare, biosecurity and traceability. The system was originally developed by the ALRTA and is now operated by the ATA TruckSafe accreditation system. Together, the accreditation systems promote legal compliance and best practice while also enabling operators to demonstrate this to other parties in the livestock supply chain.

For animals entering feedlots, the National Feedlot Accreditation Scheme (NFAS) requires that records are maintained on health management and received treatments. Records also include monitoring activities and operational processes.

The Livestock Data Link is an instrument allowing relevant information collected at processing to be communicated back to the producer to allow continuous improvement. This system monitors carcase compliance and signs of animal disease and defect which are relevant indicators of animal health prior to slaughter.

Some parts of the livestock industry have developed their own animal welfare and production quality assurance schemes. An example is the JBS Farm Assurance Program which was implemented in 2011 to provide assurance to JBS Australia and its customers that its suppliers consistently meet required food safety and animal welfare standards in their farming practices for this market. The program is accredited through the Joint Accreditation System of Australia and New Zealand (JAS-ANZ). The basis of the program revolves around ensuring the supply chain from producer to processor meets expected standards for Food Safety, Animal Welfare, Quality assurance and traceability. The processes contained within the program focus mainly on documentation and management recording systems to provide the information required to complete animal status declarations to accompany livestock sent for processing.

The Australian Beef Sustainability Framework (2022) was developed in 2017 by the Australian beef industry as an initiative to meet expectations of customers, investors, and other stakeholders. The Framework seeks to define the term 'sustainable beef production', to define relevant indicators and to track annually how the industry is performing against these indicators. The framework identifies animal welfare as one of four themes, along with economic resilience, environmental stewardship, and people and the community. The animal welfare theme includes four priorities to enhance animal wellbeing, and two priorities to promote animal health. Animal wellbeing includes competent livestock handling, safe livestock transport, animal husbandry techniques and humane processing; animal health includes to maintain healthy livestock and to minimise biosecurity risk. For each priority, indicators have been identified and monitored since 2017. Sources of data include LPA audit outcomes, NFAS audit outcomes, records of TruckCare accredited vehicle numbers, percentage of reportable incidences of shipboard mortalities reported by DAWE, MLA reports, Beef producer sustainability survey results, DAWE, compliance with Exporter Supply Chain Assurance Scheme (ESCAS), Animal Health Australia.

4.2 Gaps and limitations of existing record systems

Five fundamental wellbeing opportunities have been identified in this report. These include comfort, pleasure, confidence, interest and opportunities for a healthy and productive life. Comfort, or absence of discomfort, along with ensuring good health and productivity, have been traditionally in the centre of animal welfare initiatives and accordingly are most represented in existing accreditation schemes and initiatives (Table 6). Confidence is addressed indirectly through training of people interacting with livestock. Pleasure and interest are currently not addressed.

Currently collected data streams are predominantly collected on the property level. Some records such as veterinary drug treatments, are collected for individuals; however, this information does not leave the farm unless captured in NVDs. LPA accreditation information remains on farm unless

audited. Information collected by different accreditation schemes is not collated at any point, preventing through-chain data acquisition.

4.3 Opportunities from digital agriculture

The emerging availability of digital agriculture promises a step-change in the ability to record information on individual animals (Swain *et al.* 2013; Bocquier *et al.* 2014; Perret *et al.* 2017; Zhang *et al.* 2017; Morgan-Davies *et al.* 2019; Caja *et al.* 2020; Stachowicz and Umstätter 2021; Riaboff *et al.* 2022). The term precision agriculture is used for automated recording of livestock data off and on animal. Examples range from automated recording of liveweights including repeated measurements through Walk-over-weighing systems; individual animal treatment records collected through RFID scanners; animal location from geospatial or other location data; intake data recorded from feed scales (such as GrowSafe) or movement data based measurements (eGrazor; Greenwood *et al.* 2017; Rahman *et al.* 2017; Bishop-Hurley *et al.* 2020).

Private consultants may use data streams, for example of live weight measurements, to advise clients on management decisions. These data streams are not accessible at this stage for through-chain monitoring, or other, purposes.

Zheng et al (2017) estimated that over half of Australian beef producers collect individual or herd production data (Table 7). The potential benefit of sensor-based measurements in Australian beef production for animal health and disease monitoring has been estimated as AUD 255 million in GVP, representing an increase of 2.43% in GVP, based on productivity improvement of 5% (Perret *et al.* 2017; Table 8).

Table 6: How current measures address wellbeing opportunities

Good Wellbeing Opportunity	Resource Need	Input measures	Current outcome measures
Comfort	Comfortable physical environment	Safe feed	LPA: commodity vendor declaration
	Comfortable thermal environment	Heat load	NFAS: heat load monitoring activities and operational practices
	Safe environment	Hazards e.g. sharp edges in yards	LDL: Carcase bruising
		Hygiene; safety from diseases	LPA: Farm Biosecurity Plan (audit outcomes)
		Pain control for aversive husbandry measures	
		Safe transport; fit to transport	LPA: Livestock National Vendor declaration TruckSafe (ATA)
Pleasure	Food enrichment	Drought management strategy Pasture composition Paddock rotation plan	
	Play opportunities		
	Breeding and nurturing opportunities	Bull management practices Age at weaning	
Confidence	Positive experiences with people	Animal Welfare training	LPA completion of Animal welfare training LPA audit outcomes ALFA NFAS audit outcomes (awareness of Australian Animal Welfare Standards)
	Positive social interactions	Group size / paddock size	
Interest	Enriched environment		
	Enhanced learning opportunities	Yard weaning (southern industry) Tailing (northern industry)	

		Other animal training procedures	
Healthy and productive life	Management policy for positive health	Intervention strategies	Health records Post-mortem lesions LPA: Biosecurity plan NFAS: Register of veterinary medicine useage; antimicrobial stewardship plan
		Well managed end of life	Accreditation of establishments under Australian Livestock Processing Industry Animal Welfare Certification System (AAWCS)
	Breeding for positive welfare	Breeding objectives for health, disease resistance, resilience, immune competence, conformation, heat tolerance, etc	Incorporation of Polled Gene and Immune Resilience in breed genetic selection
	Promoting a natural body type (telos)		

Table 7: Data collection rates (in %) for types of data by livestock industries (Zhang *et al.* 2017)

Industry	Soil mapping	Pasture/ vegetation mapping	Individ. animal or herd production	Individ. animal or herd feeding	On-farm weather station	Animal breeding	Finances	Vet. medicines record	Water use/quality	None of the listed data is collected
Beef only	23	33	54	23	26	50	78	63	25	9
Beef/Grain mixed	28	30	52	25	45	41	86	67	23	8
Beef/Sheep mixed	29	29	52	23	42	61	83	70	19	4
Sheep meat only (Lamb)	20	24	44	29	49	54	70	63	17	14
Sheep/Grain mixed	27	19	31	16	31	47	71	45	23	17
Sheep wool	23	24	56	27	38	67	79	72	19	7
Dairy	37	27	80	50	17	77	82	70	38	7

Pork	20	13	93	80	27	93	93	100	67	0
Poultry eggs/meat	10	17	60	43	17	20	70	53	57	23
Aquaculture	0	0	87	47	47	63	90	37	97	3
Total	25	25	56	30	33	57	79	63	29	9

Table 8: Potential economic benefits from digital agriculture for the red meat livestock industry (Perret *et al.* 2017)

Sector	Practice	GVP $ million	Productivity Improvement modelled (%)	Increase in GVP in %
Beef	Labour saving	161.3	3.17	1.54
Sheep meat	Labour saving	39.9	2.93	1.33
Red meat processing	Labour saving	400.4	2.86	2.76
Beef	Feed, landscape & water management	610.8	11.99	5.84
Sheep meat	Feed, landscape & water management	163.3	12	5.47
Beef	Animal health & disease monitoring	254.7	5	2.43
Sheep meat	Animal health & disease monitoring	136.1	10	4.55
Livestock export	Animal health monitoring	28.1	2	1.75

5) Linkages with sustainability

While many of the identified schemes have been developed to just address animal welfare, there is also a significant portion of schemes that incorporate sustainability and product quality as well. Successful animal production is a holistic enterprise. There is an increasing understanding of the benefits of good animal welfare on the safety and quality of the end product as well as the recognition that moving forward, the impacts of animal production systems on the environment must be considered to ensure sustainability of industries and the planet. Pasture-based certification systems such as *Pasture for Life*, and *Animal Welfare Approved* strongly promote the holistic farming system where there are linkages between the animal and the environment, and both must be managed under their certifications. Additionally, the larger international sustainability networks (examples listed below) include animal welfare components. This recognition of the relevance of animal welfare to meat production sustainability has previously been captured within Australia such as documented in the final report by Witt et al. (2020).

European Roundtable for Beef Sustainability — SAI Platform (Different schemes are used across different partner countries with similar overall goals to reach regarding health and welfare management practices and outcomes)

Animal Health & Welfare - Global Roundtable for Sustainable Beef (grsbeef.org) (same comment as for EU Roundtable)

Key issues for LAWI to address as a foundation for further development through the suggestions raised in stakeholder interviews and workshop discussions include:

- International credibility
- Auditability
- A sense of ownership of the scheme by producers
- Scope for continual improvement
- What might LAWI look like?
- Scores
- …

International credibility

The international dominance of the United Kingdom's Farm Animal Welfare Council in setting the parameters for welfare assessment through the Five Freedoms Model and its subsequent extension to the Five Domains Model and the Good Life Model creates a need for LAWI to be couched in terms that reference these frameworks in order to have credence to the international community. This does not mean these models should be adopted in toto or uncritically as the basis for LAWI, but that the criteria underpinning LAWI need to be parsed in language that can be notionally mapped to these models as a basis for explaining to the international community what LAWI addresses and why it is valid within both the Australian and international contexts. So, what we need is not a "welfare

cringe" but an authentic statement of biological and philosophical knowledge of wellbeing and how this knowledge is used in the design of LAWI.

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