final report

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Common Animal Data Framework

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Executive summary

Meat & Livestock Australia (MLA) Integrity Systems Company (ISC) has been investigating ways to assist the Australian red meat supply chain to increase the effective use of technology in transparency, traceability, and improved productivity and profitability.

Effective use of digital systems by producers and others in the supply chain depends on building trust between parties and also reducing the barriers to seamless exchange of data between systems - whether on the basis of permissions or simply between systems used by the same person or company.

This project aimed to reduce the friction and overhead involved in exchanging livestock data between different systems, through the development of data schemas to enable more standardised transfer of data and information exchange. It is intended that the MLA Group can use the data schemas to facilitate streamlined transfer of data into genetics, traceability, and industry accreditation programmes, and that third-party application and device manufacturers can also use the data schemas to streamline their own data flows.

Systems that exchange livestock data include farm management software, livestock monitoring equipment, livestock genetics systems, and processor procurement management systems.

The key aims of this project were to:

- Leverage and extend the comprehensive work on livestock data that has already been undertaken in New Zealand – specifically the New Zealand Farm Data Standards and DataLinker, developed for DairyNZ, Beef+Lamb NZ, and the New Zealand Ministry for Primary Industries
- Encourage and support data sharing and greater interoperability between devices, farm, feedlot, and livestock exchange management solutions, and industry systems
- Provide a better experience for farmers (collective end-users and customers of most participants)
- Enable data analysis and manipulation that was not possible with data in silos
- Provide a standardised schema and approach to help reduce the cost of development when sharing with multiple other systems
- Encourage participation in defining schemas and allow implementation by participants in timeframes that suit their needs.

During the project, a group of more than 30 participants collaborated using online meeting software and a shared software source repository. Led by Rezare Systems and with representatives from the National Livestock Language Committee and Meat Standards Australia, the group co-created data schemas covering:

- Individual animal identification and life data
- Weights
- Scores such as condition score, frame score, muscle and fat score

- Health treatments
- Livestock registration, movements, and deaths

While deep industry experience was welcomed and integrated, the work focused on practical solutions that could be implemented by adoption partners.

Key adoption partners include:

- Software vendors, particularly for farm management software and livestock recording equipment, but also including developers and vendors in areas that utilise livestock data;
- Livestock genetics services and partners, including Sheep Genetics Australia, ABRI/Breedplan, and DNA testing and data collection providers; and
- Integration points with ISC systems, including eNVD and NLIS where applicable, and the MLA Industry Data Platform.

The immediate users of this work will be industry solution providers, including vendors of farm and feedlot software, livestock sensing and recording solutions, and vendors of solutions for processors and supply chains.

Collaboration with ICAR and the DataLinker initiative will enable the project outcomes to be adopted in an international context, with the resulting benefit in efficient transfer of trade data and greater interoperability with technologies developed internationally. The open source approach used in the project will encourage practical adoption and extension by the technology and data community in Australia and internationally.

The ultimate beneficiaries are producers, retailers, marketers, and operators of quality assurance and credence programmes. Benefits for this group will include streamlined access to and use of data, greater accuracy, and more complete information. Removing the barriers to effective use of data should provide producers and industry with better information to support productivity, sustainability, and market differentiation.

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1 Background

Historically almost every exchange of data between different IT systems has involved a “translation” from the language and format of one system to another. Usually the burden for this translation was put on the end user. Systems would produce or require a file in a specific format and would leave the user to recode and reformat data - often through an intermediate form such as Microsoft Excel. Other systems would not make data available at all.

This project sought to deliver a common data dictionary, data schema, and a set of extendable standard API definitions that could be used by software developers and vendors to implement modern data exchange that does not require users to export, manipulate, and import files.

Recent improvements in connectivity and the drive to digitisation has encouraged solution providers and industry programmes to update their software solutions and to build connections between systems. ISC is actively promoting this interoperability between solution providers.

Software developers frequently search for existing models and solutions to avoid reinventing the wheel. Having data dictionaries, documentation, and model data schemas available will encourage solution providers to incorporate these into their projects and to use the models for data exchange.

The business benefits for this project:

- Industry solution providers, including vendors of farm and feedlot software, livestock sensing and recording solutions, and vendors of solutions for processors and supply chains can gain from using the information published from of this project through greater consistency, and reduction in custom development and rework.
- Producers, retailers, marketers, and operators of quality assurance and credence programmes will benefit from streamlined access to and use of data, greater accuracy and more complete information.
- Producers and the industry at large will benefit from having better information to support productivity, sustainability, and market differentiation.

When fully adopted the outcomes would provide:

- Driven by demand from producers and other value chain participants, software vendors already want to make sure that their systems integrate, and exchange data well with industry systems. The current cost of negotiating how to do this makes it prohibitive and drives integration down the list of priorities below other features. Clear, easy to implement standards will make it much easier for vendors to add integration.
- Integration not only saves producers time (sometimes several hours per week, per producer of duplicate data entry or file management), but more we know that for many producers, ease-of-use barriers such as data management stop adoption altogether. Over many producers this adds up to poorer decisions and significant missed opportunities.

- Other systems across the industry, whether MLA systems or those of processors and marketers, will benefit from being able to integrate data that is more complete and of higher quality.

2 Project objectives

This project had the following objectives

a. Facilitate co-creation with participants to produce a common data dictionary, data schema, and a set of extendable standard API definitions to be used by software developers and vendors to implement modern data exchange without requiring users to export, manipulate, and import files.
b. Creation of an overarching schema to organise the data sets in a way that makes sense to Australian livestock organisations and ISC; without compromising international compatibility; and
c. Documentation in a readily searchable and maintainable form to enable adoption by Australian companies and industry organisations.
d. The delivery of a final report to ISC outlining the project's achievements.

3 Methodology

A busy landscape of technology and standards development already existed upon commencement of the project. This project sought to leverage existing work where possible and adapt as required rather than attempt to develop new standards from scratch. This approach would help align Australian work towards other international work, reaching for an overarching goal of a global set of standards that are able to cater for local needs.

Rezare Systems holds strong knowledge and expertise in the development of international standards, having developed the New Zealand Farm Data Standards (www.farmdatastandards.org.nz) which contain data dictionaries for livestock data (among other topics), and collaborated with ICAR on the Animal Data Exchange (ADE) working group.

The existing work from ICAR formed a strong basis for a livestock dictionary and schema for industry. The methodology for this project, was based on drawing upon previous work of ICAR, and ensuring the needs of Australian red meat are addressed, namely:

- Testing the existing proposed schema with software developers and vendors in Australia, considering the specific use cases (and therefore data sets to be exchanged) to support industry needs;

- Creation of an overarching schema to organise the data sets in a way that makes sense to Australian livestock organisations and MLA, without compromising international compatibility; and

- Documentation in a readily searchable and maintainable form to enable adoption by Australian companies and industry organisations.
- Collaboratively submitting feedback from the Australian red meat market to international standards groups (ICAR) to encourage adoption for a global set of standards.

The ICAR Animal Data Exchange Working Group GitHub repository is publicly available via an open source licence. Rezare Systems, having representation on the ICAR working group is well versed on the discussion and decisions that have been made on these schemas, and how they will continue to be updated.

Relevant schema objects were duplicated from the ICAR repository and set up in an open-source ISC animal schema repository. During the project these copies were built upon based on participant requirements. The intention is that updates will be presented back to ICAR that have been made to their original objects (as pull requests) to see if they would be happy to accept these changes. The result for ISC is a set of international standards maintained by ICAR that users can draw upon, alongside specific needs for the Australian market that would be maintained by ISC. This is discussed further in the recommendations section.

3.1 Project Scope

The project focussed on livestock data and was broken into the below areas of focus.

These areas were agreed by ISC from the outset of the project in order to provide participants with a defined scope.

- Identity, Life data and Parentage – covers the data attributes for an animal related to how an animal is identified in various systems, its life data characteristics like species, birthdate, gender, and parentage.
- Weight and Condition Score and related events – covers the data attributes for an animal related to its weights, fat, and muscle scores.
- Health Treatments and related events – covers the scenarios for recording parameters regarding the health of the animal and related events such as diagnosis, treatments, course summaries, medicines, doses administered, and withdrawals related to the treatments.
- Registrations and Movements – covers data attributes for an animal related to events like births, deaths, and movements across locations.

In addition, based on feedback from participants a webinar was also held to discuss the structure of the Application Program Interface (API) models to be implemented, based on how they would be used. This included discussion around use cases and protocols for use (for instance, HTTP verbs and API operations).

3.2 Project Approach

Rezare Systems was able to draw upon its experience in collaborating with representatives from a variety of organisations regarding agreement on data schemas, to propose an effective approach for this project. Some of the key issues that have previously been faced in similar projects included:

- the availability of participants to attend physical workshops;
- costs involved in hosting face to face sessions;
- ability to cover the breadth of subject matter in limited time;
- difficulties in transparency of follow up where participants had limited visibility of each other's comments or feedback;
- and the time spent administering a more traditional email based process.

Considering those challenges, Rezare Systems proposed an approach where feedback would be sought via webinars hosted at regular intervals over the project timeline, and the use of software development platform GitHub as a collaboration tool.

The scope was broken down and covered over a series of webinars, where the topics were known up front and the sessions were all diarised from project outset.

The workshops were held on the following dates, and covered the following topics:

- 12 December 2019 Introductory session
- 19 December 2019 Identity, Life data and Parentage
- 16 January 2020 Weight, Condition Scores and related events
- 30 January 2020 Health Treatments and related events
- 13 February 2020 Registrations and Movements
- 27 February 2020 API models

Draft object models were provided prior to relevant session so participants could prepare in advance. Participants were encouraged to review the inputs and submit changes via pull requests or raise issues in GitHub prior regardless of whether they were able to attend or not.

The co-creation webinars were used to facilitate joint discussion and agreement reached on participants suggestions. The sessions were used as a means of collectively resolving issues. This methodology embraced peer to peer accountability and reduced the amount of to-and-fro between individuals as decisions were worked through and confirmed by the group as a whole. Recordings of the webinar and minutes of each meeting, along with updates to the issues were all available on GitHub for all participants to review throughout the project

The intent of setting GitHub up in this way was to encourage adoption and a way of working during the project which can continue upon project completion. The collaboration is completely transparent, where participants can see and comment upon each other's suggestions, and they are able to submit proposed changes through a process called "Pull Requests". During the project Rezare Systems assumed the role as the maintainer, and this role should be retained ongoing by ISC to ensure schema relevancy. This will be discussed in more detail under the recommendations section.

3.3 Attendees

A wide variety of organisations were invited to participate in the project based on their industry knowledge and involvement in data sharing in the Australian red meat sector.

MLA received a positive response, with more than 30 representatives across 14 or more organisations signalling they would like to be involved in the project.

4 Results

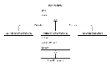
Rezare Systems constructed “straw man” object models for individual animal identification and life data, and a set of individual animal events, based on their industry experience, existing software tools, and the NZ Farm Data Standards (www.farmdatastandards.org.nz). These were socialised with participating organisations prior to online workshops in spreadsheet form.

Based on feedback from participants during the workshops, and issues that the participants raised on the GitHub platform, Rezare Systems updated these spreadsheet models.

Formal specifications were created using “JSON Schema”, a data description format for the widely used “JSON” (JavaScript Object Notation), based upon the updated spreadsheet models. The use of JSON schema was discussed with participants in the first workshop. Both the spreadsheet models and JSON Schema files are available on GitHub, along with minutes of each webinar. Participants could raise issues for discussion, and these conversations were also held on GitHub. These all remain publicly available and all participants have been encouraged to continue discussions on the animal schema repository.

After discussion with participants, Open API specification files were also created. Open API specification is used to describe APIs in a form that can be used by software developers regardless of their preferred language and technology platform, and which can also be visualised in human-readable form. The Open API files in this project were used to describe how data could be retrieved or updated.

Rezare Systems encouraged participants to view the schemas as working documents that can be continued to be refined and extended to ensure they remain relevant and fit for purpose. Use of the GitHub platform and an open source model will allow current and future participants to submit changes that can be reviewed and merged to update the data schemas. As the results will continue to evolve based on community participation, this report provides links to the relevant items rather than including the results in an appendix.

	Home page for the ISC Animal Schema project in GitHub
	https://github.com/integritysystemscompany/animal_schema
	Meeting Minutes
	https://github.com/integritysystemscompany/animal_schema/wiki/Meeting-Minutes
	Spreadsheet Models (models in spreadsheet form)
	https://github.com/integritysystemscompany/animal_schema/tree/master/WorkingDocuments
	JSON Schema source code
	https://github.com/integritysystemscompany/animal_schema/tree/master/JSON_Schemas
	Class Documentation (GitHub Wiki)
	https://github.com/integritysystemscompany/animal_schema/wiki/ISC-Animal-Schema-extended-resources

5 Discussion

The key points discussed during each webinar are summarised below.

5.1 Animal identity, life data, and parentage

Attendees: ABRI, Agrinous, AgriWebb, Ceres Tag, Datamars, Gallagher Group, Integrity Systems Company, Maia Technology, Management for Technology, Practical Systems, Sheep Genetics Australia Smart Shepherd

Rezare Systems provided information about the two-piece identity model developed for the *NZ Farm Data Standards* and adopted by ICAR. This approach provides for each identifier: a scheme (for instance "au.gov.ag.pic") and an ID (an individual Property Identification Code (PIC) code). Different schemes can be used for locations (PICs) and animals (for example NLIS tags). An animal may have multiple alternative identifiers (for instance, a genetics identifier as well as a NLIS tag).

Rezare Systems provided information about the ICAR "Animal Core Resource" data model adopted by ICAR, which in turn was based on a data model from datalinker.org.

Participants endorsed the animal identity model and discussed what likely schemes would be used for Australia – principally PIC and NLIS identity based, but with options for sheep genetics and breed societies.

Participants identified several additional data attributes and validations that would be extensions to the ICAR data model, and which could be submitted to ICAR.

Participants noted that there would be value in being able to track dates of change of key life data information, such as status, de-sexing date, and breed society registration. There was discussion whether a generalised date-based model was created, or whether additional specific date fields should be added.

5.2 Weights, condition scores, and related events

Attendees: ABRI, Agrinous, AgriWebb, Ceres Tag, Gallagher Group, Integrity Systems Company, Livestock Language Committee, Maia Technology, Practical Systems, Sheep Genetics Australia, Smart Shepherd

Rezare Systems provided information about the generalised individual animal event (observation or action) model employed by the ICAR Animal Data Exchange. This is based on an "Event Core Resource" that captures the animal, event date and time, location and unique ID. Derived classes provide attributes specific to the event.

The attendees discussed features relevant to weight events, focusing specifically upon methods of weighing, the resolution of the weight data (minimum detectable differences in weight), and the units used (kilograms and pounds).

Particular focus was made on how specific weights for genetic performance recording purposes would be identified. These may be different between Sheep Genetics and ABRI, or even individual breed societies. A Trait Label mechanism (consisting of the recording scheme and the trait ID) was chosen.

Use of a contemporary or management group to identify different management regimes that may have affected the weight were discussed. It was decided that this could apply to a number of traits, so both the Trait Label and the Contemporary Group should be submitted to the ICAR Animal Data Exchange working group.

The attendees discussed Condition Score, Frame Score, Muscle Score, and Fat Score, and noted that there are other scores used in some cases. One of the challenges is that the scores have different measurement types (numeric and alphabetic codes), and ranges (A-E, 1-5, 1-6, 1-7, 1-9). Attendees asked Rezare Systems to propose ways that this could be implemented but noted that one method would be to identify the scoring scheme being used.

Before and after the meeting, several attendees used the GitHub Issues functionality (https://github.com/integritysystemscompany/animal_schema/issues) to record questions and suggestions, which was useful.

5.3 Health treatments

Attendees: AgriWebb, Datamars, Integrity Systems Company, MLA Animal Health specialist, Practical Systems

Rezare Systems proposed a structure for recording animal health treatments, particularly medicine applications. This was based on work that Rezare Systems had done with Bristol University on the UK medicine recording system.

Several attendees recorded GitHub Issues prior to the meeting to start the discussion. These covered:

- Diagnoses
- Differentiating plans for treatment, courses of treatment, and individual treatments
- Non-medicine treatments (surgeries and other procedures)
- Standardising dose units
- Standardising diagnosis codes

After discussion, the group concluded that separate data structures were necessary to represent a diagnosis, an individual treatment, and a treatment plan that might include a diagnosis and a course of treatments. Treatments needed to cater for medicine, non-medicine, and combined treatments, and product batch and expiry dates needed to be captured.

Codes for diagnoses and medicines should use the “scheme and identifier” form to allow for multiple international medicine registration databases, and for diagnostic schemes such as VENOM and ICAR. The idea of a global (or event Australian), API-based database of medicines that all software vendors could use to validate data was welcomed but agreed to be out of scope.

5.4 Registration and movements

Attendees: ABRI, AgriWebb, Ceres Tag, Gallagher Group, Integrity Systems Company, Practical Systems

Rezare Systems provided information about the four existing registration and movement events that have been defined by ICAR, in turn based on the NZ Farm Data Standards and the needs of recording systems in UK, Europe, and New Zealand. These events were:

- Registration (official registration or induction of new animals)
- Arrival (new animals onto a location)
- Departure (animals leaving a location)
- Death (including killed for on farm use, and losses)

In addition, a Consignment object represents much of the shared information about the source and destination of animals being moved.

Attendees reviewed the events and suggested further fields. Three other event types were identified:

- Retagging animals with lost tags
- Recording animals as found that were lost (implemented as a variation of Registration)
- Change of Ownership (sale and purchase), distinct from a movement

There was substantial discussion about assessments and other information accompanying animals at sale time, and participants undertook to investigate further what was required. There was also much discussion about sale transactions and how pricing information could be represented. Pricing information is optional (as are most other fields) as this could be sensitive and therefore might not routinely be exchanged electronically.

Several issues were recorded by attendees using the GitHub issue system, including suggestions for further related events and functionality. Only some of the items were in the current scope, and other issues were marked as enhancements to be covered in future projects.

5.5 API Models

Attendees: AgriWebb, Ceres Tag, Integrity Systems Company, Practical Systems, Smart Paddock

The topic for the final workshop was initially undefined. During the process Rezare Systems canvassed participants using an online survey in order to decide the topic for the final workshop. Of the options, discussing the API model was the preference.

Three key questions were covered at this workshop:

- Whether APIs should have an explicit structure (so that clients of any service know where to insert the appropriate location and animal identifiers to retrieve data), or whether the structure should be able to be discovered by navigation (data returned from one API call provides links to retrieve related data).

- Whether common URL filters should be provided for collections of data, and if so, what filters are required.
- Whether (as suggested in earlier workshops and some GitHub Issues) there should be the concept of a "Session" or other mechanism for grouping together events recorded for multiple animals together (such as a movement).

Participants did not have a clear preference around how APIs were structured. Navigable URLs are attractive but can have the overhead of navigating each time. Explicit URLs will be quicker to access but potentially more work upfront and more fragile. It is also not clear how to understand what capabilities are implemented by a given service. One participant noted that their preference was to use the data model but to use GraphQL for queries.

Rezare Systems' recommendation is that navigable links between objects is good practice for web data, and not harmful. However, a capability mechanism or explicit URLs published with OpenAPI schema might make data access more efficient. These approaches do not have to be mutually exclusive.

Participants indicated that filters or the ability to request subsets of data by location, date created/modified, and perhaps birth date (for animals) would be advantageous. There was discussion about the ability to define a group of animals (either defined on the server or posted by the client) and then query for animals in that group.

Most attendees could see benefit in being able to associate together events which were recorded on a group of animals at the same time. This is more useful for events which can apply to multiple animals (such as a movement, or a drench), than for events which are inherently individual (such as weights). However, even being able to provide all weight data to a service at once would be useful. Rezare Systems suggests that a Session object be developed further in future work.

5.6 Open Issues

In addition to the items mentioned above, several issues have been left open in GitHub. These are primarily suggestions for future work (marked as "Enhancements") or areas where attendees were unable to provide enough detail (which again should be addressed later when more detail is available). Details of these issues can be found here: https://github.com/integritysystemscompany/animal_schema/issues.

Rezare Systems recommends that open issues could be prioritised into future projects in this area.

6 Recommendations

The engagement with participants showed a willingness to adopt the developed schemas. For this to be successful, Rezare Systems provides five key recommendations as detailed below.

1. Appoint a maintainer for the schemas.
2. Submit schemas to ICAR to become global animal recording standards.
3. Incentivise and support adoption by organisations.

4. Continue to build and enhance the schemas.
5. Nurture adoption by MLA programmes and partner projects.

6.1 Appoint a maintainer for the schemas

During this project, Rezare Systems fulfilled the role of maintainer for the GitHub repository.

In an open source project, a maintainer:

- Maintains loose oversight of the entire project.
- Tracks ongoing work and submitted changes to ensure they get reviewed and merged in a timely manner. This encourages participation from external organisations and developers.
- Directs the orchestra of (mainly volunteer) developers and reviewers, making sure that they connect to each other appropriately and the project maintains its direction.
- Points participants to related work, ensures common development practices, and passes on institutional (project) knowledge.

Open source projects without a maintainer can become outdated, inactive, or abandoned.

Rezare Systems recommends that ISC continues to part-fund a maintainer role after the completion of this project, until the schemas reach critical mass where maintainers can be provided “in-kind” by other parties. There may also be value in aligning the maintenance and direction of these standards with an existing industry committee over the longer term.

6.2 Submit schemas to ICAR to become global standards

The data model components that formed the basis for this work were derived from DataLinker.org and ICAR Animal Data Exchange projects. It is appropriate for the improvements and extensions made in this project to be submitted back to those source projects.

Importantly, if the changes are embraced by the ICAR Animal Data Exchange working group, they will form part of a global standard. This will make it easier for Australian software vendors to sell their products internationally and will ensure that Australian producers have access to compatible international technology.

The live weight specification developed in this project were submitted to the ICAR Animal Data Exchange Working Group, and was accepted by the working group in its entirety, becoming part of the official ADE-1 specification being released internationally in April 2020. This will further support adoption by equipment and technology developers.

It is possible that not all the extensions proposed in this project will be adopted by ICAR. However, this will still result in a set of international standards maintained by ICAR that Australian software developers can draw upon, with Australian-specific extensions that are maintained within this project.

6.3 Incentivise and support adoption by organisations

Most standards development processes, such as the World-wide Web Consortium (W3C) require that any specification must demonstrate implementation as part of the standardisation process. In the same way, the animal schema specifications developed in this project will only be of benefit to Australian producers if software, equipment, and database vendors adopt these in their product roadmaps.

MLA should incentivise and support early adoption by willing participants. Mechanisms to achieve this could include:

- Co-funding development using the schemas through industry funding mechanisms.
- Coordinating a pilot project where two to four willing participants build and demonstrate data exchange using the schemas.
- Providing support assistance, perhaps through the maintainer, for early adopter participants so that they receive help to understand and make effective use of the data schemas.

6.4 Continue to build and enhance the schemas

During this project, participants identified potential further events and other data types that could be added to the animal schema or addressed in future schema projects. These included:

- Session-based recording
- Mobs and groups of animals
- Sightings of animals at locations (including GPS location)
- Traits of interest to livestock performance recording schemes and breed societies
- Carcase measurements (building on the ISC Carcase Data Schema work)
- Feed management or feeding events
- Potential exposure of animals to environmental pollutants
- Inventory control (purchase, stocktake, and disposal) for medicines
- An Australian database of identifier types and schemes

ISC might prioritise a set of enhancements of greatest interest to industry participants, and address these in a follow-on programme of work, including through the ISC Solution Provider Network. It is not necessary to address the suggestions above before encouraging adoption: the initial set of schemas will facilitate initial adoption and encourage organisations to participate in co-creating enhancements.

6.5 Require adoption by MLA programmes and partner projects

Workshop participants showed substantial interest in the potential of animal schema compliant APIs to access MLA and ISC services. Adoption by MLA programmes or piloting through partner projects would clearly demonstrate to software, database, and equipment vendors that the animal schemas are suitable for industry use.

MLA could consider a demonstration or pilot project, such as creating an animal schema-based wrapper around NLIS APIs. Alternatively, appropriate partner or contract R&D projects might consider using the animal schemas in data collection or delivery.

7 Conclusion

This project has delivered a series of schemas for animal data that can be used by organisations within the red meat supply chain in Australia. The schemas have been created in an open source project that leverages and encourages contribution from industry participants. Participants from a number of industry and commercial organisations participated using collaborative tools and online meetings, and provided valuable and thoughtful input. MLA could consider this approach for use in other industry projects, particularly where participants may have a technical background.

There are several ways that MLA could leverage the opportunity that this project has created. These include demonstrating how the schemas could be used and incentivising their adoption, and also continuing and extending the technical collaboration to related areas of interest.

Australian red meat producers and supply chains stand to benefit from wider use of animal data in producer-facing tools and decision support models, and in industry databases and analytics, through the more effective transfer of data using these schemas.