Final report

Demonstrating the value of an end-to-end feedback systems for the sheep supply chain [Milestone 4]

Project code: P.PSH.1392

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Abstract

A system that can provide end to end feedback for red meat supply chains has significant benefits to both producers and processors as both key stakeholders can strive to get the "the right animal for the right market". The ability to correlate meat quality with animal characteristics as well as husbandry and farming practices allows for optimisation across the supply chain. The prototype systems in the cattle supply chain have shown significant potential, reduced variability leads to more efficient processing while also yielding better returns for the producer. The shorter life cycle in the sheep supply chain suggest that such a data driven approach can lead to more rapid results and drive optimisation of this sector. The project's objective was to design, implement and pilot a sheep supply chain control tower that would provide actionable insights to all stakeholders.

The project aimed to create two pilots, Binginbar Farms and Clear Creek, which demonstrate how production and processing data can inform decision making along the entire lamb supply chain (farm, feedlot, processor). The purpose of this project is to pilot an end-to-end feedback system in these lamb supply chains using an IoT platform for data capture and predictive analytics.

In this report the outcome of the review of the potential transferability of models and solutions used in the development of the beef end to end feedback system (P.PSH.1392) is presented with a high degree of transferability determined. A detailed process mapping exercise was conducted to document the two supply chains, their existing sensors, data capture, integration with farm management as well as third party systems. The analysis also included an examination of the integration with processor feedback systems including Livestock Data Link. Sustainability and GHG emission sources and measures were also identified and documented in the SCCT mapping system.

The initial partner engagement/ assessment and facilitated adoption phase [i.e. Milestone 1] has been delivered by:

- Review beef supply chain service models & tools potentially transferrable to lamb SC
- SCCT Rapid Assessor across the entire lamb supply chain including assessment of IoT sensors, connectivity and data capture, analyses and management systems
- Analysis of integration with existing SC's Data Platform(s)
- Assessment to include identifying sustainability and GHG emission measures included in the SCCT

After significant participation in the design phase of the Sheep Supply Chain Control Tower, the stakeholder's participation significantly reduced. Labour shortages and other external business factors were the cause. Clear Creek disengaged and Binginbar Farms failed to keep their sheep management systems updated and introduced a new business model raising their own lambs. Insufficient data was available from Binginbar Farm's processor.

Two significant issues were experienced. Firstly, a critical shortage of labour has meant the producer did not have the resources to EiD tag the trade lambs (~10,000). Subsequently, only EiD data was available on the lambs bred on farm instead of all lambs (~5,500). Secondly, the processor is paying ~$1/kg less for lambs than another nearby processor. In addition, the second processor still does not have a functional and fully operational tracking system.

In consultation with Sea Forest, a potential supplier of Red Asparagopsis product, there's a potential very exciting proposition to conduct a commercial scale trial in Binginbar Farms' feedlot with the lambs bred on farm with EiD tags installed to capture all associated data.

Whilst labour issues continue to hinder the progress of further developments of the lamb SCCT, producer(s) remain committed to the project and intend to initially transport a minimum of truckload (approximately 650 lambs) to the processor to get the data required for the project. Once labour issues are resolved for the upcoming seasons, data collection will again become a priority and focus. Also, hook tracking at the processing plant(s) is a critical capability issue to enable on-farm data to be linked to carcase compliance data, including DEXA and IMF scoring as one lamb plant has already achieved.

Overall, the project faced many challenges on the producer-side, which is hindering the ability to capture and process mapping the data, including Binginbar' s introduction of a new business model – raising their own lambs, the post Covid labour shortage and a level of "scepticism" from the processors to participate in data sharing. There was less data than ideal, however it was considered enough available data to prove concept of linking whole of life data, particularly once carcass data can be linked to individual live animal data.

Despite these challenges, Binginbar Farms was committed to the original objectives to proceed, and a decision was made for Hitachi to continue development of the Sheep Control Tower, using simulated data, so that once Binginbar Farms has stabilised their new business model the solution can be evaluated with real data. A budget has been set aside for this evaluation.

While this project faced challenges in accessing specific data both on farm and from the producers the high-level objectives of the project were met. The establishment of an end-to-end feedback system for the sheep supply chain is technically feasible, at enterprise and industry scale. The design has been done and the key functionality demonstrated. The challenges faced in collecting data on farm and establishing collaborative relationships with the processors are not insurmountable. Automating the on-farm data collection, which has been successfully demonstrated in the earlier PFID projects is key to a successful sheep supply chain control tower solution, coupled with managing the expectations of all stakeholders across the supply chain so that both the producer, processor, and end customer benefit.

It is recommended that the outcomes of this project are seen as a proof of concept for a Sheep Control Tower and that the learnings and designs are carried through to a larger scale project. A scaled-up phase 2 project is posed whereby the challenges experienced in this project can be mitigated through adequate resourcing and the end goal is to get several producers and processors to commit to implementing this solution operationally.

Executive summary

Background

A system that can provide end to end feedback for red meat supply chains has significant benefits to both producers and processors as both key stakeholders can strive to get the "the right animal for the right market". The ability to correlate meat quality with animal characteristics as well as husbandry and farming practices allows for optimisation across the supply chain. The prototype systems in the cattle supply chain have shown significant potential, reduced variability leads to more efficient processing while also yielding better returns for the producer. The shorter life cycle in the sheep supply chain suggest that such a data driven approach can lead to more rapid results and drive optimisation of this sector.

Objectives

The objective was to design, implement and pilot a sheep supply chain control tower that would provide actionable insights to all stakeholders.

Methodology

An action design research methodology was applied, engaging the stakeholders in workshops to capture their requirements, and feeding these into the technical design of the control tower through several iterative steps. A rapid prototype was developed using historical data captured from Binginbar and presented via the business intelligence tool Power BI. Once this functionality was accepted by the stakeholders an enterprise level prototype was developed to demonstrate the capability of managing a Sheep Control Tower at scale across the entire industry.

Results/key findings

The outcome of the project to date has been a review of the potential transferability of models and solutions used in the development of the beef end to end feedback system with a high degree of transferability determined. A detailed process mapping exercise was conducted to document the two lamb supply chains, their existing sensors, data capture, integration with farm management, as well as third party systems. The analysis also included an examination of the integration with processor feedback systems including Livestock Data Link. Sustainability and GHG emission sources and measures were also identified and documented in the SCCT mapping system.

The key findings for the project were:

- An enterprise scale sheep control tower, with multi-tenant capability to provide a cost-effective platform across the industry is technically feasible and capable of being deployed in the short term.
- On-farm data capture challenges should be eliminated with automation.
- Program management and ongoing stakeholder management is required, in order to ensure all are aligned.

Due to operational changes in Binginbar's farming practice as well as labour shortages current data could not be obtained from both the producer, as well as the processor. Binginbar Farms remained committed to the original objectives for Hitachi to complete the design and test the application using simulated data. The result is the design of an enterprise capable solution, designed to be hosted by

MLA on its Amazon Web Services and capable of serving the entire industry. The core visualisation capability was demonstrated on the simulation data.

Benefits to industry

The project has proven that the technology is available for the commercial scale deployment of a Sheep Control Tower solution. Such a solution will optimise the sheep supply chain, through providing actionable insights. The sheep industry, due to the shorter animal lifecycle has significant opportunity to optimise the supply chain, per region, per market based on the actionable insights of a Sheep Supply Chain Control Tower.

While this project faced challenges in accessing specific data both on farm and from the producers the high-level objectives of the project were met. The establishment of an end-to-end feedback system for the sheep supply chain is technically feasible, at enterprise and industry scale. The design has been done and the key functionality demonstrated. The challenges faced in collecting data on farm and establishing collaborative relationships with the processors are not insurmountable. Automating the on-farm data collection, which has been successfully demonstrated in the earlier PFID projects is key to a successful sheep supply chain control tower solution, coupled with managing the expectations of all stakeholders across the supply chain so that both the producer, processor, and end customer benefit.

Future research and recommendations

While the technology and design have been proven and are ready to scale in a future project, the on-farm challenges faced during this project indicate that future projects will need to factor in support in the data gathering and automation of data collection as much as possible. Producers face daily labour challenges, especially in the post Covid era, and while very keen to digitise and improve their practices still need to find the time to support such a project.

Hitachi Australia will provide technical support to the lamb supply chains (Binginbar Farms & Clear Creek) to ensure that detailed on farm data requirements are captured. Hitachi Consulting will provide technical services to develop and further refine the platform to integrate existing sheep data captured on farm. Notably, the Digital Agriculture Transformation and Value Chain Efficiency and Information Programs will be supported by Hitachi Vantara's Development service centres. Hitachi Vantara's Global Development Network (GDN) will provide ongoing research support, data integration services and support all data analytics.

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1. Background, scope and purpose

1.1 Background: End-to-end feedback system for red meat producers

Hitachi Australia has partnered with MLA since 2016 to pilot an end-to-end feedback system in vertically integrated beef supply chains using processing intelligence for data capture and predictive analytics. A series of pilots were established across several vertically and/or non-vertically integrated beef supply chains to demonstrate how individual animal data made available through the supply chain can be extracted and analysed to provide feedback and insights to the various stakeholders in the beef supply chain. The overall objective was to provide supply and demand visibility across the supply chain through the development of decision support that achieves "the right animal for the right market at the right time".

The learnings from this beef supply chain work to date have been converted to a Connected Beef Supply Chain Control Tower framework with design principles as the key contribution to the meat and livestock industry. Specifically, this beef supply chain work showed how this information captured can be used for decision support to improve the overall outcomes of the beef supply chain.

The key findings were:

- Fundamental to this process was the identification of individual animal data from breeding, backgrounding, feed lotting, and processing required to provide the necessary insights to achieve the objective.
- Integration of the various systems from farm to processing is achievable at an individual animal level.
- The insights produced from this integration can improve the overall yield, efficiency and ultimately profitability across an integrated beef supply chain.
- The co-created framework for end-to-end feedback across the beef supply chain was operationalised through an IT artifact which proved that a combination of low code user interface development and appropriate use of public cloud infrastructure provides an effective platform for widespread deployment of a Connected Beef Supply Chain Control Tower.

The outcome was that a Connected Beef Supply Chain Tower [or Beef SCCT] can be provided to small, medium, and large businesses cost effectively. The deeper insights provided by the Beef SCCT not only benefit those businesses with integrated beef supply chains they also benefit the individual supply chain partners who run standalone businesses e.g., breeding, or backgrounding farms, feedlots, or processing plants (i.e., via a supply chain sharing approach). A suite of service modules developed from the Beef SCCT are currently being adopted and customised by beef supply chains for day-to-day use.

To evaluate the framework an IT artifact was built using process intelligence and an industrial IoT (Industrial Internet of Things) platform with integration to a variety of systems and sensors. This IT artifact has been designed at industrial scale with multi tenancy capability (i.e., the solution can be used by multiple businesses with complete security of their data, processes, and systems). With industry support this IT artifact can be converted to an operational, subscription as a service, solution for wide adoption. Broader industry engagement has also occurred, both at the technology level as well as overall adoption. Significant industry interest has been received and currently discussions are underway with several businesses.

Supply chain control tower (SCCT) is a solution that combines advanced process and data analytics to support business decisions and accelerate digital transformation. SCCT uses open-source software and

during a series of beef supply chain pilot trials were evaluated using customised SCCT solutions. The initial beef supply chain project evaluated the initial SCCT solution developed for a backgrounding property [i.e. Assessing value chain improvements in processes, practices and technologies using optimised data capture and analytics Phase 1 (i.e. project P.PSH.0815)]. The Beef SCCT solution was further developed in an expanded supply chain project across the entire beef supply chain, including breeding, backgrounding, feed-lotting, and processing (Refer to recently completed project P.PSH.1238). This beef work has demonstrated SCCT digital platform's capability to deliver predictive analytics, decision modelling and decision support capability.

While there are further refinement and enhancements recommended for the next commercial phase of the Beef SCCT, it was identified that opportunity exists for much of the infra-structure, processes, and data applications to be transferable to lamb supply chains. MLA and Hitachi have been on a data use and application journey with segmented lamb supply chains, including Binginbar Farms (a 65,000-lamb breeding and backgrounding enterprise) and Clear Creek (multi-enterprise business comprising of beef and lamb production). Specifically, Binginbar Farms partnered with MLA as one of the early Producer Innovation Fast-Track (PFID) programs on on-farm data acquisition and decision-making tools. Furthermore, Binginbar Farms has automated farm management by developing technologies to monitor troughs, water and pumps, measure pasture growth and provide weather, market, and other paddock management information. There is a unique opportunity to build on existing data platform and data capture work commenced with Hitachi, MLA, and its lamb supply chain partners (including Binginbar Farms and Clear Creek). The project will also build on the foundational on-farm data mapping and analytical work with Binginbar Farms through the Producer Innovation Fast Track Program (PIFT), and evaluate new objective live animal and carcase measurements, plus on-farm sustainability measures, valued by the in-kind participating processor.

There is an opportunity to expand the initial Hitachi work to evaluate existing and novel sensing and data capture devices throughout livestock production systems and evaluate it using SCCT. It further provides a case study of the value of collecting and analysing individual animal data across the lamb supply chain. Initially a 12-month pilot with Binginbar Farms and Clear Creek is proposed as the initial supply chain pilot to integrate existing sheep data captured on farm, which can be extended with technical support provided by Hitachi Australia and Hitachi Vantara. The lamb supply chain connected at individual animal level is illustrated in Figure 1 below.

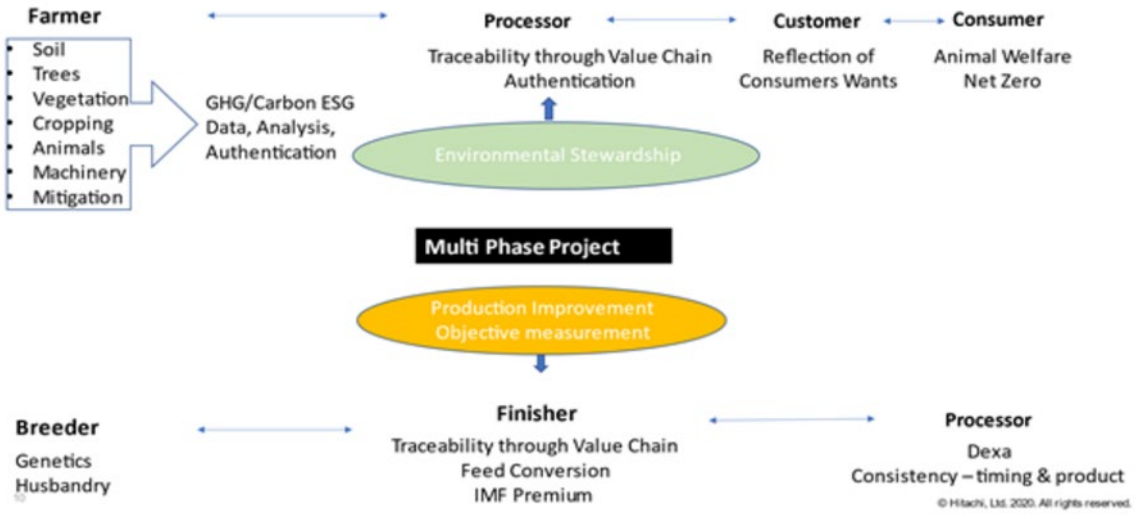


Figure 1: Mapping lamb supply chain.

1.2 Project scope and Binginbar Farms journey to date

Binginbar Farms has already taken steps to set the foundations for their carbon neutral brand. The first step was to develop a digital system for tracking individual animals to provide full provenance.

Working with MLA Donor Company in its Producer Innovation Fast-Track program, Binginbar Farms developed an online platform to record all on-farm animal data for interpretation, analysis, and quality assurance. Data is matched with processing and grading feedback from Thomas Foods to identify ideal performers. In addition, Hitachi has also previously worked with Binginbar Farms to further digitise and automate farm management through developing technologies to monitor troughs, water and pumps, measure pasture growth and provide weather, market, and other paddock management information. The next step was to do a carbon account through MLA's pilot carbon accounting research project for an average year of pasture, crop and meat production for their enterprise. These are the key learnings from the pilot:

i) *Key learning #1* - Maintaining a high level of ground cover is essential for building soil carbon, encouraging biodiversity and maximising carbon sequestration. In consultation with their agronomist, Binginbar Farms aim was to maintain a minimum of 600kg of dry matter per hectare as a baseline.

ii) *Key learning #2* - Pasture needs to be high-quality with good density to maintain high growth rates in animals while improving soil carbon. Binginbar Farms is aiming to maintain a strict rotation of six to 10 years of pasture followed by annual crops for no more than six years before going back into pasture.

Because of the method used by MLA in the pilot carbon accounting workshops (estimating stored carbon from publicly available vegetation datasets in accordance with Australia's National Greenhouse Gas Accounts) trees planted pre-1990 were not included in the Binginbar Farms' carbon account. According to MLA, the use of technologies such as remote sensing and improved modelling of vegetated areas may enable producers to include all stored carbon attributable to their properties in their carbon account in the future.

The future steps to be initiated in part in the current proposed work) in Binginbar Farms' carbon neutral branding strategy, which is Sustainability is key to productive and profitable farming, will involve the following key focus areas:

- Animal performance
- Managing ground cover
- A decade of tree planting

1.3 Project scope

The project aims to create two pilots which demonstrate how production and processing data can inform decision making along the entire lamb supply chain (farm, feedlot, processor). The purpose of this project is to pilot an end-to-end feedback system in lamb supply chains using an IoT platform for data capture and predictive analytics. The learnings from a suite of beef supply chain projects, including Connected Beef Supply Chain Control Tower [SCCT] framework, will be used to leverage and fast track transfer to lamb supply chains. These pilots will demonstrate how individual animal data made available through the supply chain via a data platform and applications can be extracted and analysed to provide feedback and insights to the various stakeholders in the lamb supply chain. The

SCCT digital platform will have predictive analytics, decision modelling and decision support capabilities. The project aims to also show how this information can be used for decision support to improve the overall outcomes of the lamb supply chain. The overall objective is to provide supply and demand visibility across the supply chain through the development of decision support that achieves "the right animal for the right market at the right time".

1.4 Expected Outcomes

The deliverables of the program are:

- Supply chain pilots that demonstrate the value of collecting and sharing individual animal data across the supply chain and providing feedback to all stakeholders in the supply chain
- Develop a platform and data sharing capabilities for supply chains
- A cloud-based solution that is configured from SCCT and used to manage a vertical integrated red meat supply chain business's transformation process
- Integration with ISC's data platform and Livestock Data Link
- Performance Management with Data Analytics, where the key data is identified by SCCT and is displayed on a Control Centre with trending and analytics
- Process compliance checking and process mining. SCCT is configured to automatically check compliance of critical processes using specialised Process Intelligence software
- Decision Modelling. SCCT is configured to automatically provide Decision Support for critical processes using specialised Decision Modelling software
- Workflow Management. SCCT is configured to manage the workflow of key processes using specialised Workflow Management software

The intention is to develop the supply chain improvement system where companies including Binginbar Farms, Clear Creek or other lamb supply chains can further customise for their specific supply chain priorities. The project will be used to develop a case study that can be made publicly available to demonstrate the value of data and supply chains using emerging technologies to make real time business decisions and strengthen and improve the red meat integrity system.

Hitachi Australia will provide technical support to the lamb supply chains (Binginbar Farms & Clear Creek) to ensure that detailed on farm data requirements are captured. Hitachi Consulting will provide technical services to develop and further refine the platform to integrate existing sheep data captured on farm. Notably, the Digital Agriculture Transformation and Value Chain Efficiency and Information Programs will be supported by Hitachi Vantara's Development service centres. Hitachi Vantara's Global Development Network (GDN) will provide ongoing research support, data integration services and support all data analytics.

2. Objectives

The project aims to create two pilots which demonstrate how production and processing data can inform decision making along the entire lamb supply chain (farm, feedlot, processor). The purpose of this project is to pilot an end-to-end feedback system in lamb supply chains using an IoT platform for data capture and predictive analytics. The learnings from a suite of beef supply chain projects, including Connected Beef Supply Chain Control Tower [SCCT] framework, will be used to leverage and fast track transfer to lamb supply chains. These pilots will demonstrate how individual animal data made available through the supply chain via a data platform and applications can be extracted and analysed to provide feedback and insights to the various stakeholders in the lamb supply chain. The SCCT digital platform will have predictive analytics, decision modelling and decision support

capabilities. The project aims to also show how this information can be used for decision support to improve the overall outcomes of the lamb supply chain. The overall objective is to provide supply and demand visibility across the supply chain through the development of decision support that achieves "the right animal for the right market at the right time".

The overall objective of the project is to pilot an end-to-end feedback system in two different lamb supply chains using processing intelligence (i.e. SCCT) for data capture and predictive analytics. The learnings from a suite beef supply chain projects will be used to leverage and help fast track transfer to lamb supply chains to integrate existing sheep data captured on farm.

The specific objectives of the project are to:

- Develop and deliver a data management and analytics solution using SCCT to connect a lamb supply chain and integrate existing sheep data captured on farm
- Define the various processes, technologies and required metrics at best practice levels
- Evaluate a suite of supply chain scenarios starting with two large vertically integrated lamb enterprises (Binginbar Farms & Clear Creek)
- Measure and predict business improvements and profitability across breeding, backgrounding, and finishing for Binginbar Farms & Clear Creek lamb supply chains to forecast more profitable business outcomes.
- Demonstrate trial data sharing up & down supply chain between the breeder, finisher, and processor to create value
- Develop data sharing systems for value propositions for processor(s) and sheep industry, including LMY, IMF, EQA traits, animal disease health status and/or sustainability credentials
- Create data MVP platform
- Validate producer testing of environmental IoT, Data ingestion, authentication and auditing
- Identify key data metrics for producers to calculate baseline data to facilitate sustainability accounting

3. Methodology

The following methodology was applied:

- Partner engagement and assessment [Stage 1]
- Co Creation with Supply Chain Partners [Stage 2]
- Facilitated adoption and enterprise level visualisation [Stage 3]
- Final report and deliverables [Stage 4]

3.1 Partner engagement and assessment [Stage 1]

Rapid assessment of lamb supply chains (Binginbar Farms & Clear Creek) using Hitachi Vantara's agribusiness tools and analytics as conducted. The feasibility of implementing new data capture on-farm options in selected lamb production supply chain, including breeding, backgrounding, and finishing (through processing) was reviewed. A rapid assessment was undertaken across the segmented supply chains (Binginbar Farms & Clear Creek) using Hitachi Process Intelligence Rapid Assessor. Assessment of existing data capture, analyses and management systems currently being utilised by lamb on-farm and processing enterprise was carried out.

Partner engagement/ assessment /and mapping of beef work to assist with lamb facilitated adoption delivered:

- Assessment across the entire supply chain to be conducted using SCCT Rapid Assessor. Assessment of existing IoT sensors, connectivity and data capture, analyses and management systems applied across i) Binginbar Farms and ii) Clear Creek supply chains.
- Analysis of preliminary breeding, backgrounding, finishing and processor carcass data
- Identification of the value of industry data and the opportunities of efficient integration of ISC's data platform
- Demonstrated SCCT Advanced Process Data Analytics, Prediction and Decision Support, Conformance checking across supply chain for farms, finishing operations and processor
- Demonstrated SCCT Advanced Process Data Analytics, Prediction and Decision Support, Conformance Checking across supply chain for farms
- SCCT Assessor deployed across the entire lamb supply chain including assessment of IoT sensors, connectivity and data capture, analyses, and management systems
- Assessment included identifying sustainability and GHG emission measures that could be included in the SCCT.

The project involved the following phases:

i) Review beef supply chain service models and tools that are potentially transferrable to lamb supply chains
ii) Identify gaps on stations on existing capabilities and capacities in data capture and management addressed
iii) Describes value chain pilot exercise for data capture, analyses and management
iv) Identifies transformation and facilitated adoption across Value Chain Presentation/s and update to respective red meat company (Binginbar Farms & Clear Creek)
v) Identifies sustainability and GHG emission measures that could be included in the SCCT

3.2 Co Creation with Supply Chain Partners [Stage 2]

Analyses of preliminary farm, feedlot, and processing data. Detailed Supply Chain analysis and configurations. Assessed all functionality of data capture and analytics. Designed and built initial SCCT Control Centres from preliminary analyses. Analysed preliminary on-farm data. Assessed functionality of data capture and analytics. Detailed Supply Chain mapping and configurations. Designed and built initial SCCT Control Centres, leveraged from beef analyses.

At the conclusion of co-creation phase was a stage gate review by the project steering group with a critical decision point. The examination of overall productivity and profitability during a period of extended technical support will use Hitachi's SCCT big data analytics platform to provide meaningful project insights. The consulting team will compile a report with project findings that will then be shared with project working group. The working group and consulting team reviewed the findings and approve draft report on productivity and profitability during the period of Hitachi Consulting's extended technical support.

3.3 Facilitated adoption and enterprise level visualisation [Stage 3]

Aligned performance measures across the supply chain. Develop SCCT Decision Support models to optimise the supply chains (Binginbar Farms & Clear Creek). Hitachi Vantara generated the visualisation of the operations monitor by taking the system requirements and creating a Control Centre display for all functions. In addition, Hitachi Vantara will perform next-level analysis for advanced decision support of operations. This will provide the algorithms needed to further the advancement of decision support functionality for key decisions. With the complete development of functionality, the dashboard will be linked to on-farm data collection points and decision support functionality with advanced data analytics. The outcome of integration will encompass lamb supply chain requirements. A financial benefit analysis was performed in concurrence with the system implementation analysis.

3.4 Final report and deliverables [Stage 4]

Final project reviewed with associated groups compiled and analysed, areas covered included:

- Partner engagement and assessment
- Co-Creation with Supply Chain Partners
- Transformation and facilitated adoption
- Enterprise level visualisation
- Initial report generation and approval
- Data statement and results
- Financial analysis and project benefit rationale

Final report drafted and finalised with all collaborators and submitted to MLA. Confidential company report delivered to business owners of the selected lamb supply chains. Provide a presentation on project findings and outcomes to respective companies (Binginbar Farms & Clear Creek) and MLA. Industry report was approved by project steering group to be disseminated to wider industry.

4. Results and findings

4.1 Partner Engagement and Facilitated Adoption

The specific activities for Milestone 1, includes:

i) Review beef supply chain service models and tools that are potentially transferrable to lamb supply chains
ii) Identify gaps on stations on existing capabilities and capacities in data capture and management addressed
iii) Describes value chain pilot exercise for data capture, analyses, and management
iv) Identifies transformation and facilitated adoption across Value Chain Presentation/s and update to respective red meat company (Binginbar Farms & Clear Creek)
v) Identifies sustainability and GHG emission measures that could be included in the SCCT

4.1.1 Supply Chain Mapping

The lamb supply chain mapping exercises were conducted across both lamb supply chains (Binginbar Farms & Clear Creek). [Refer to Figure 2].

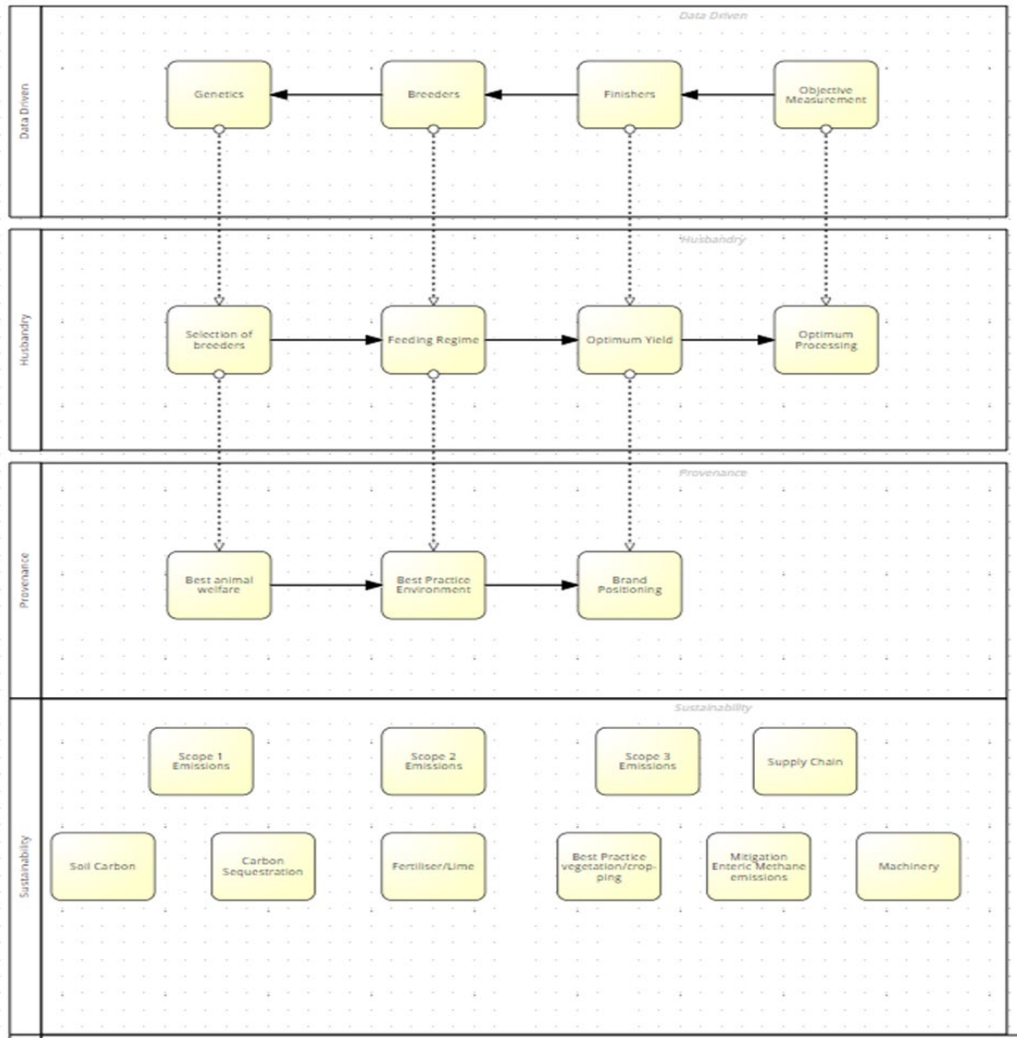


Figure 2: Level Process Approach.

4.1.2 Binginbar Farms and Clear Creek Discovery Workshop Notes

Discovery workshops were conducted with both lamb supply chains (Binginbar Farms & Clear Creek) and the notes captured on their on-farm data capture priorities. The initial pre-project workshop between Hitachi, MLA & lamb supply chains (on 23 March 2022) identified key priority on-farm data capture points. A farm visit was conducted at Binginbar on the 23 August 2022 to discuss the measurement and mitigation of GHG emissions. Dr Nigel Tomkins, from Seaforest, a producer of asparagopsis that is currently being proven to mitigate methane emissions in sheep, accompanied Hitachi to provide expert advice on the addition of asparagopsis to sheep in the Binginbar feedlot system.

The Hitachi Team has been in regular communication with the producers discussing data requirements. See decomposition of the process layers and data layers in Figures 3 to 7 below. [Refer to Appendix, Section 7.1].

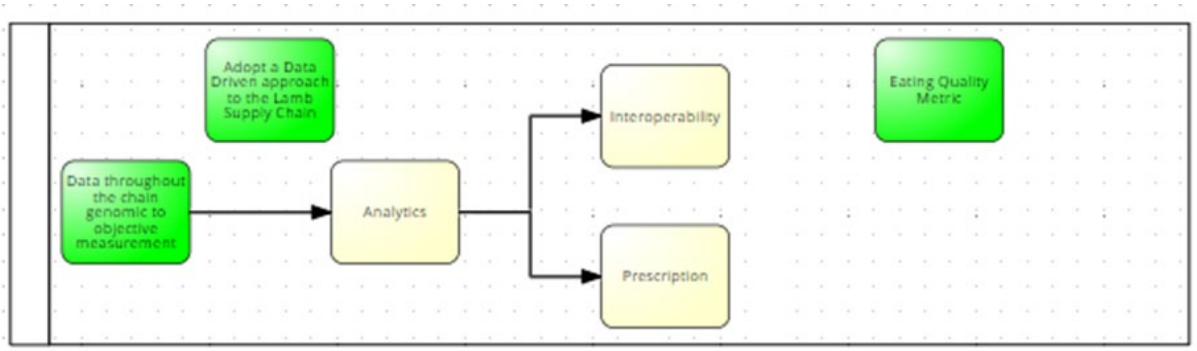


Figure 2: Required Analytics.

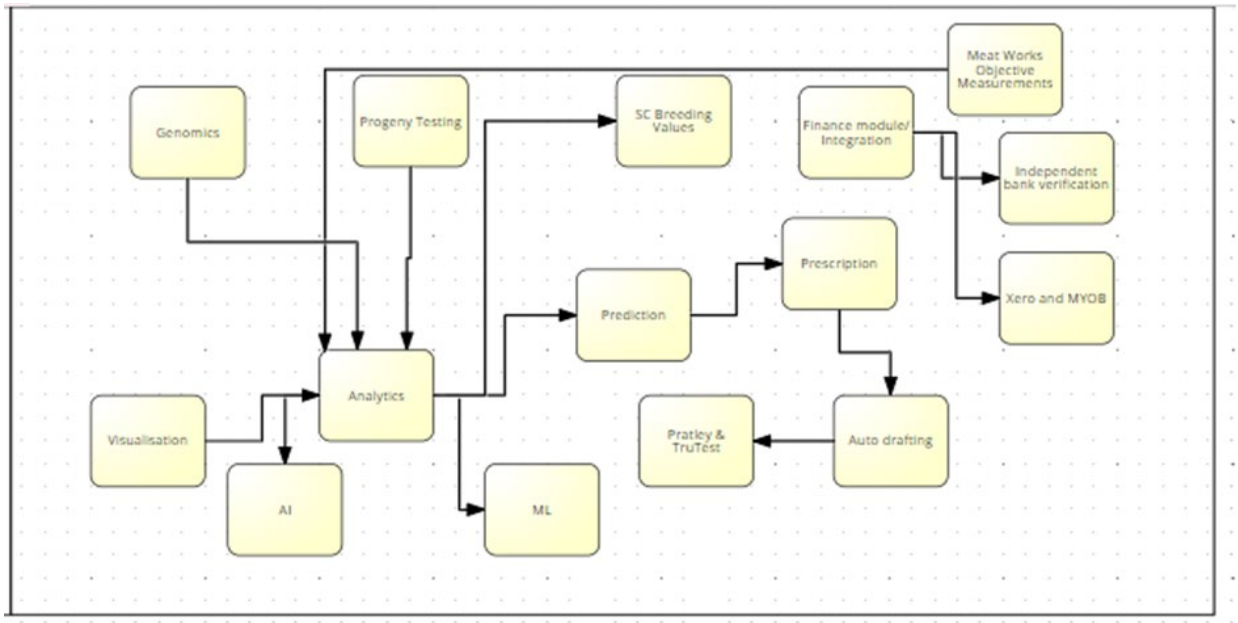


Figure 3: Required Analytics Level 2.

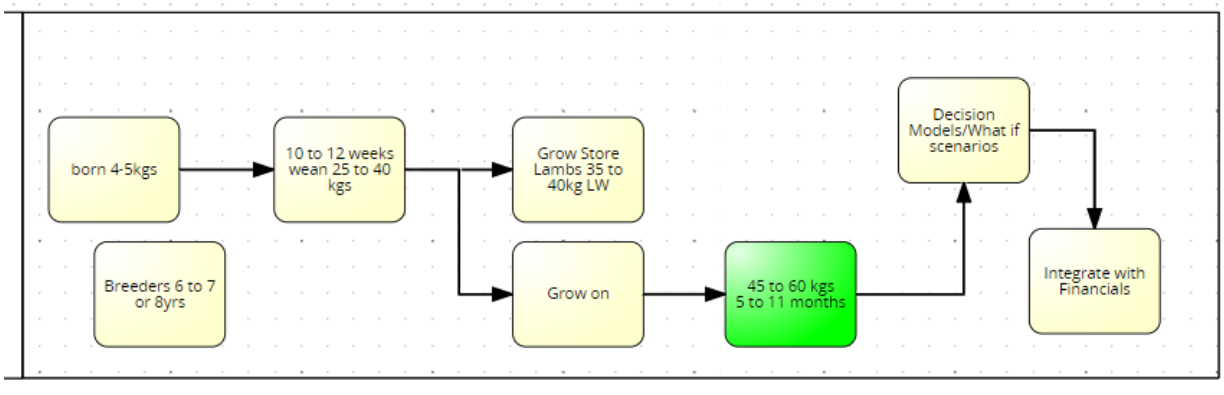


Figure 4: Lamb data capture requirements.

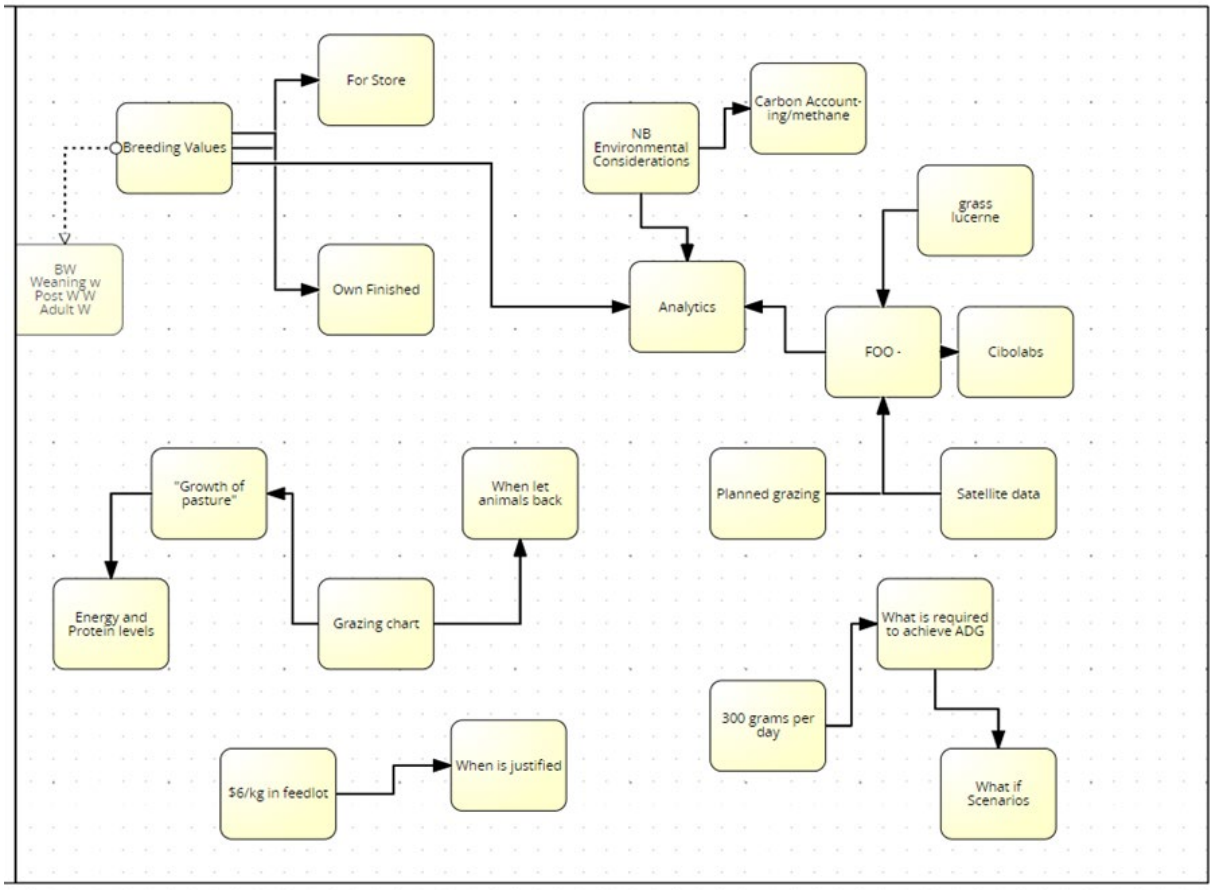


Figure 5: User Interface requirements.

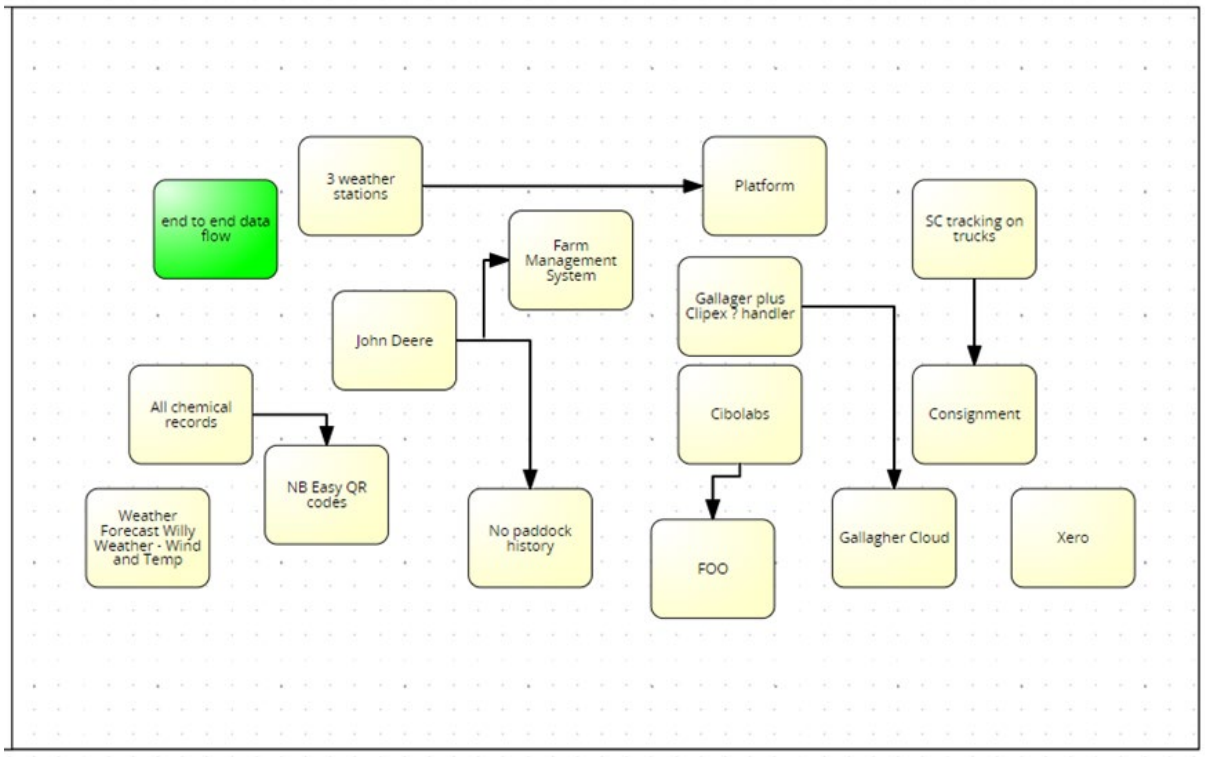


Figure 6: External system integration requirements.

4.1.3. Workshop notes comparing Beef SCCT for potential transferability to Sheep SCCT

Workshop notes were documented comparing Beef SCCT for potential transferability to Sheep SCCT, and shown in Figure 8.

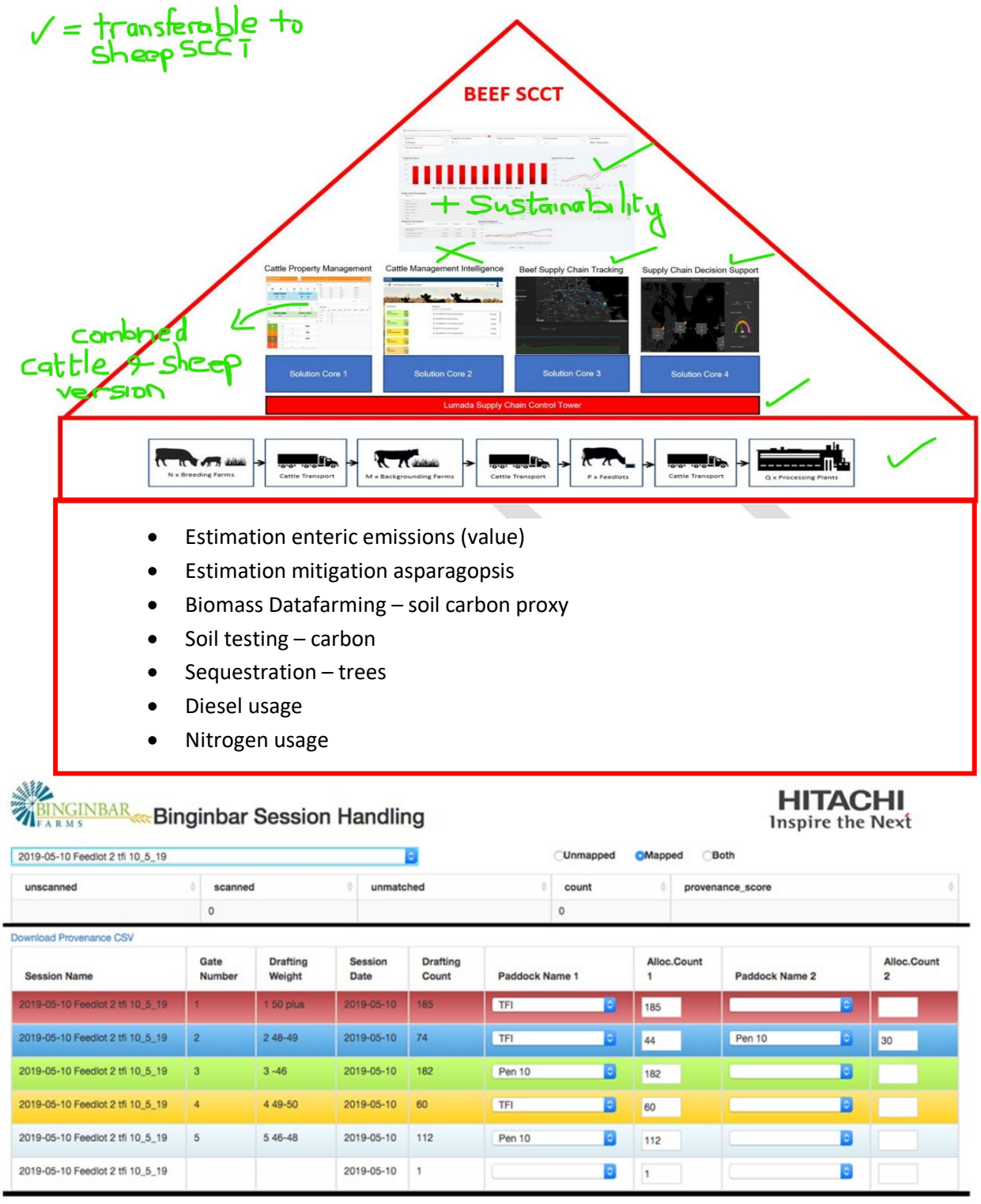


Figure 7: Historical data available from Binginbar Farms.

The proposed high level scope and timeline is detailed in Figure 9.

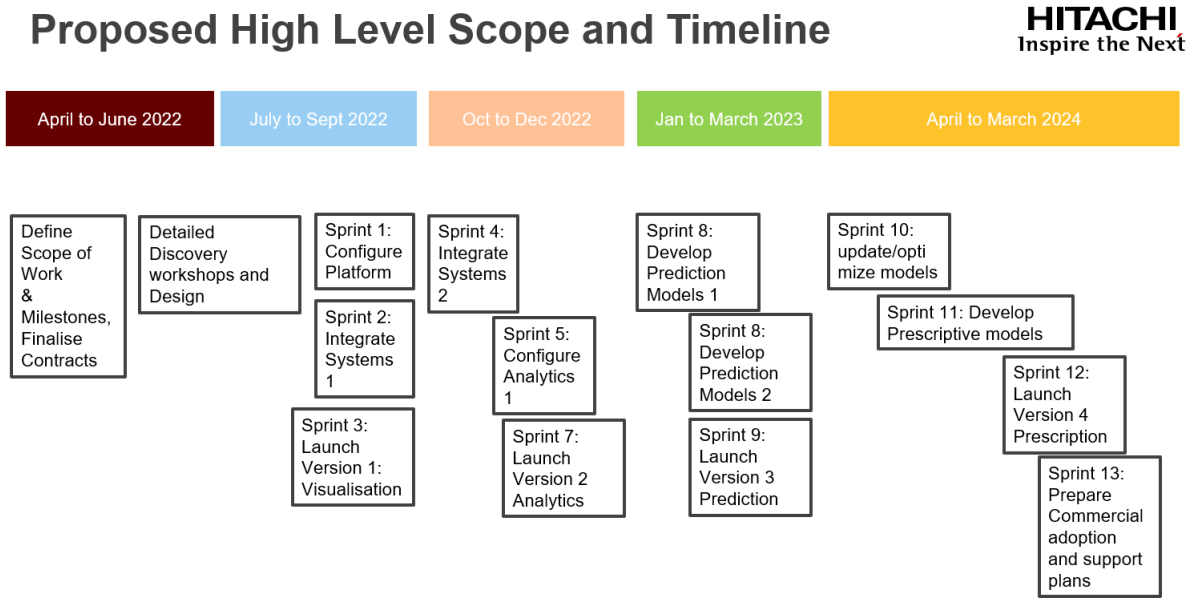


Figure 9: Proposed high level scope and timeline.

4.2 Co Creation with Supply Chain Partners [Milestone 2]

Co-creation with supply chain partners required the following assessment stages, including:

- Analyses of preliminary on-farm, feedlot and processing data
- Detailed Supply Chain analysis and configurations
- Assess all functionality of data capture and analytics
- Design and build initial SCCT Control Centres from preliminary analyses
- Analyses of preliminary on-farm data
- Analysis of captured sustainability and GHG Emission data
- Assess functionality of data capture and analytics
- Detailed Supply Chain mapping and configurations

The below summary outlines the key activities undertaken as well as describe the supply chain pilot exercise for data capture, analyses and management.

4.2.1. Analyses of preliminary on-farm, feedlot and processing data

Analyses of preliminary data was undertaken on supply chain data captured on-farm, feedlot and processing. As highlighted in the Executive Summary a deep dive into the data availability and data quality from the producers revealed a gap. As shown in the screenshot of Binginbar Farms Gallagher APS (see Figure 10) the last entry was 23 November 2021.

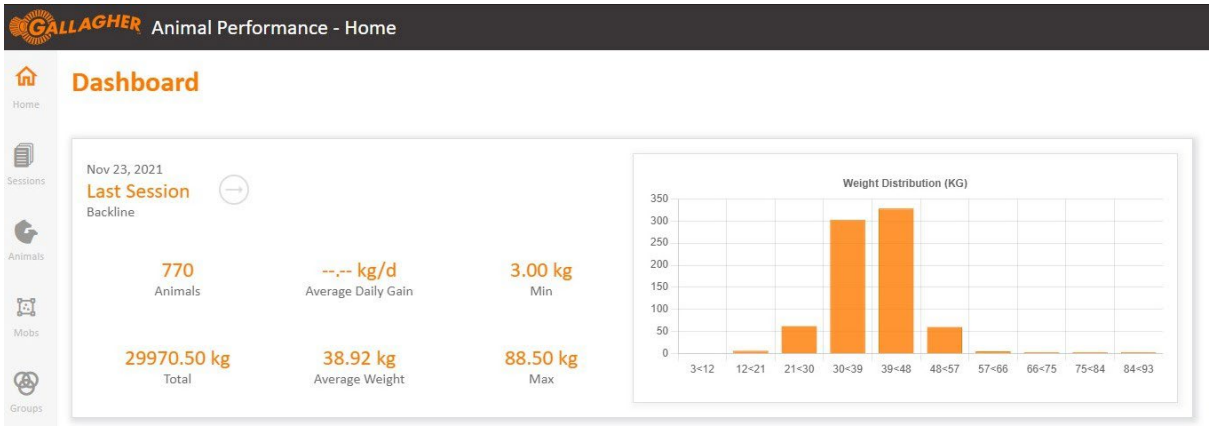


Figure 10: Binginbar Farms Animal Performance Management System.

In addition, the Smart Farming system at Binginbar has been disconnected. Data from the weather station as well as soil moisture sensors and the Cibolabs available biomass data from the paddocks is therefore not available.

To rectify this gap, in consultation with the producers the following action has been undertaken.

1. Binginbar Farms has updated their Gallagher APS and committed to keeping it updated.
2. Hitachi has engaged in discussions with Gallagher to establish an API to directly ingest data to the Sheep SCCT.
3. (During Milestone 3) Two additional workshops were scheduled with the producers to implement processes that will ensure the ongoing maintenance of the key data collection systems.

An example of carcase performance analysed against a customised grid based on individual market specifications. [Refer to Figure 11]. The following data will be ingested to the platform:

Figure 8: The LDL data to be ingested into the Sheep Control Tower via API.

The compliance data obtained from LDL at an individual animal level will be correlated with the individual on farm animal data. While the additional sensor data (weather, soil moisture and satellite – biomass) provide value information this data is not essential to the core requirements of the Sheep SCCT. It is recommended that integration of these sensors occurs in a subsequent project.

4.2.2 Detailed Supply Chain analysis and configurations

The study will follow 4,500 high breeding index ewes and a subset – likely 600 of the (3,000-3,750 Ram and selected Ewe lambs) from 5,625 (individually RFID tagged and weighed) marked lambs through to slaughter by DEXA/hook tracking enabled Gundagai Meat Processors (GMP). The resulting Intramuscular Fat (IMF), lean meat yield and fat score measurements will be analysed against the individual animal's genetics and live weight gain. These data will then be shared back with the Ewe breeders to improve future selection for IMF and other key objective measures.

4.2.3 Assess all functionality of data capture and analytics

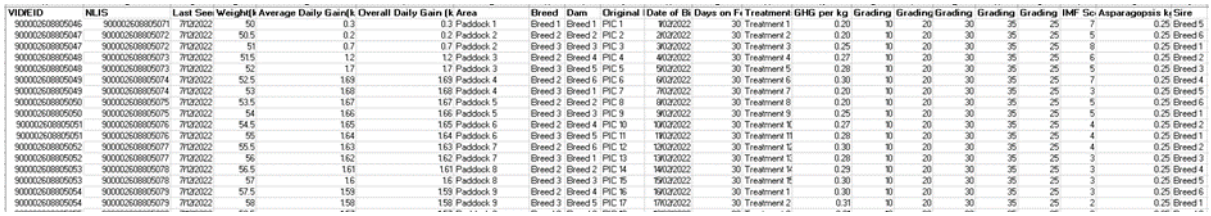
Collected data includes:

- Marking weight
- Weaning weight
- Sex
- Breed
- Animal health treatments
- Timed Lamb weights
    - o Inferred grow rates
    - o Inferred GHG number by lamb

- Intramuscular Fat
- Lean Meat Yield
- Fat Score

4.2.4. Design and build of initial Sheep SCCT Control Tower from preliminary analysis

Due to the lack of data available from the Gallagher APS, the initial configuration has been based on synthetic data (ex-ante). This configuration was updated with the actual producer data once the appropriately cleansed and uploaded by the producer. The initial database construct is shown below (historical and simulated data, see Figure 12):



VIDEID	NLIS	Last Seen Weight(k	Average Daily Gain(k	Overall Daily Gain (k	Area	Breed	Dam	Original	Date of Bi	Days on Fe	Treatment	GHG per kg	Grading	Grading	Grading	Grading	Grading	IMF Sc	Asparagopsis k	Sire
900002608805046	900002608805071	7/12/2022	50	0.3	0.3 Paddock 1	Breed 1	Breed 1	PIC 1	1/02/2022	30	Treatment 1	0.20	10	20	30	35	25	7	0.25	Breed 5
900002608805047	900002608805072	7/12/2022	50.5	0.2	0.2 Paddock 2	Breed 2	Breed 2	PIC 2	2/02/2022	30	Treatment 2	0.20	10	20	30	35	25	5	0.25	Breed 6
900002608805047	900002608805072	7/12/2022	51	0.7	0.7 Paddock 2	Breed 3	Breed 3	PIC 3	3/02/2022	30	Treatment 3	0.25	10	20	30	35	25	8	0.25	Breed 1
900002608805048	900002608805073	7/12/2022	51.5	1.2	1.2 Paddock 3	Breed 2	Breed 4	PIC 4	4/02/2022	30	Treatment 4	0.27	10	20	30	35	25	6	0.25	Breed 2
900002608805048	900002608805073	7/12/2022	52	1.7	1.7 Paddock 3	Breed 3	Breed 5	PIC 5	5/02/2022	30	Treatment 5	0.28	10	20	30	35	25	5	0.25	Breed 3
900002608805049	900002608805074	7/12/2022	52.5	169	169 Paddock 4	Breed 2	Breed 6	PIC 6	6/02/2022	30	Treatment 6	0.30	10	20	30	35	25	7	0.25	Breed 4
900002608805049	900002608805074	7/12/2022	53	168	168 Paddock 4	Breed 3	Breed 1	PIC 7	7/02/2022	30	Treatment 7	0.20	10	20	30	35	25	3	0.25	Breed 5
900002608805050	900002608805075	7/12/2022	53.5	167	167 Paddock 5	Breed 2	Breed 2	PIC 8	8/02/2022	30	Treatment 8	0.20	10	20	30	35	25	5	0.25	Breed 6
900002608805050	900002608805075	7/12/2022	54	166	166 Paddock 5	Breed 3	Breed 3	PIC 9	9/02/2022	30	Treatment 9	0.25	10	20	30	35	25	5	0.25	Breed 1
900002608805051	900002608805076	7/12/2022	54.5	165	165 Paddock 6	Breed 2	Breed 4	PIC 10	10/02/2022	30	Treatment 10	0.27	10	20	30	35	25	4	0.25	Breed 2
900002608805051	900002608805076	7/12/2022	55	164	164 Paddock 6	Breed 3	Breed 5	PIC 11	11/02/2022	30	Treatment 11	0.28	10	20	30	35	25	4	0.25	Breed 1
900002608805052	900002608805077	7/12/2022	55.5	163	163 Paddock 7	Breed 2	Breed 6	PIC 12	12/02/2022	30	Treatment 12	0.30	10	20	30	35	25	4	0.25	Breed 2
900002608805052	900002608805077	7/12/2022	56	162	162 Paddock 7	Breed 3	Breed 1	PIC 13	13/02/2022	30	Treatment 13	0.28	10	20	30	35	25	3	0.25	Breed 3
900002608805053	900002608805078	7/12/2022	56.5	161	161 Paddock 8	Breed 2	Breed 2	PIC 14	14/02/2022	30	Treatment 14	0.29	10	20	30	35	25	3	0.25	Breed 4
900002608805053	900002608805078	7/12/2022	57	16	16 Paddock 8	Breed 3	Breed 3	PIC 15	15/02/2022	30	Treatment 15	0.30	10	20	30	35	25	3	0.25	Breed 5
900002608805054	900002608805079	7/12/2022	57.5	158	158 Paddock 9	Breed 2	Breed 4	PIC 16	16/02/2022	30	Treatment 1	0.30	10	20	30	35	25	3	0.25	Breed 6
900002608805054	900002608805079	7/12/2022	58	158	158 Paddock 9	Breed 3	Breed 5	PIC 17	17/02/2022	30	Treatment 2	0.31	10	20	30	35	25	2	0.25	Breed 1

Figure 9: Database table design using historical and simulated data.

From this initial database design, the following live dashboards were created which will be expanded upon and detailed with the LDL data and more accurate producer data. The below rapid prototype was created using the business intelligence tool, Power BI. Data from the above database. This demonstrated the capability to present the Sheep Control Tower data in various forms with underlying data transformation. The initial prototype was to demonstrate functionality only with the overall intent to produce an enterprise level solution this concept was then moved to an enterprise scale platform. [Refer to Figures 13 and 14].

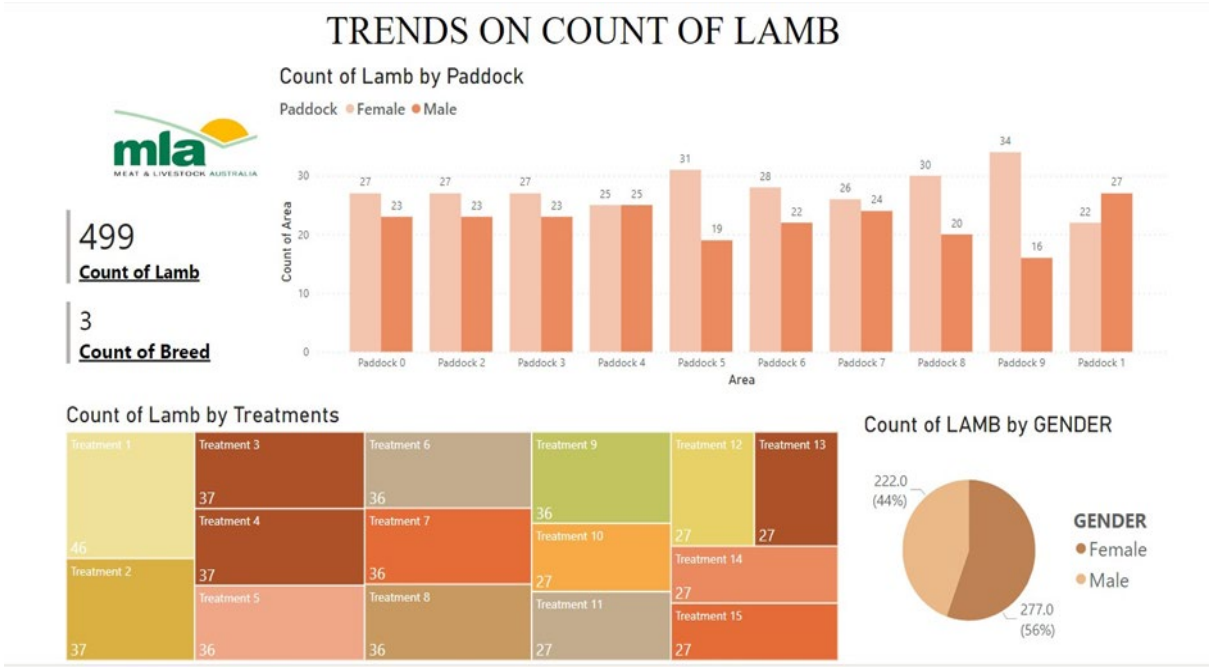


Figure 10: Demonstrating the visualisation potential by connecting Power BI to the database 1.

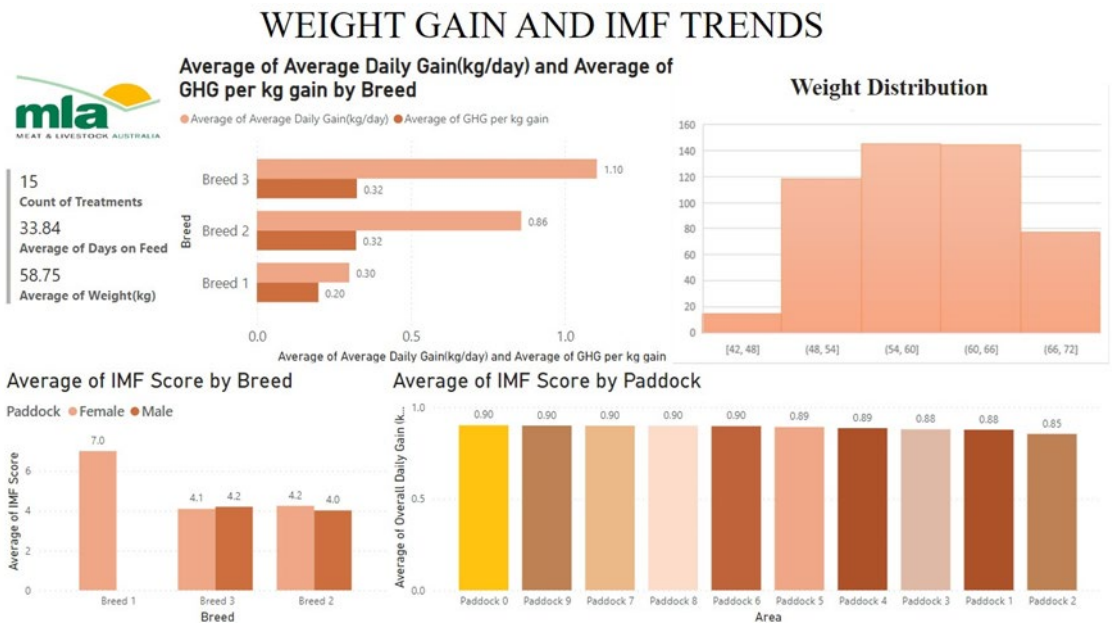


Figure 11: Demonstrating the potential by connecting Power BI to the database 2.

4.2.5 Analyses of preliminary on-farm data

Two key data sets were required from both Binginbar Farms and Clearwater Farms:

- Marking weights, breeds and sex of terminal lambs
- Genetic data of Dams

Once these data was received the application was linked to the individual lamb and its marking, weaning and subsequent weights (weight gain, terminal weight, IMF, LMY, Fat score and estimated GHG emissions) back to its Dam and its genetics. Data was shared with the Ewe breeder. The processor was intended to be engaged and consulted with respect target lamb weight and IMF lines over and above the processor grid. Note due to delays in collecting data from the producers, processor engagement had been deferred.

Additionally, the processor could, if it chooses, make a claim of reduced GHG emissions by the lamb included in the above data set.

4.2.6. Analysis of captured sustainability and GHG Emission data

From the data proposed to be captured, a GHG estimation can be made. Data can be attached to the RFID tagged animal and reported to the processor. The proposition is that the processor can track individual animals through the boning room and if they wish, attribute a reduced GHG claim to particular cuts. Dr Nigel Tomkins committed to providing a GHG curve for lambs.

A template for modelling a sustainability concept for lamb supply chains was based on the review of previous successfully executed case studies, including:

i) Sustainability Smart Horticulture Farming in the Great Barrier Reef Catchment Area [Case study #1 (see Figure 15)].
ii) An environmental management review of Bartle Frere bananas [Case study #2 (See Figure 16)]

Figure 15: Sustainability concept for lamb SCs based on previous case studies (Case study#1)

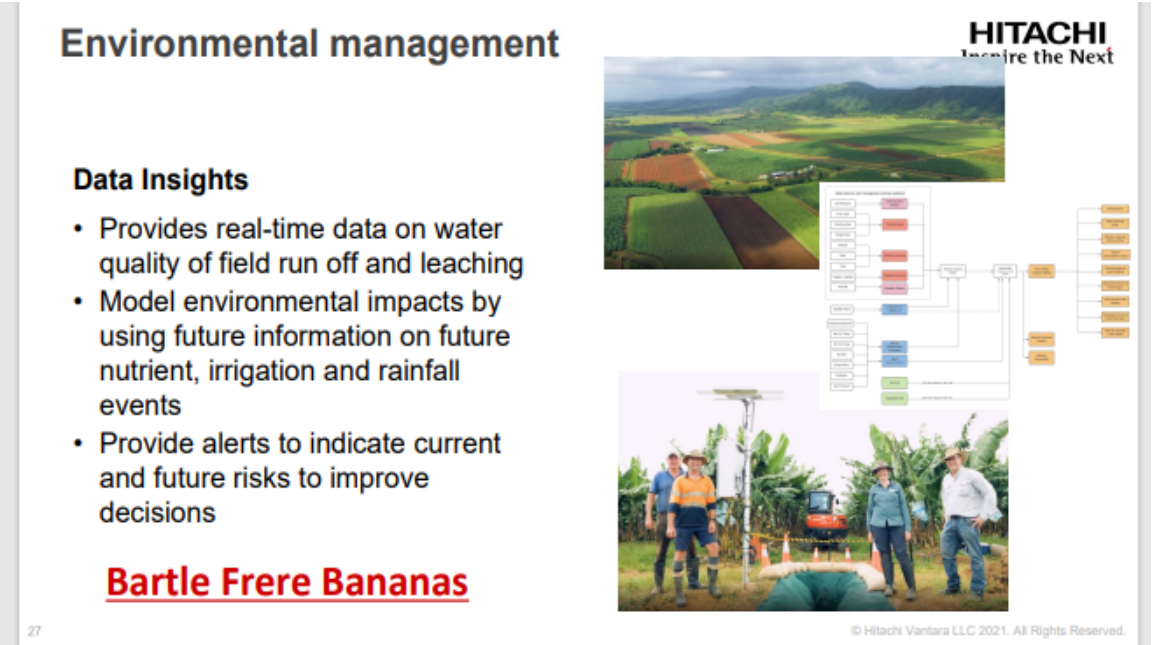


Figure 16: Sustainability concept for lamb SCs based on previous case studies (Case study#2)

Concept sustainability dashboards were created from the successfully demonstrated dashboards. (Refer to Figure 17).

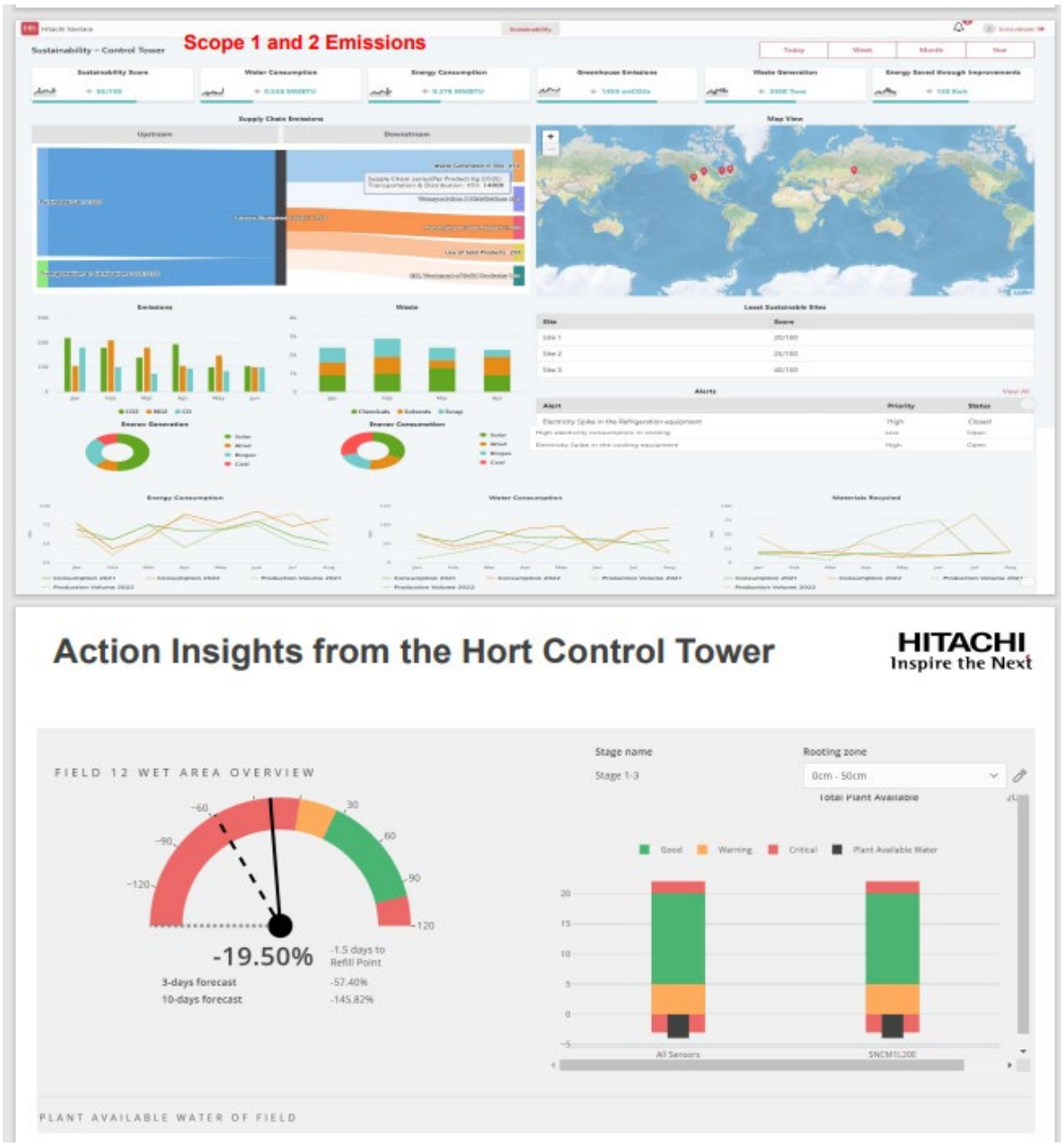


Figure 17: Concept sustainability dashboards created from successful case studies.

4.2.7 Assess functionality of data capture and analytics

A key output of the data ingestion, analysis, reporting and adoption is to reduce the days to slaughter. Lambs of the target weight and IMF (not overfat) will have created materially less GHG than the average. This delta will increase in a compounding manner overtime as breeders select for growth

rate, IMF score and other objective measurement traits. Additional progress will occur as finishes use the insights gathered on feeding and other husbandry levers to improve growth rates.

Once the combined data sets have been ingested and analysed, the project plans to add Asparagopsis to the lamb feed ration and calculate the reduction in GHG emissions.

i) Tools to estimate GHG emissions

The project will use the MLA sheep greenhouse gas accounting (S-GAF) tool which has been combined with the Beef GHG accounting into one tool, the SB-GAF.

ii) Project asparagopsis trial as part of Carbon accounting

The trial followed on from the findings of Dr Nigel Tomkins et el. where sheep were offered a high-fibre pelleted diet (offered at 1.2 · maintenance) at five inclusion levels of Asparagopsis for 72 days (0% (control), 0.5%, 1%, 2% and 3% organic matter basis as offered). Individual animal CH4 measurements were conducted at 21-day intervals using open-circuit respiration chambers. Asparagopsis inclusion resulted in a consistent and dose-dependent reduction in enteric CH4 production over time, with up to 80% CH4 mitigation at the 3% offered rate compared with the group fed no Asparagopsis($P < 0.05$). Sheep fed Asparagopsis had a significantly lower concentration of total volatile fatty acids and acetate, but a higher propionate concentration. No changes in liveweight gain were identified.

The Seaforest Asparagopsis trial is very encouraging as we are independently work on a pilot with Seaforest to completely track their product from marine and/or land cultivation area to farm and will be able to provide this right through to Binginbar as well.

It is envisaged that Hitachi is able to link this additional supply chain tracking component to the Sheep SCCT.

4.2.8 Detailed Supply Chain mapping and configurations

Hitachi in consultation with MLA and the producers have decided to expedite the configuration of the Sheep SCCT. It was also decided that the supply chain has already been defined in sufficient detail in Milestone 1, and that the discovery of certain data quality issues as describes requires a deeper focus on the key capture of animal data. The activity of cleansing of animal data and ensuring processes are in place for the accurate uploading of animal data has taken the place of this sub milestone.

There have been challenges experienced in the project with re-focused priorities of producer(s). Specifically, Binginbar Farms decided to move from a largely trading based feedlot proposition to buying in ~5,000 breeding ewes. The proposition was to individually EiD tag all trade lambs as well as the resultant lambs and sell them through the processor thereby getting the grow rate and objective measurement data required for the project.

Two significant issues were experienced. Firstly, a critical shortage of labour has meant the producer did not have the resources to EiD tag the trade lambs (~10,000). Subsequently, only EiD data was available on the lambs bred on farm instead of all lambs (~5,500). Secondly, the processor is paying ~$1/kg less for lambs than another nearby processor. In addition, the second processor still does not have a functional and fully operational tracking system.

In consultation with Sea Forest, a potential supplier of Red Asparagopsis product, there's a potential very exciting proposition to conduct a commercial scale trial in Binginbar Farms' feedlot with the lambs bred on farm with EiD tags installed to capture all associated data.

Whilst labour issues continue to hinder the progress of further developments of the lamb SCCT, producer(s) remain committed to the project and intend to initially transport a minimum of truckload (approximately 650 lambs) to the processor to get the data required for the project. Once labour issues are resolved for the upcoming seasons, data collection will again become a priority and focus. Also, hook tracking at the processing plant(s) is a critical capability issue to enable on-farm data to be linked to carcase compliance data, including DEXA and IMF scoring as one lamb plant has already achieved.

Overall, the project faced many challenges on the producer-side, which is hindering the ability to capture and process mapping the data, including Binginbar' s introduction of a new business model – raising their own lambs, the post Covid labour shortage and a level of "scepticism" from the processors to participate in data sharing. There was less data than ideal, however it was considered enough available data to prove concept of linking whole of life data, particularly once carcass data can be linked to individual live animal data.

4.3 Facilitated adoption and enterprise level visualisation [Milestone 3]

Facilitated adoption and enterprise level visualisation, including design architecture for operational and enterprise level visualisation monitor for operations.

4.3.1. Designing architecture for operational and enterprise level visualisation

iii) Selecting the Cloud Platform

In designing the enterprise level platform Hitachi has considered the fact that Meat and Livestock Australia have selected Amazon Web Services (AWS) as the preferred cloud provider and have therefore design the application to run on AWS. It is cost effective for MLA to host this solution, which has been designed as a multi-tenant application as MLA members could log onto the application via myMLA, allowing for single sign on and efficient onboarding of new users. This approach also ensures that more effective cyber security protocols can be applied through MLA's cyber security protocols and a managed service can be supplied by Hitachi focusing only on the Sheep SCCT application, reducing overall managed service cost.

iv) Solution Architecture

The enterprise level solution architecture is presented below, optimising the use of native AWS services while containerising the Sheep SCCT application. In Figure 18 below MFI refers to Hitachi's Manufacturing Insights which is core layer driving our applications.

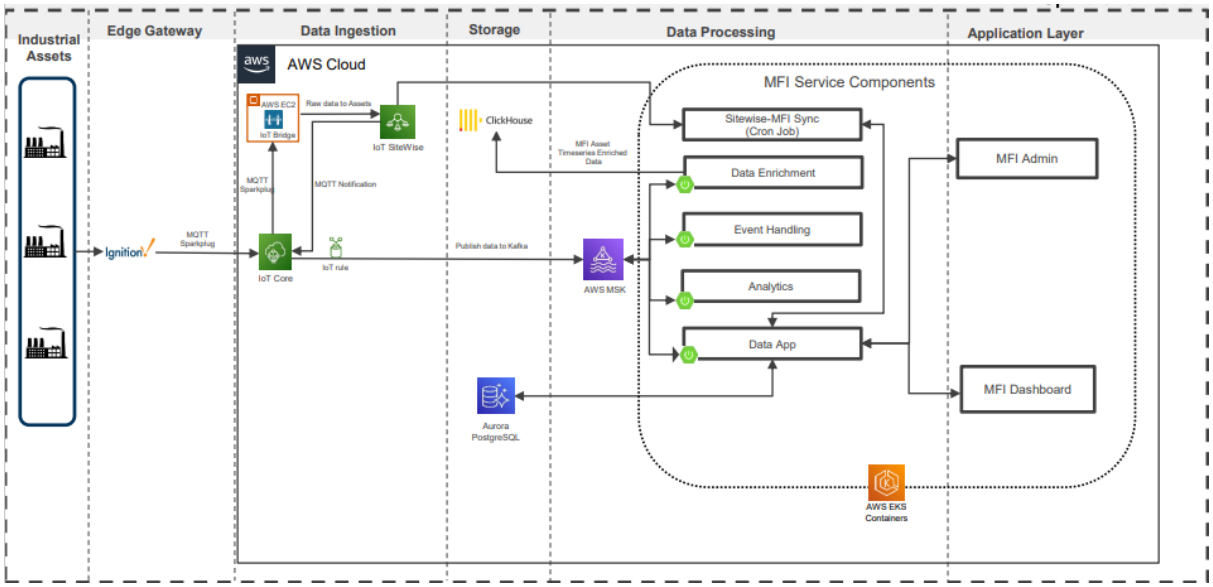


Figure 12: Designing an enterprise scale Sheep SCCT for hosting on MLA's AWS cloud.

Within the core application Hitachi runs Pentaho, which drives the Data Processing "container" illustrated above. Pentaho has many advantages as illustrated below, allowing for rapid customisation through its no code environment, a very useful feature for the larger corporates who may wish to further integrate the Sheep SCCT into their business systems e.g., their Enterprise Resource Planning Systems (ERPs). Furthermore, Pentaho has one of the most advanced integration capabilities available today with several thousand pre-configured Application Programming Interfaces (APIs) and an efficient no/low code process for developing new APIs for farming systems.

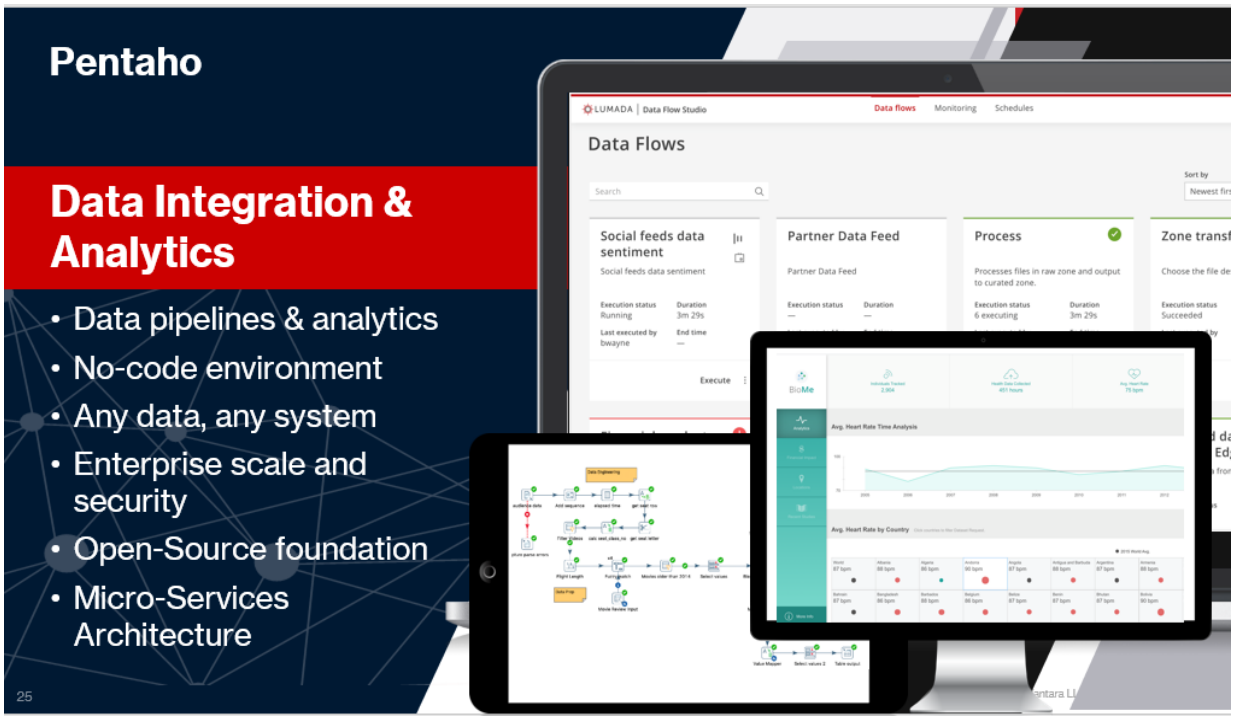


Figure 13: Pentaho, the core of Hitachi's application.

4.3.2. Enterprise level visualisation delivered

As mentioned, due to the lack of data from the sheep farms and abattoirs the Hitachi team had to rely on simulated and ex ante data to configure and test the various systems. The Enterprise Level Sheep Control Tower prototype was configured on an on-premise Hitachi Server with the simulated data imported directly into a Clickhouse database (the same database that would be used in the AWS instance). To visualise the data Grafana was used (https://grafana.com/) which has enterprise grade processing capability and used by Hitachi in large scale operations such as mining. The display of the simulation data via Grafana is shown in Figure 20 below.

Figure 20: Demonstrating enterprise scale visualisation from a ClickHouse database with simulated data 1.

Hitachi has significantly progressed designing an enterprise grade solution , which is considered to be transferred to industry grade, to be hosted on MLA's Amazon Web Services environment with the ultimate aim that MLA users can access the multi-tenant platform via myMLA. We then demonstrated the enterprise scalability by ingesting the simulation data into ClickHouse and presenting visualisations through Grafana.

It is envisaged that the next phase of the project will focus on implementing real data, with ongoing support from the in-kind lamb producers as soon as the internal challenges are resolved.

To this end, Hitachi are committed to developing the next phase of the project, when the stakeholders are ready, expected to be no later than the end of our financial year in March 2024. [Refer to Figure 21].

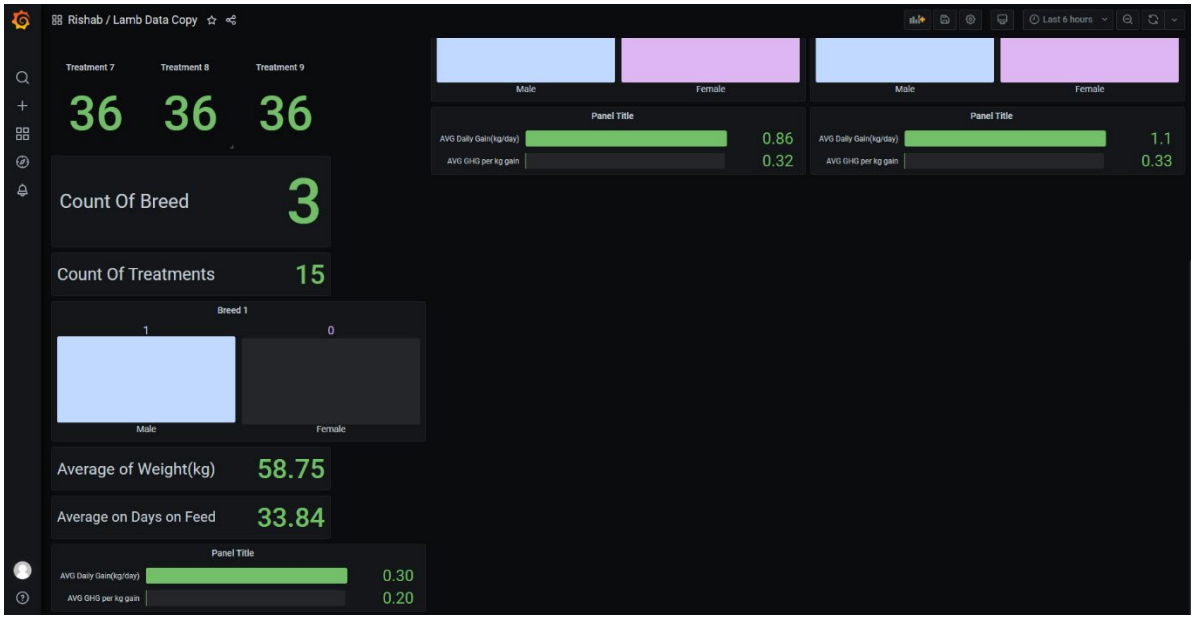


Figure 14: Demonstrating enterprise scale visualisation from a ClickHouse database using simulated data 2.

The above user interfaces are highly configurable including having the ability to drill into specific summary charts to obtain trends of the historical data.

4.3.3. Factoring in Sustainability and GHG estimation

From the data described earlier in a GHG estimation can be made. These data can be attached to the RFID tagged animal are reported to GMP. GMP can track these animals through the boning room and if they so wish, attribute a reduced GHG claim to cuts. Dr Nigel Tomkins has committed to providing a GHG curve for lambs. A key output of the data ingestion, analysis, reporting and adoption is to reduce the days to slaughter. Lambs of the target weight and IMF (not overfat) will have created materially less GHG than the average. This delta will increase in a compounding manner overtime as breeders select for growth rate, IMF score and other objective measurement traits. Additional progress will occur as finishes use the insights gathered on feeding and other husbandry levers to improve growth rates.

Once the combined data sets have been ingested and analysed, the project plans to add asparagopsis to the lamb feed ration and calculate the reduction in GHG emissions. The project will use the MLA sheep greenhouse gas accounting (S-GAF) tool which has been combined with the Beef GHG accounting into one tool, the SB-GAF. The trial will follow on from the findings of Dr Nigel Tomkins et el. where sheep were offered a high-fibre pelleted diet (offered at 1.2 · maintenance) at five inclusion levels of Asparagopsis for 72 days (0% (control), 0.5%, 1%, 2% and 3% organic matter basis as offered). Individual animal CH4 measurements were conducted at 21-day intervals using open-circuit respiration chambers. Asparagopsis inclusion resulted in a consistent and dose-dependent reduction in enteric CH4 production over time, with up to 80% CH4 mitigation at the 3% offered rate compared with the group fed no Asparagopsis ($P < 0.05$). Sheep fed Asparagopsis had a significantly lower concentration of total volatile fatty acids and acetate, but a higher propionate concentration. No changes in liveweight gain were identified.

5. Conclusion

After significant participation in the design phase of the Sheep Supply Chain Control Tower, the stakeholder's participation significantly reduced. Labour shortages and other external business factors were the cause. Clear Creek disengaged and Binginbar Farms failed to keep their sheep management systems updated and introduced a new business model raising their own lambs. Insufficient data was available from Binginbar Farms' processor(s).

Two significant issues were experienced. Firstly, a critical shortage of labour has meant the producer did not have the resources to EiD tag the trade lambs (~10,000). Subsequently, only EiD data was available on the lambs bred on farm instead of all lambs (~5,500). Secondly, the processor is paying ~$1/kg less for lambs than another nearby processor. In addition, the second processor still does not have a functional and fully operational tracking system.

In consultation with Sea Forest, a potential supplier of Red Asparagopsis product, there's a potential very exciting proposition to conduct a commercial scale trial in Binginbar Farms' feedlot with the lambs bred on farm with EiD tags installed to capture all associated data.

Whilst labour issues continue to hinder the progress of further developments of the lamb SCCT, producer(s) remain committed to the project and intend to initially transport a minimum of truckload (approximately 650 lambs) to the processor to get the data required for the project. Once labour issues are resolved for the upcoming seasons, data collection will again become a priority and focus. Also, hook tracking at the processing plant(s) is a critical capability issue to enable on-farm data to be linked to carcase compliance data, including DEXA and IMF scoring as one lamb plant has already achieved.

Overall, the project faced many challenges on the producer-side, which is hindering the ability to capture and process mapping the data, including Binginbar Farms introduction of a new business model – raising their own lambs, the post Covid labour shortage and a level of "scepticism" from the processors to participate in data sharing. There was less data than ideal, however it was considered enough available data to prove concept of linking whole of life data, particularly once carcass data can be linked to individual live animal data.

Despite these challenges, Binginbar Farms was committed to the original objectives to proceed, and a decision was made for Hitachi to continue development of the Sheep Control Tower, using simulated data, so that once Binginbar Farms has stabilised their new business model the solution can be evaluated with real data. A budget has been set aside for this evaluation.

It is recommended that the outcomes of this project are seen as a proof of concept for a Sheep Control Tower and that the learnings and designs are carried through to a larger scale project. A scaled-up phase 2 project is posed whereby the challenges experienced in this project can be mitigated through adequate resourcing and the end goal is to get several producers and processors to commit to implementing this solution operationally.

While this project faced challenges in accessing specific data both on farm and from the producers the high-level objectives of the project were met. The establishment of an end-to-end feedback system for the sheep supply chain is technically feasible, at enterprise and industry scale. The design has been done and the key functionality demonstrated. The challenges faced in collecting data on farm and

establishing collaborative relationships with the processors are not insurmountable. Automating the on-farm data collection, which has been successfully demonstrated in the earlier PFID projects is key to a successful sheep supply chain control tower solution, coupled with managing the expectations of all stakeholders across the supply chain so that both the producer, processor, and end customer benefit.

5.1 Key findings

The outcome of the project has been a review of the potential transferability of models and solutions used in the development of the beef end to end feedback system with a high degree of transferability determined. A detailed process mapping exercise was conducted to document the two lamb supply chains, their existing sensors, data capture, integration with farm management, as well as third party systems. The analysis also included an examination of the integration with processor feedback systems including Livestock Data Link. Sustainability and GHG emission sources and measures were also identified and documented in the SCCT mapping system.

The key findings for the project were:

- An enterprise scale sheep control tower, with multi-tenant capability to provide a cost-effective platform across the industry is technically feasible and capable of being deployed in the short term.
- On-farm data capture challenges should be eliminated with automation.
- Program management and ongoing stakeholder management is required in order to ensure all are aligned.

Due to operational changes in Binginbar Farms' management practices as well as labour shortages current data could not be obtained from both the producer as well as processor. Binginbar Farms remained committed to the original objectives for Hitachi to complete the design and test the application using simulated data. The result is the design of an enterprise capable solution, designed to be hosted by MLA on its Amazon Web Services and capable of serving the entire industry. The core visualisation capability was demonstrated on the simulation data.

5.2 Benefits to industry

The sheep industry, due to the shorter animal lifecycle has significant opportunity to optimise the supply chain, per region, per market based on the actionable insights of a Sheep Supply Chain Control Tower. The project has proven that the technology is available for the commercial scale deployment of a Sheep Control Tower solution. Such a solution will optimise the sheep supply chain, through providing actionable insights.

5.3 Commercialisation/Dissemination Strategy

The intention is to develop the supply chain improvement system where companies including Binginbar Farms, Clear Creek or other lamb supply chains can further customise for their specific supply chain priorities. A commercialisation strategy will be developed as part of this project. The project will be used to develop a case study that can be made publicly available to demonstrate the

value of data and supply chains using emerging technologies to make real-time business decisions, and strengthen and improve the red meat integrity system.

Hitachi Australia will provide technical support to the lamb supply chains (Binginbar Farms & Clear Creek) to ensure that detailed on farm data requirements are captured. Hitachi Consulting will provide technical services to develop and further refine the platform to integrate existing sheep data captured on farm. Notably, the Digital Agriculture Transformation and Value Chain Efficiency and Information Programs will be supported by Hitachi Vantara's Development service centres. Hitachi Vantara's Global Development Network (GDN) will provide ongoing research support, data integration services and support all data analytics.

6. Future research and recommendations

It is recommended that the outcomes of this project are seen as a proof of concept for a Sheep Control Tower and that the learnings and designs are carried through to a larger scale project. A scaled-up phase 2 project is posed whereby the challenges experienced in this project can be mitigated through adequate resourcing and the end goal is to get several producers and processors to commit to implementing this solution operationally.

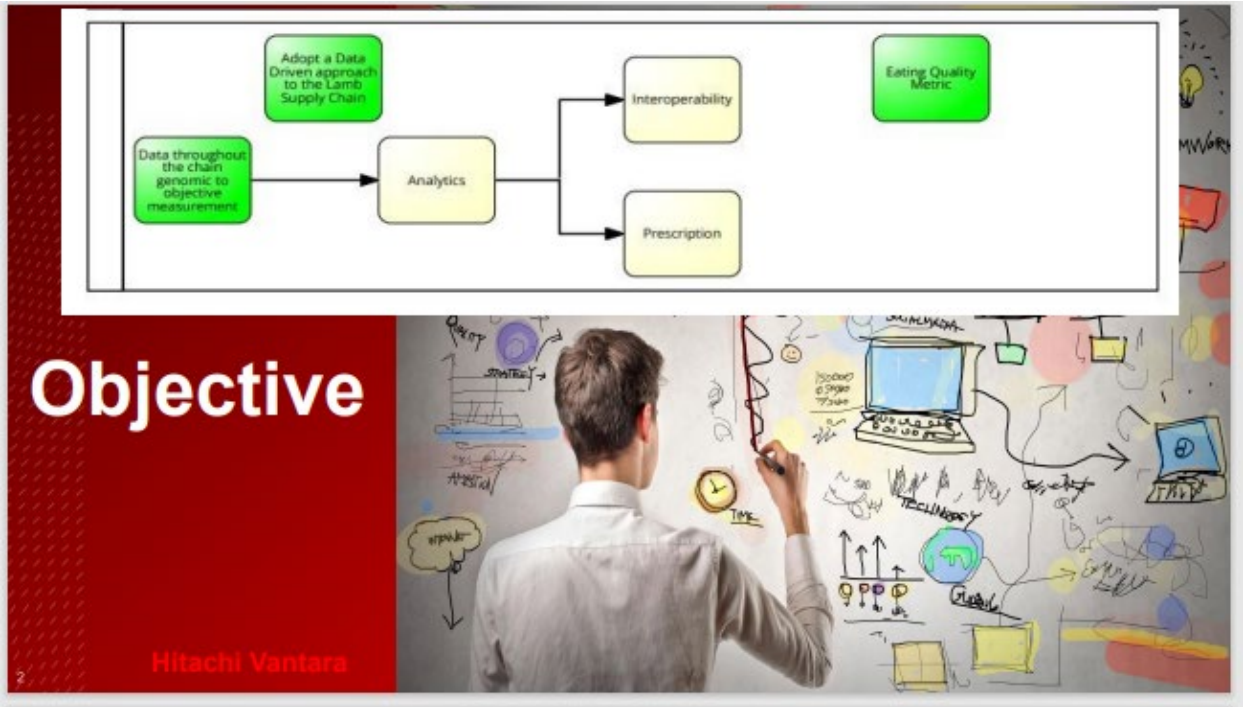
While the technology and design have been proven and are ready to scale in a future project, the on-farm challenges faced during this project indicate that future projects will need to factor in support in the data gathering and automation of data collection as much as possible. Producers face daily labour challenges, especially in the post Covid era, and while very keen to digitise and improve their practices still need to find the time to support such a project.

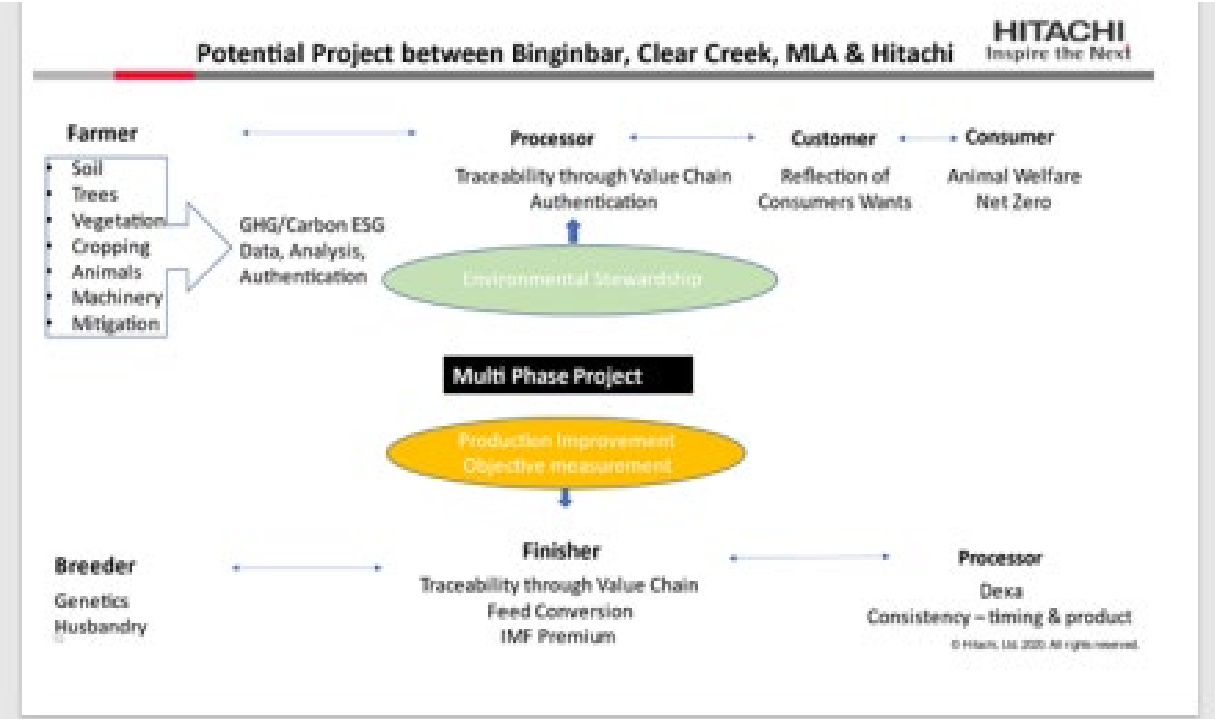
Hitachi Australia will provide technical support to the lamb supply chains (Binginbar Farms & Clear Creek) to ensure that detailed on farm data requirements are captured. Hitachi Consulting will provide technical services to develop and further refine the platform to integrate existing sheep data captured on farm. Notably, the Digital Agriculture Transformation and Value Chain Efficiency and Information Programs will be supported by Hitachi Vantara's Development service centres. Hitachi Vantara's Global Development Network (GDN) will provide ongoing research support, data integration services and support all data analytics.

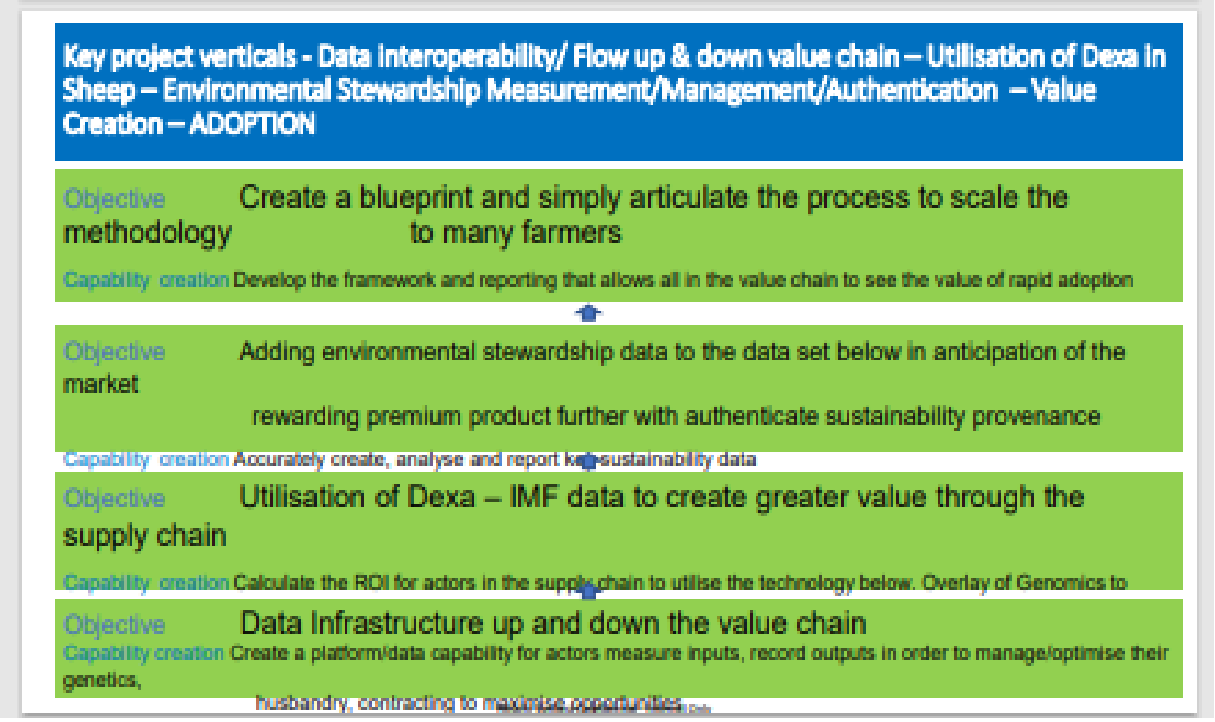
As documented in the report, the project faced many challenges on the producer-side, which is hindering the ability to capture and process mapping the data, including Binginbar Farms introduction of a new business model – raising their own lambs, the post Covid labour shortage and a level of "scepticism" from the processors to participate in data sharing.

7. Appendix

7.1 Hitachi Lamb SC slide deck [Pre-planning workshop)




Potential Project between Binginbar, Clear Creek, MLA & Hitachi
HITACHI
Inspire the Next
Farmer
Soil
Trees
Vegetation
Cropping
Animals
Machinery
Mitigation
GHG/Carbon ESG
Data, Analysis,
Authentication
Processor
Traceability through Value Chain
Authentication
Customer
Reflection of
Consumers Wants
Consumer
Animal Welfare
Net Zero
Environmental Stewardship
Multi Phase Project
Production Improvement
Objective measurement
Breeder
Genetics
Husbandry
Finisher
Traceability through Value Chain
Feed Conversion
IMF Premium
Processor
Dexa
Consistency – timing & product

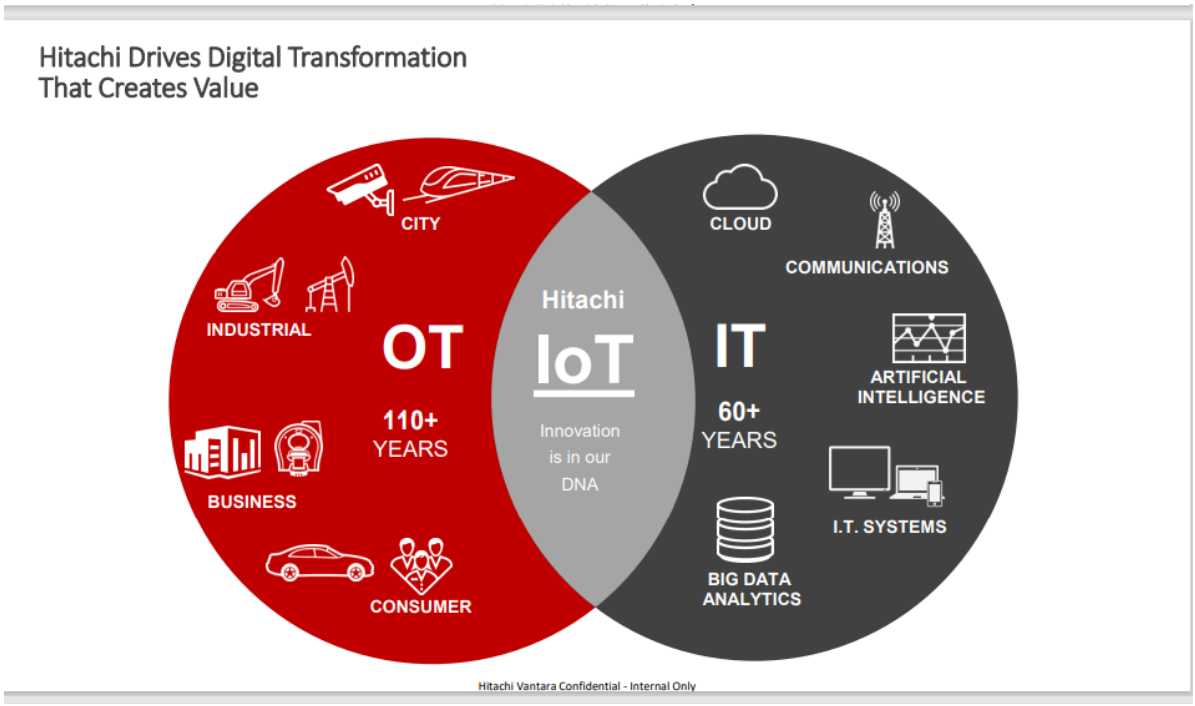

Key project verticals - Data interoperability/ Flow up & down value chain – Utilisation of Dexa in Sheep – Environmental Stewardship Measurement/Management/Authentication – Value Creation – ADOPTION
Objective methodology
Create a blueprint and simply articulate the process to scale the to many farmers
Capability creation Develop the framework and reporting that allows all in the value chain to see the value of rapid adoption
Objective market
Adding environmental stewardship data to the data set below in anticipation of the
rewarding premium product further with authenticate sustainability provenance
Capability creation Accurately create, analyse and report key sustainability data
Objective supply chain
Utilisation of Dexa – IMF data to create greater value through the
Capability creation Calculate the ROI for actors in the supply chain to utilise the technology below. Overlay of Genomics to
Objective
Data Infrastructure up and down the value chain
Capability creation Create a platform/data capability for actors measure inputs, record outputs in order to manage/optimise their genetics,
husbandry, contracting to maximise opportunities

Where does the Binginbar project fit with MLA's 2025 Strategic imperatives

MLA's Strategic Priority	MLA will…	Success will be …	Binginbar will …
Targeted investment to address the industry's big, complex challenges Prioritising which challenges to address by the impact they could deliver for the industry. ..... We will also continue our focus on meeting the expectations of customers, consumers and the community around animal health, animal welfare and environmental stewardship	Have a focused and targeted investment portfolio. Increase investment in and explore new approaches to producer adoption around areas such as adaption to climate variability, reproduction, mortality and objective measurement. Invest in the strengthening of our integrity systems, demonstrating the important role of red meat in a sustainable food system	Producers have the capability to adopt R&D outcomes that directly improve their productivity and profitability. Improved market specification compliance across defined quality, animal health and other value based pricing dimensions. Objective measures of animal welfare for live export, feedlot and extensive production systems implemented, with an increase in practice change. Progress towards net zero carbon emissions goal by 2030. Strengthened perception of Australian production practices, across domestic and international markets	Full Animal health data individually recorded. Market specification compliance objectively measured, recorded and feed back, allowing for improved decision making by both breeder (genetics & husbandry), finisher (vendor preference) Processor (producer preference – contracting – better matching market demand with supply) Opportunity to compare performance over time (3yrs) by comparing outcome from preferred breeders to non preferred, establishing and ROI case for more farmers to adopt the process

Where does the Binginbar project fit with MLA's 2025 Strategic imperatives

MLA's Strategic Priority	MLA will…	Success will be …	Binginbar will …
Decisions informed through data & insights Transitioning to a culture that captures & shares data across every point in the supply chain. This will enable the identification of the highest value opportunities & a shared understanding of challenges that need addressing. Collectively, we can then make more informed, strategic decisions & align responses for greatest impact	Prioritise investments that allow for the seamless transfer of information through a national data platform. Invest in our people, providing them with the skills and confidence to interpret and use integrated data to drive their decision-making.	More producers with access to data and feedback on animal performance to inform production decisions. Industry has a data culture, with supply chain decisions based on data capture and analysis	Enable two farms, 140,000 lamb Individually identified, Intermuscular Fat data up and down the value chain between Breeder, Finisher and processor bring greater return to all actors in the value chain


Hitachi Drives Digital Transformation
That Creates Value
CITY
INDUSTRIAL
OT
110+
YEARS
BUSINESS
CONSUMER
Hitachi
IoT
Innovation
is in our
DNA
CLOUD
COMMUNICATIONS
IT
60+
YEARS
ARTIFICIAL
INTELLIGENCE
I.T. SYSTEMS
BIG DATA
ANALYTICS
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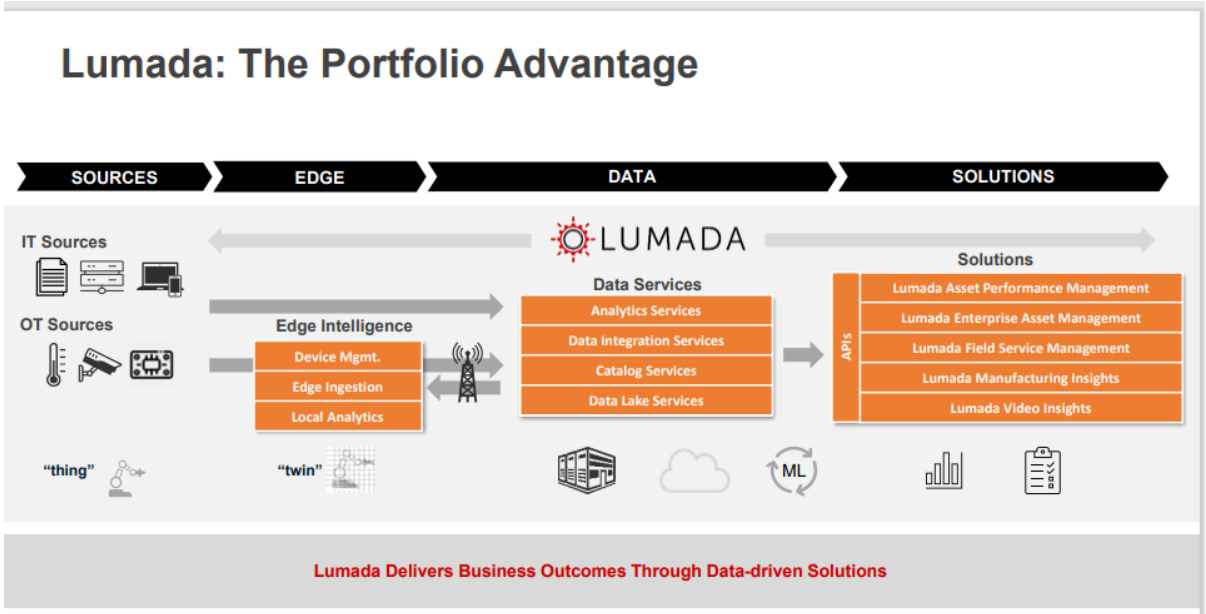
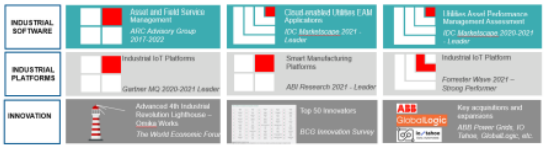

Lumada: The Portfolio Advantage
SOURCES
EDGE
DATA
SOLUTIONS
IT Sources
OT Sources
"thing"
Edge Intelligence
Device Mgmt.
Edge Ingestion
Local Analytics
"twin"
LUMADA
Data Services
Analytics Services
Data Integration Services
Catalog Services
Data Lake Services
ML
Solutions
APIs
Lumada Asset Performance Management
Lumada Enterprise Asset Management
Lumada Field Service Management
Lumada Manufacturing Insights
Lumada Video Insights
Lumada Delivers Business Outcomes Through Data-driven Solutions

Industrial IoT Leadership Recognition

Lumada Industrial Insights is Hitachi's flagship platform to gain insights from industrial data

The world's most respected analysts rank Hitachi as an Industrial IoT and digital operations leader



*Gartner consistently ranks Hitachi high on **Ability** to **Execute***

Horticulture Solution

Cattle Solution

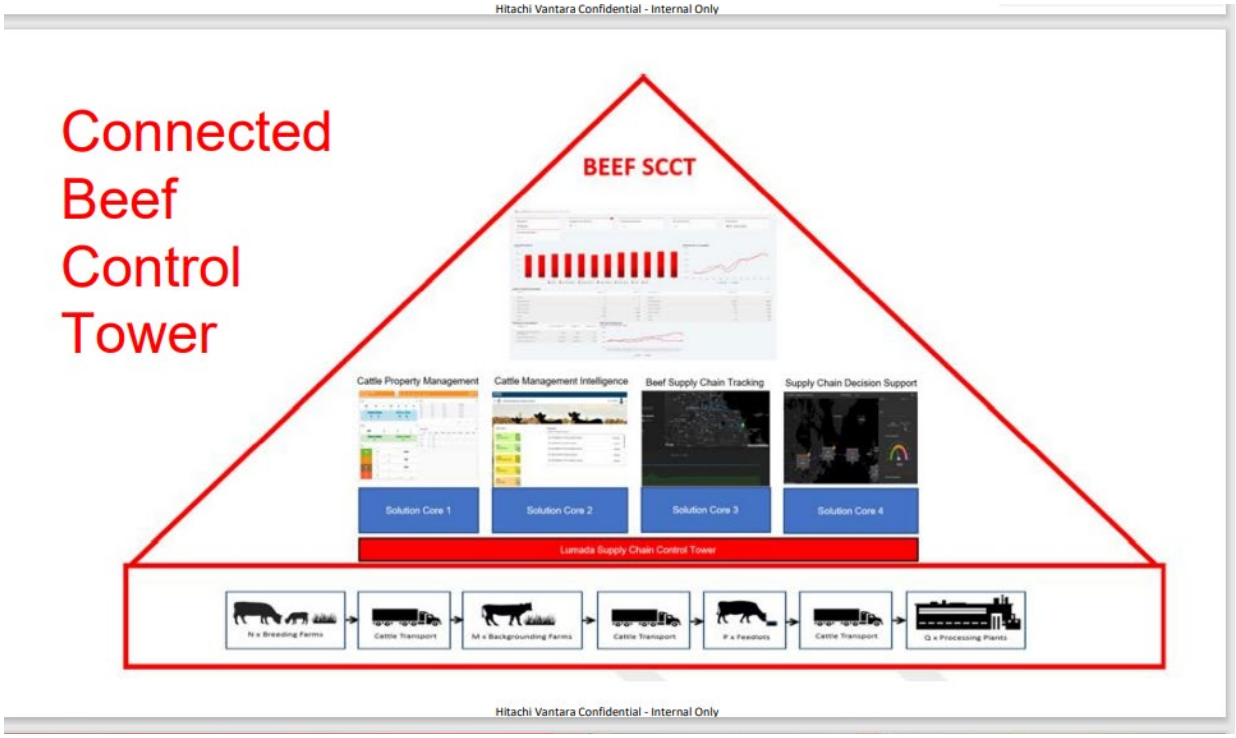
Protected Cropping Solution

Supply Chain and Sustainability Solution

Aquaculture Solution

SOURCES → EDGE → DATA SERVICES → INSIGHTS

LUMADA


Hitachi Vantara Confidential - Internal Only
Connected
Beef
Control
Tower
BEEF SCCT
Cattle Property Management
Cattle Management Intelligence
Beef Supply Chain Tracking
Supply Chain Decision Support
Solution Core 1
Solution Core 2
Solution Core 3
Solution Core 4
Lumada Supply Chain Control Tower
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Hitachi Vantara Confidential - Internal Only
Design Led
Thinking
Workshop
Hitachi Vantara
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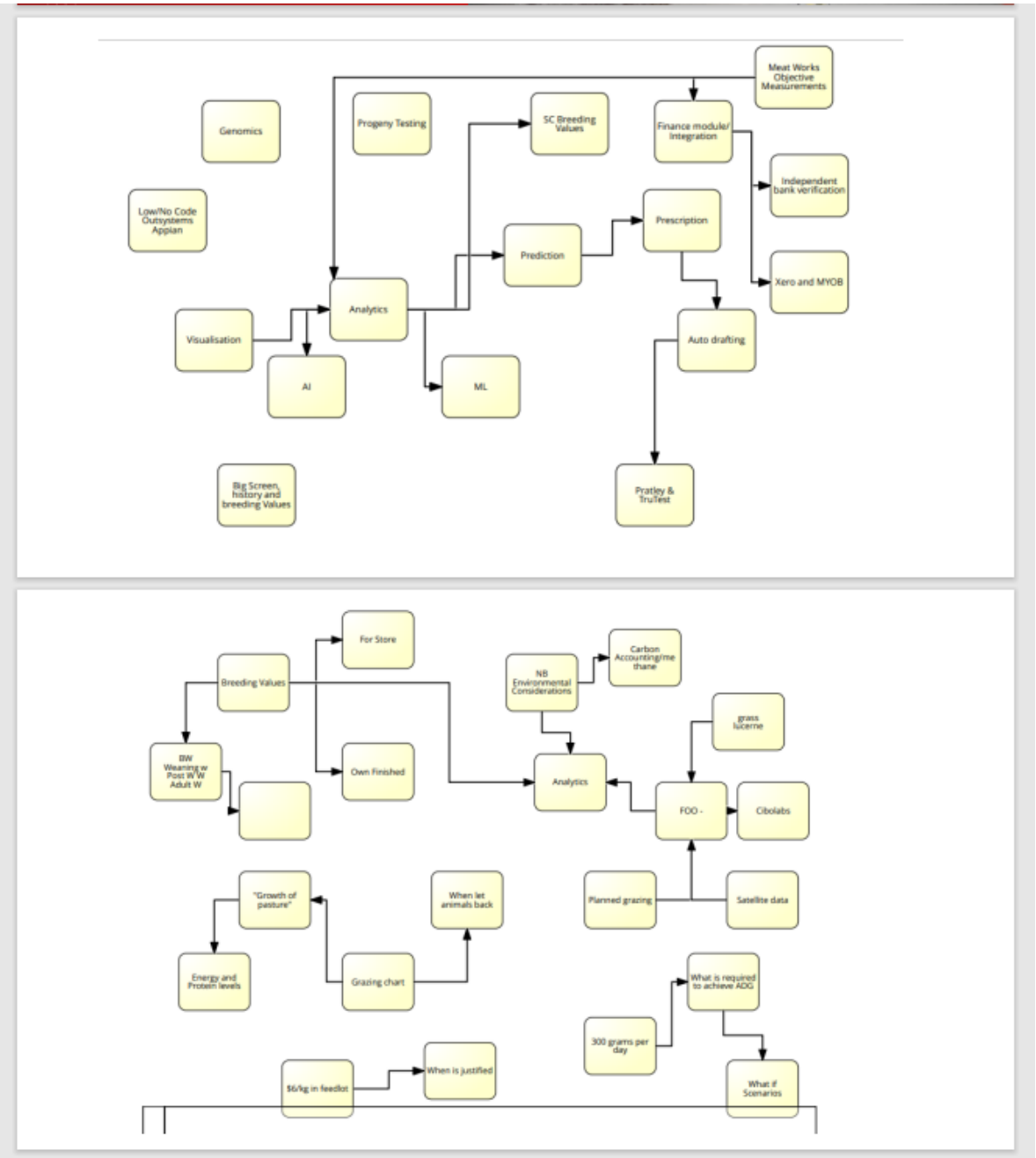
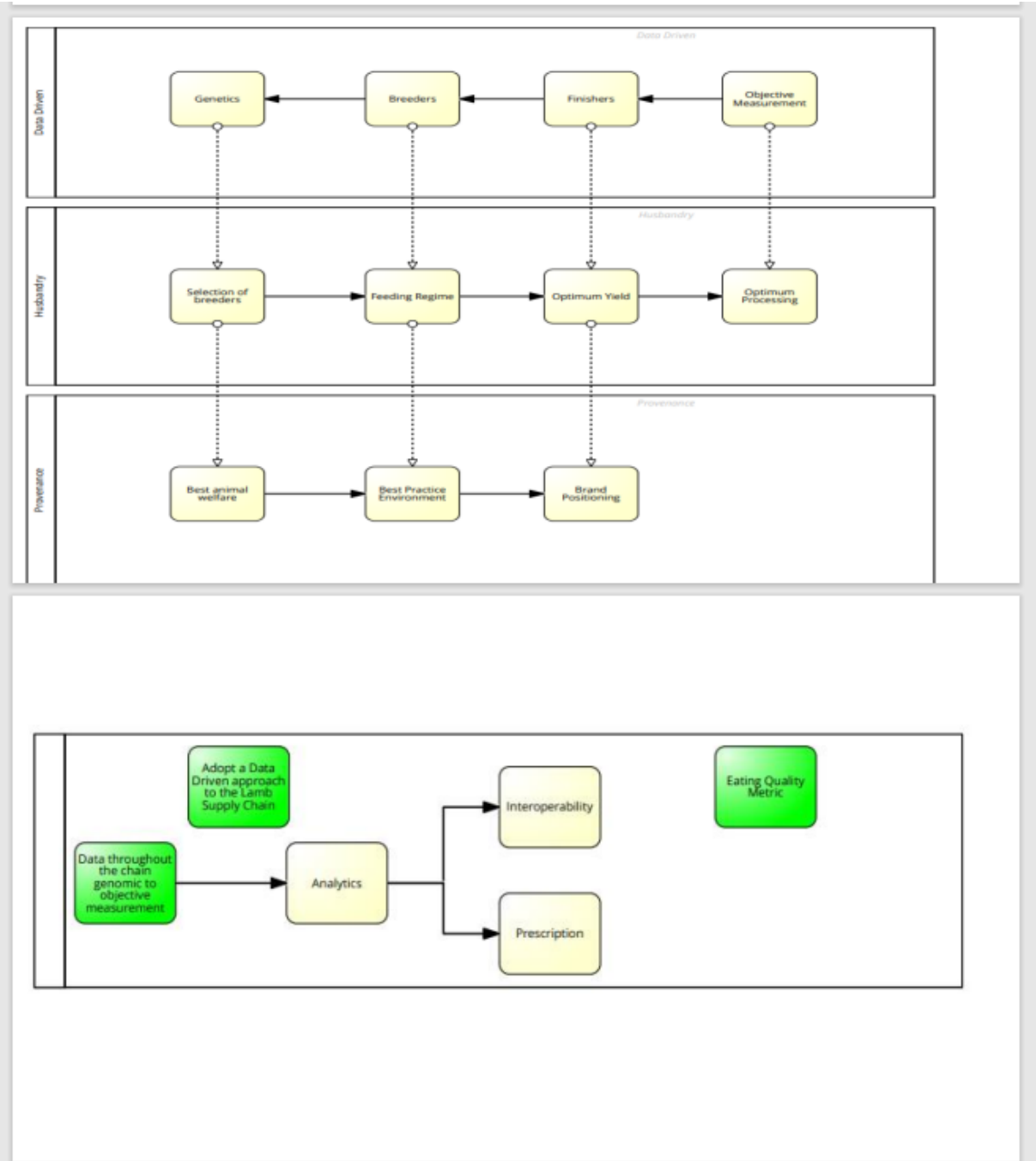
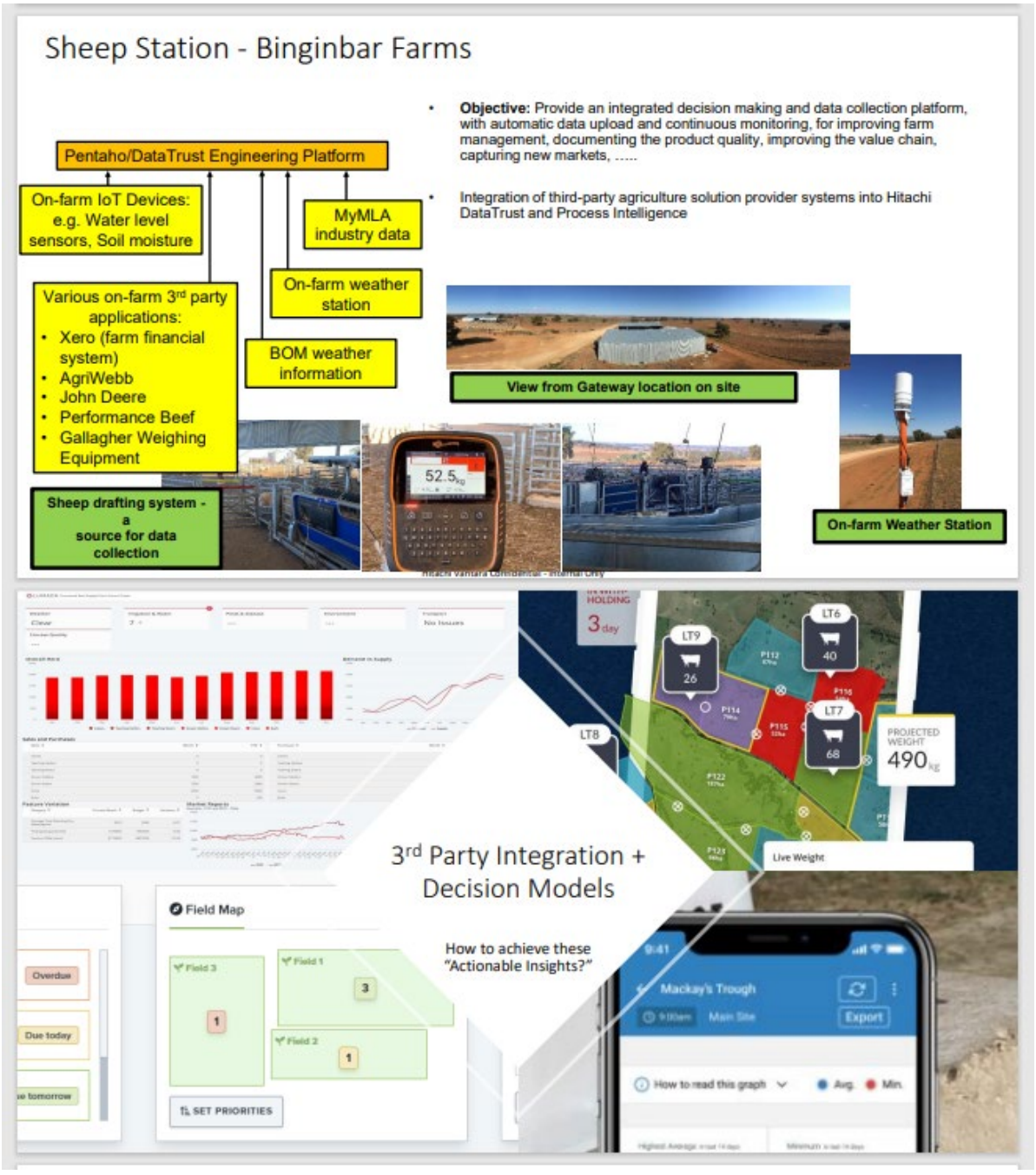

Meat Works Objective Measurements
Genomics
Progeny Testing
SC Breeding Values
Finance module/ Integration
Independent bank verification
Low/No Code Outsystems Appian
Prescription
Prediction
Xero and MYOB
Analytics
Visualisation
Auto drafting
AI
ML
Big Screen, history and breeding Values
Pratley & TruTest
For Store
Carbon Accounting/methane
Breeding Values
NB Environmental Considerations
grass lucerne
BW Weaning w Post W W Adult W
Own Finished
Analytics
FOO -
Cibolabs
"Growth of pasture"
When let animals back
Planned grazing
Satellite data
Energy and Protein levels
Grazing chart
What is required to achieve ADG
300 grams per day
$6/kg in feedlot
When is justified
What if Scenarios


Data Driven
Genetics
Breeders
Finishers
Objective Measurement
Husbandry
Selection of breeders
Feeding Regime
Optimum Yield
Optimum Processing
Provenance
Best animal welfare
Best Practice Environment
Brand Positioning

Adopt a Data Driven approach to the Lamb Supply Chain
Data throughout the chain genomic to objective measurement
Analytics
Interoperability
Prescription
Eating Quality Metric


Sheep Station - Binginbar Farms
Objective: Provide an integrated decision making and data collection platform, with automatic data upload and continuous monitoring, for improving farm management, documenting the product quality, improving the value chain, capturing new markets, ...
Integration of third-party agriculture solution provider systems into Hitachi DataTrust and Process Intelligence
Pentaho/DataTrust Engineering Platform
On-farm IoT Devices: e.g. Water level sensors, Soil moisture
MyMLA industry data
On-farm weather station
BOM weather information
Various on-farm 3rd party applications:
Xero (farm financial system)
AgriWebb
John Deere
Performance Beef
Gallagher Weighing Equipment
Sheep drafting system - a source for data collection
View from Gateway location on site
On-farm Weather Station
3rd Party Integration + Decision Models
How to achieve these "Actionable Insights?"
Field Map
SET PRIORITIES
Mackay's Trough
Export
Live Weight
PROJECTED WEIGHT
490kg

Linking it together

Binginbar Session Handling

HITACHI
Inspire the Next

2019-05-10 Feedlot 2 tfi 10_5_19

Unmapped Mapped Both

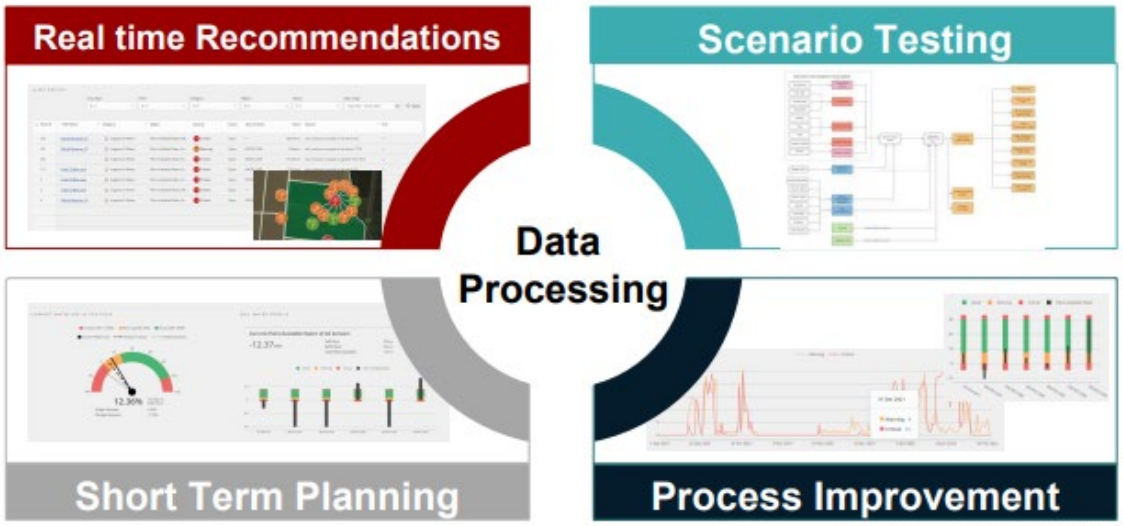
unscanned	scanned	unmatched	count	provenance_score
	0		0	

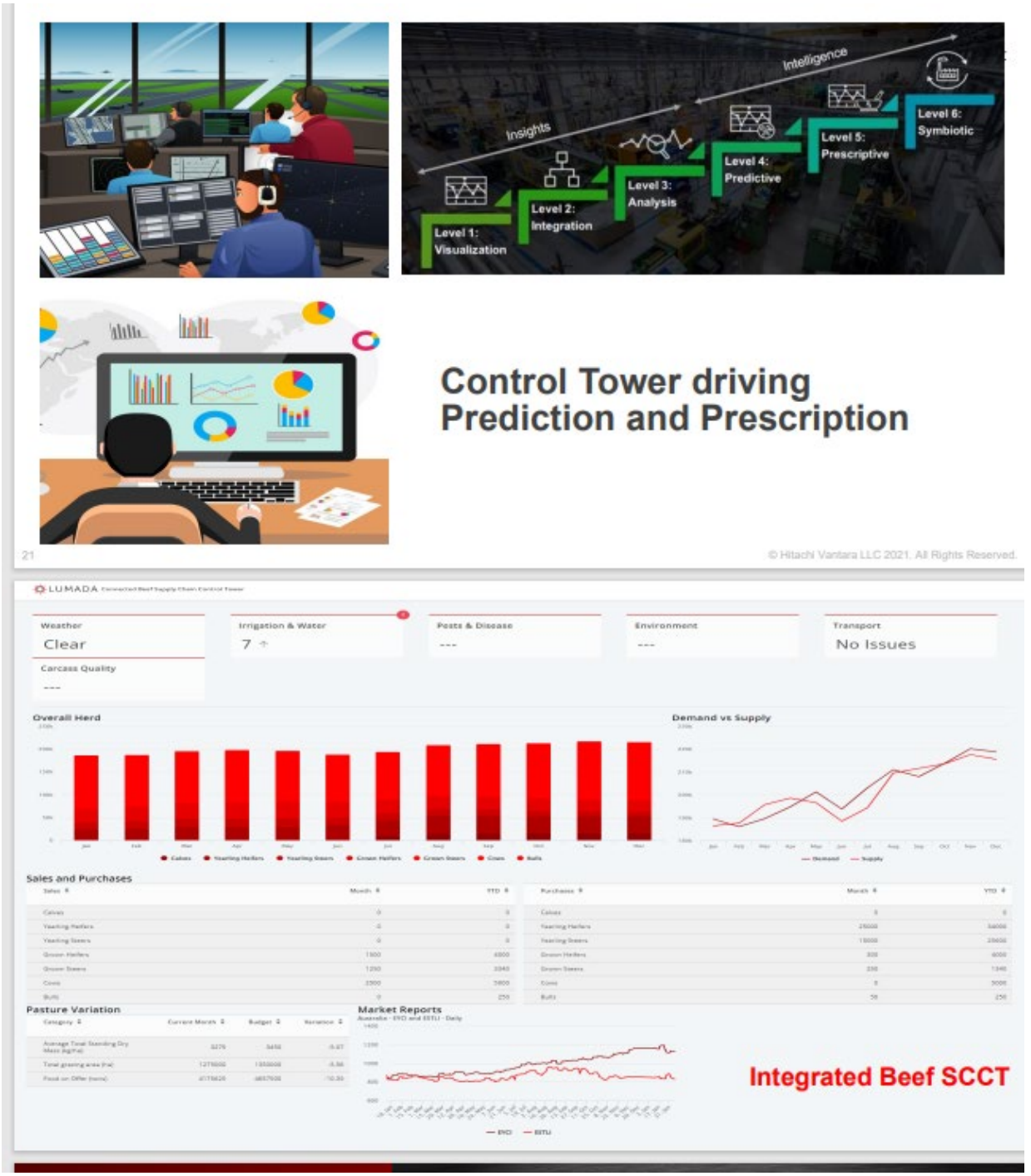
Download Provenance CSV

Session Name	Gate Number	Drafting Weight	Session Date	Drafting Count	Paddock Name 1	Alloc.Count 1	Paddock Name 2	Alloc.Count 2
2019-05-10 Feedlot 2 tfi 10_5_19	1	1 50 plus	2019-05-10	185	TFI	185		
2019-05-10 Feedlot 2 tfi 10_5_19	2	2 48-49	2019-05-10	74	TFI	44	Pen 10	30
2019-05-10 Feedlot 2 tfi 10_5_19	3	3 -46	2019-05-10	182	Pen 10	182		
2019-05-10 Feedlot 2 tfi 10_5_19	4	4 49-50	2019-05-10	60	TFI	60		
2019-05-10 Feedlot 2 tfi 10_5_19	5	5 46-48	2019-05-10	112	Pen 10	112		
2019-05-10 Feedlot 2 tfi 10_5_19			2019-05-10	1		1		

Sheep SCCT

HITACHI
Inspire the Next




Intelligence
Insights
Level 1: Visualization
Level 2: Integration
Level 3: Analysis
Level 4: Predictive
Level 5: Prescriptive
Level 6: Symbiotic
Control Tower driving Prediction and Prescription
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LUMADA
Weather
Clear
Irrigation & Water
7
Pests & Disease

Environment

Transport
No Issues
Carcass Quality

Overall Herd
Demand vs Supply
Sales and Purchases
Pasture Variation
Market Reports
Integrated Beef SCCT

Proposed High Level Scope and Timeline

HITACHI
Inspire the Next

April to June 2022	July to Sept 2022	Oct to Dec 2022	Jan to March 2023	April to March 2024
Define Scope of Work & Milestones, Finalise Contracts	Detailed Discovery workshops and Design	Sprint 1: Configure Platform Sprint 2: Integrate Systems 1 Sprint 3: Launch Version 1: Visualisation	Sprint 4: Integrate Systems 2 Sprint 5: Configure Analytics 1 Sprint 7: Launch Version 2 Analytics	Sprint 8: Develop Prediction Models 1 Sprint 8: Develop Prediction Models 2 Sprint 9: Launch Version 3 Prediction	Sprint 10: update/optimize models Sprint 11: Develop Prescriptive models Sprint 12: Launch Version 4 Prescription Sprint 13: Prepare Commercial adoption and support plans

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