



Final report

Carwoola data leverage (Pilot) for research and extension activities (Update)

Project code: V.DIG.0017

Prepared by: Hamish Munro
Pairtree Intelligence Pty Ltd

Date published: 16th August 2021.

PUBLISHED BY
Meat and Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

This publication is published by Meat & Livestock Australia Limited ABN 39 081 678 364 (MLA). Care is taken to ensure the accuracy of the information contained in this publication. However MLA cannot accept responsibility for the accuracy or completeness of the information or opinions contained in the publication. You should make your own enquiries before making decisions concerning your interests. Reproduction in whole or in part of this publication is prohibited without prior written consent of MLA.

Abstract

This project was to outline the opportunity to leverage data once it has been centralised to an analytics and visualisation platform [like Pairtree] for the Carwoola Digital Twin. Data from the digital twin has been re-purposed from the original MLA RedMeat 2018, Carwoola Pastoral Company (CPC) Digital Forum to expose new opportunities for the red meat industry.

During the Redmeat 2018 Digital Forum, Pairtree had demonstrated the aggregation and centralisation of the wide range of Agtech and 'Digital agriculture' solution providers that deployed services over the several properties owned by CPC.

The objective of this pilot project is to better understand the opportunities, once converged data is integrated to a single site; and the future capacity to utilise data convergence platforms like Pairtree, for industry research extension.

The key deliverables for the project were to allow the leveraging of disparate data sets and sources to provide operational oversight and opportunity for assisted decision support, (through paddock view and diary view type concepts and consideration of Research and Development extension and adoption pathways ie: algorithm marketplace/ app store).

The project has successfully demonstrated that:-

- Data Convergence is certainly an opportunity for the red meat industry and the methodologies that Pairtree has designed within its operational platform can reliably provide beneficial outcomes to industry.
- The variance and wide nature of data types that Australian Agriculture require, causes significant issues within the normalisation of data to even allow the concept of data centralisation, before even data convergence can be considered.
- There is opportunity where disparate Agtech solution providers can now complement and collaborate services to enhance decision support and operational oversight for farm productivity gains.

This Pilot demonstrated that the Pairtree platform is a stable and reliable resource that industry and farmers can utilise as either middleware or as a single sign on (SSO) platform. Providing centralised and converged data services for future productivity and integrity gains, with connections to localised data that is used for 'Business as Usual' operational activities. This project proved that research and extension activities are easily able to be delivered to levy payers in a meaningful and farmer friendly application.

Executive summary

Background

The Project objective was to provide a Proof of Concept (POC) pilot for Industry to assess the potential for aggregated data from remote sources to be able to be utilised within research and extension to improve research adoption and delivery.

Through the Redmeat2018 Digital Forum and with the addition of several new data providers, the Carwoola 'digital twin' was used to converge data at a Paddock and/or Enterprise level. This can then be used for targeted tools and outputs to improve management decision making, through leveraging Agtech with levy funded research outcomes.

The main beneficiaries are two-fold within the findings of this project.

- Levy payers:- As data convergence can provide improved decision support through both simple data correlations and complex algorithmic computations from industry research.
- Agtech and Digital Agricultural solution providers:- Now their data can be used to generate additional value and services to their clients.

The Potential of the findings of this report will be to open a range of new opportunities to industry and levy payers. As it can be said that "the sum of the centralised data, is significantly more than the total of all individual parts".

Utilising data aggregation services [like Pairtree] that are designed for agricultural functionality and provide secure data services solely for the data owner/ creator (the farmer), will protect the longevity and underlying value of on-farm data. This will allow significant opportunities to better manage data, time and resources corresponding with the increasing demand for produce with diminishing physical and financial resources.

Objectives

The Project objective was to provide a Proof of Concept (POC) pilot for Industry to assess the potential for aggregated data from remote sources to be able to be utilised within research extension and to improve research adoption.

Through the Redmeat2018 Digital Forum and with the addition of several new data providers, the Carwoola 'digital twin' is to be used to converge data at a Paddock and Enterprise level. This then can also be used to improve management decision making, through the addition of levy funded research outcomes.

The objective of the report was to better understand how the myriad of potential data issues and complexities that are encountered in general integration works within this project can provide leveraged decision support and productivity outcomes.

Methodology

The Methodology was to simply ingest key sets of data that can inter-relate multiple assumptions and leverage the existing data outputs on farm. Once the ability of convergence had been achieved it was then to demonstrate multiple visualisation approached to understand how best, data can be utilised by industry in the future for productivity, research and extension.

Results/key findings

The key results are that:-

- Research and extension computations can be computed on the fly with localised real-time data sets from the farm, that the levy payer is operating within,
- There is a significant process to curate, normalise and make available disparate data sets for wider industry use, But it is possible.
- There is considerable work still to do, within identifying key research extension options and the best User interface (UI) or User Experience (UX) to propel adoption.
- That Farmers (levy Payers) and Agtech solution providers can both benefit from data centralisation and convergence. Saving industry costs, time and physical and financial resources, whilst also providing flexibility of choice and a greater value proposition for each solution.

Benefits to industry

This project has tested and proven that there is potential to supply meaningful research and extension services to levy payers, through tailored and customised approaches. A key benefit to industry will be that localised (on-farm or specific supply chain) data can now auto populate extension services. Essentially 'The Last Mile' or delivering directly to the consumer (farmer) is always the hardest step to deliver, this project has shown that there is capability there to deliver, the question is now, 'HOW TO'?

Also that visualisations or recommendations from the extension can be tested in a MVP type approach with iterations of the same outputs to be tested by the user for better User interface (UI) and User Experience (UX) outcomes, thus creating potentially greater adoption levels.

With Industry spending considerable investments in research annually, it is important to ensure that extension and adoption do not limit the opportunities that the research has created. Generally the outcome has to be to create a new App, which may not be the best option for extension and actual adoption. This project has provided the ability for auto-population of research variables and also a centralised and targeted resource to deliver new and old research.

Future research and recommendations

There are numerous research opportunities from this projects direction that can potentially positively impact the red meat industry. These may include, but not limited to:-

- Identify key industry calculators, algorithms and computations that may be tested under licence for localised real-time decision support,
- Identify key industry problems where multiple data sets are required to provide insight or operational support to levy payers,
- Review internal supply chain data sources to consider new services to levy payers
- Review UI and UX preferences for industry specific bodies of work and how they can be re-delivered, tested and improved upon. Is there elements of Gamification that can assist uptake?

- Review the different red meat species and production systems to develop more tailored extension services. Essentially utilising geographic location of sites to drive dynamically targeted and timely (seasonal) suites of services that levy payers can easily access.
- There are a number of ‘Smart Farms/ demonstration Farms’ that are exploring similar concepts for Industry or State based review and commentary. Pairtree is working with a number and it would be beneficial Nationally to see how the data from these many sites can be cross utilised for greater farmer and supply chain review, access and direction.

Table of contents

Abstract	2
Executive summary	2
1. Background.....	7
2. Objectives.....	7
3. Methodology	8
4. Results.....	8
4.1 Data Leverage Menu List	8
4.1.1 Paddock connect.....	8
4.1.2 Enterprise Connect	12
4.1.3 Compliance Connect	14
4.1.4 Research and Extension	16
4.1.5 Specific Agtech solutions	18
4.1.6 Farmers	18
4.1.7 Uptime report	19
5. Conclusion	20
5.1 Key findings.....	20
5.2 Benefits to industry	21
6. Future research and recommendations	21
7. Acknowledgements.....	22
7.1.1 Software Providers.....	22
7.1.2 IoT Providers	22

1. Background

In 2018, Carwoola Pastoral Company and MLA, hosted the RedMeat Digital Forum, where a wide variety of devices were deployed and assessed against a theory of ‘The Hype or the Happening’. Essentially trying to test, brake and assess the commerciality of many of the digital solutions that were touting their services within the Australian Agtech market.

Pairtree was one such provider and integrated with 4 networks, 15 different providers, 25 different device types, 5 properties and approximately 280 individual IoT devices, plus then satellite imagery and mapping services.

As the original deployment was an open call, there was several gaps within the overall farm management layer that could have better utilised some of the IoT devices to assist daily operations and oversight.

The Data Leverage concept and pilot is to add data solutions that fit within the data gaps to assist daily decision making. This then allows a more uniform and ‘whole of farm’ data concept to be tested to apply levy funded research algorithms or third-party algorithms too.

Extension and adoption of research is one of the largest issues for RDC’s and Government bodies to ensure that levy/ public funds are being spent prudently. This pilot is planned to assist in discovering new potential pathways for extension and adoption of research and development.

It is noted that with the management changes at Carwoola Station and Carwoola Pastoral Company that a ‘Digital Twin’ was created, where the existing data was complemented with the additional data sets. This additional data was replicated to a similar management regime as per the first 12+ months, by Mr Darren Price maintaining these new Apps and software offerings. The replication of daily management activities will demonstrate the overall capacity of data ingestion and higher-level decision making, from the multitude of available data sets now deployed within the Carwoola digital twin.

2. Objectives

The Project objective was to provide a Proof of Concept (POC) pilot for Industry to assess the potential for aggregated data from remote sources to be able to be utilised within research extension and to improve research adoption.

The aims for this project was to review the existing device deployment and data sources on the Red Meat 2018 Carwoola Properties and identify key data gaps that would enable the leveraging of multiple data concepts and data convergence.

Through the Redmeat2018 Digital Forum and with several new data providers, the Carwoola ‘digital twin’ is to be used to converge data at a Paddock and Enterprise level. This then can also be used to improve management decision making, through the addition of levy funded research outcomes.

The objective of the report was to better understand how the myriad of potential data issues and complexities that are encountered in general integration works within this project can provide leveraged decision support and productivity outcomes.

3. Methodology

Through a number of embedded integration, normalisation and visualisation technologies within the Pairtree platform the project was to ingest the wide range of existing deployed services as well as several new key solutions, identified within the data gap analysis.

The Methodology was simply to ingest key sets of data that can inter-relate multiple assumptions and leverage the existing data sources on farm. It was assumed that as data is traditionally created and stored in disparate silos, that 'Linking' services would be required to enable a range of inter-related outputs. The work provided in this project was based around the mapping of the aggregated data sets to allow these assumptions to be linked and viewed in farmer (levy payer) friendly visualisations.

Once the ability of convergence had been achieved it was then to demonstrate multiple visualisation approaches to understand how best, data can be utilised by industry in the future. Pairtree had a range of dashboards and proof of concept pages that were used as the starting point to create a range of visualisations to demonstrate to stakeholders and farmers.

With stakeholder review, there was feedback from this work and some minor changes were made to the final outcomes within the Data-leverage menu item, within the Red Meat 2018 Carwoola Pairtree Instance.

The data integration methodology used within the project was to normalise the data within the Pairtree platform, rather than forcing providers to change their descriptions and variables. [It is noted that by forcing providers to 'Standardise' their data, will potentially add significant time lags and costs to wider adoption of collaboration and data sharing by both farmers and Agtech providers.]

4. Results

4.1 Data Leverage Menu List

The Data Leverage Menu List within the Carwoola RedMeat 2018 instance, allows access to the key dashboards that Pairtree has initiated to provide converged outcomes for the range of services that were deployed within this project and the Red Meat 2018 instance.

Through Pairtree's 3 main 'Connect Solutions' (Paddock, Enterprise and Compliance) there were a number industry specific examples provided.

4.1.1 Paddock connect

Within 'Paddock Connect' (where a paddock map approach allows paddock specific data to be accessed through a map view) there were several paddock related concepts that were displayed from the multitude of data sets that were present within the digital-twin at Carwoola.

The below examples are for 'Bottom Flat' paddock and there is a range of paddock specific data sets now in a position to be appropriately converged for production or issue specific research and extension activities.

Within the different examples we can see:-

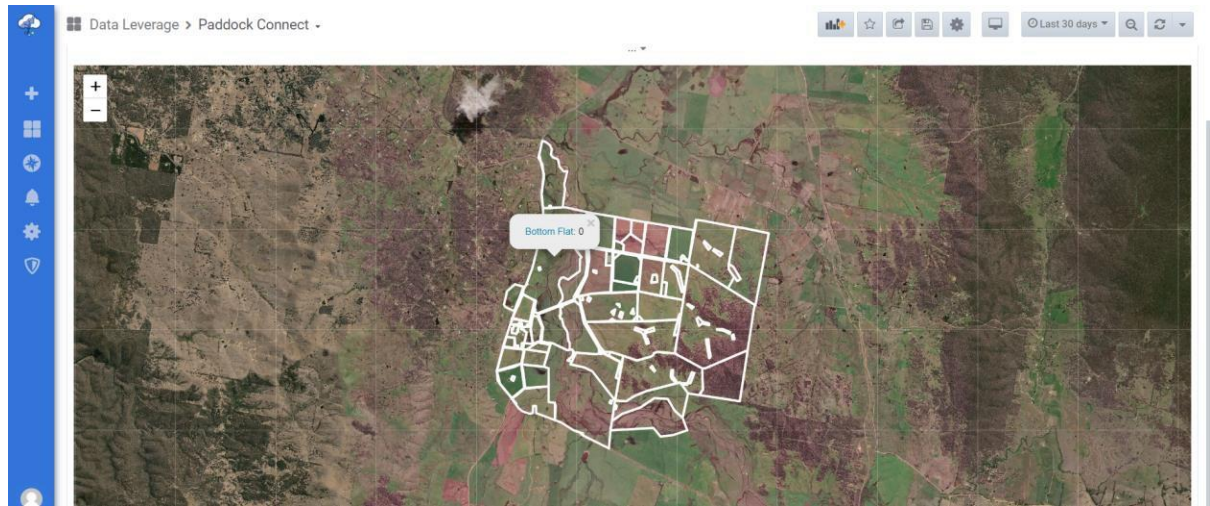


FIG 0: Paddock Connect interface

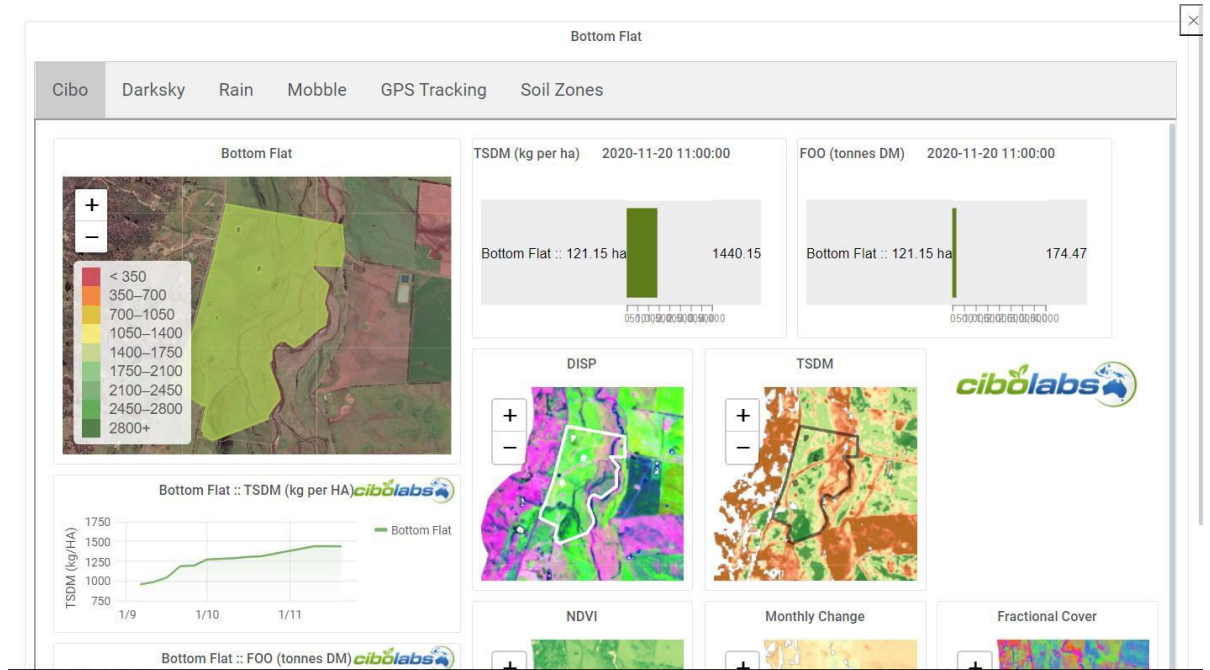


FIG 1: The Cibolabs data sets, with historic and actual pasture availability figures on hand for the paddock.

<https://www.cibolabs.com.au/>

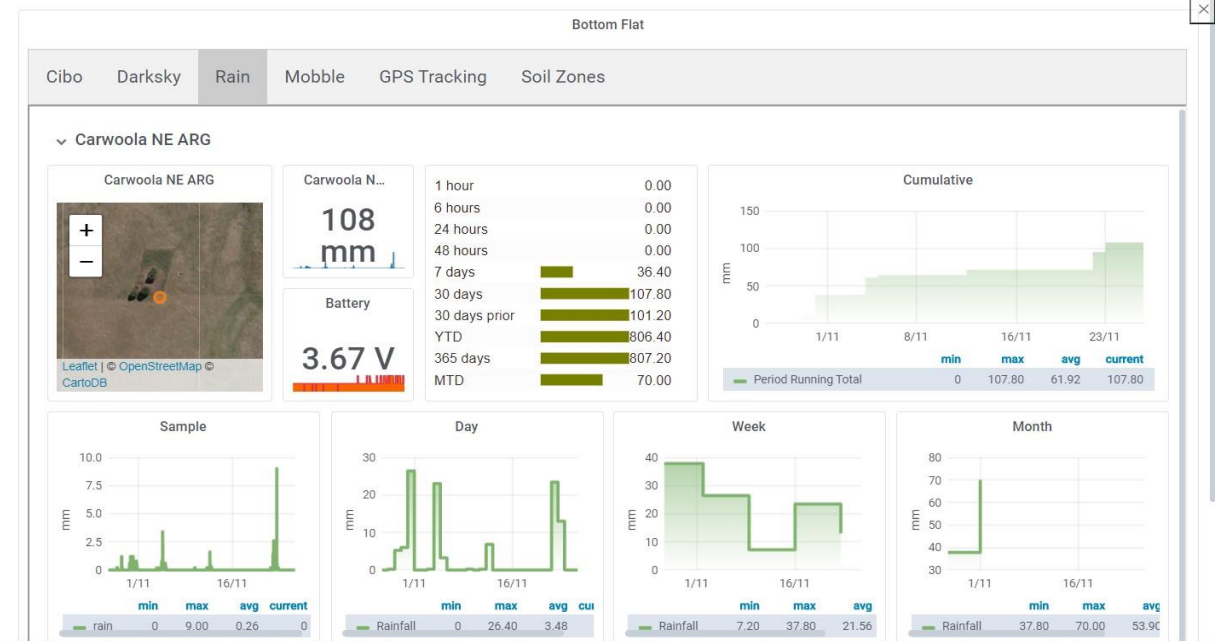


FIG 2: This 'Rain' Tab over rules the 'Darksy' (Bureau of Mwaterology, BOM) 5x5km interpolated weather data. The Rain tab (driven by a GoannaAg Automatic Weather Station) looks for the Variable 'Rain' within the paddock boundary or within a specified distance from the boundaries edge. Effectively providing precise localised rainfall recordings for the paddock and production system that is being carried out at that time in that paddock.

<https://www.goannaag.com.au/>

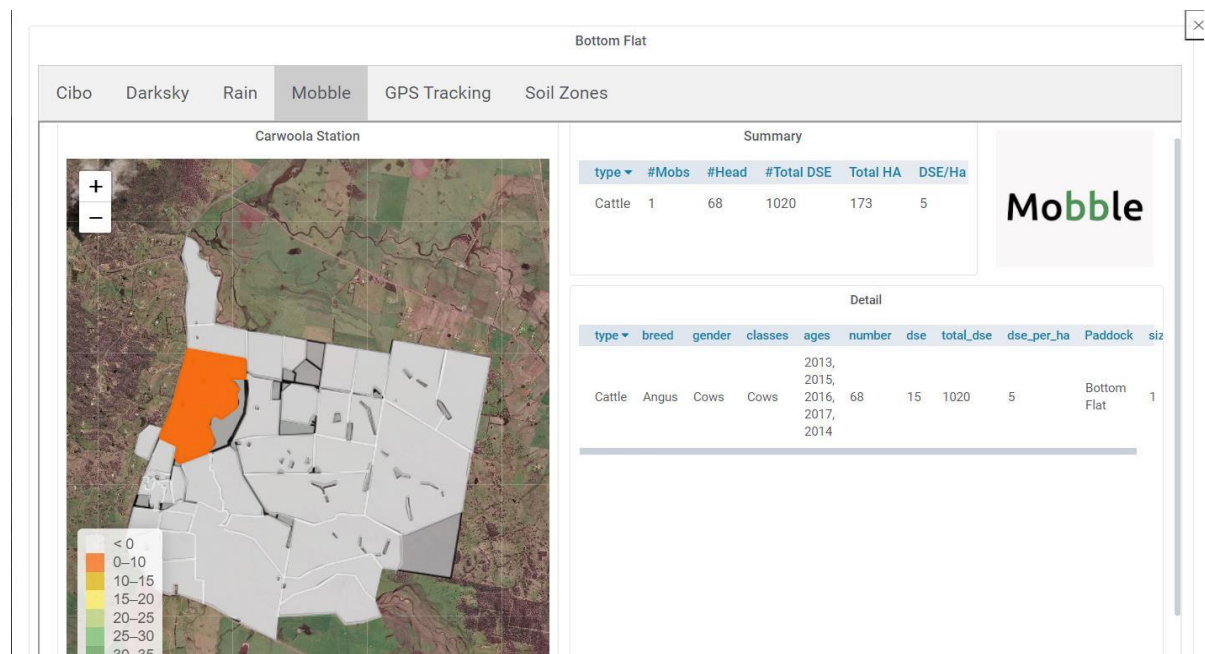


FIG 3: Is the Mobble Tab, which provides quick access to the livestock mobs and interactions that are within that paddock, including Total DSE, Length of grazing, number of head, species type and a range of other key attributes that can allow for Research, extension and adoption of services where automated data population can occur.

<https://www.mobble.io/>

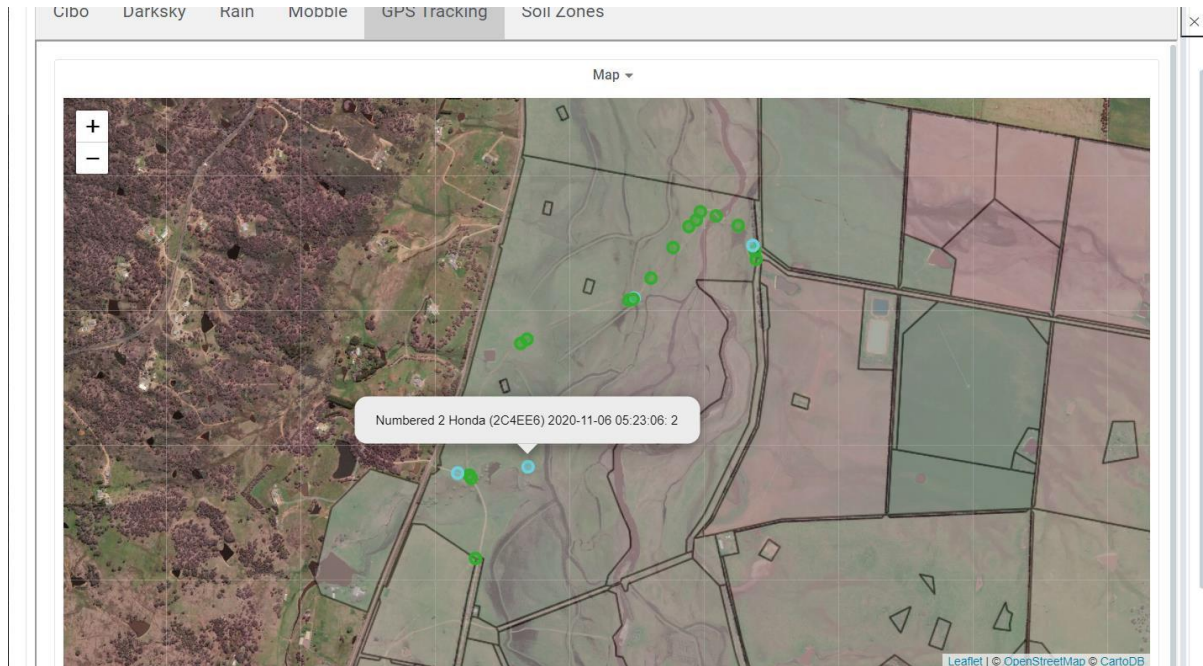


FIG 4: As there is Livestock in the paddock, this is the first converged concept of inter-related assumptions. We can see that there has been a GPS Oyster tracker on the Honda Bike (Blue, Date and time) and the Tractor (Green) within that paddock, whilst livestock are present. This assumption can improve surveillance, biosecurity and animal welfare documentation.

<https://www.digitalmatter.com/devices/oyster2/>

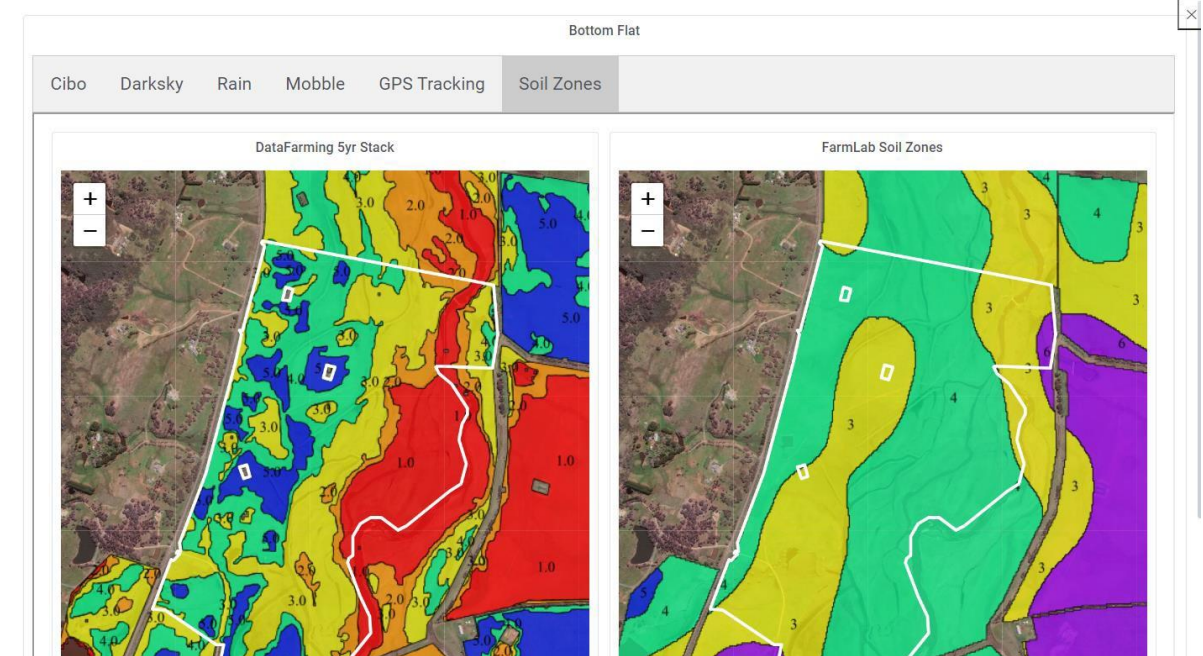


FIG 5: Geo-tiff Maps, this tab shows some key underlying variables that are or will affect paddock performance. The DataFarming – Five year NDVI (Considering vegetation growth and availability) stack selects a point in time (March) for the last 5 years and then creates 5 zones of productivity over that time. The Farmlabs Gamma radiation reflectance zones does a similar thing, but with

reflectance of soil types (considering sand, silt and clay content) provides a similar 5 or 6 zones for soil type. There are some loose correlations that can be drawn from these maps and management options that could be addressed. It is NOTED that both these providers will soon have Geojson file types available, so that Pairtree then can utilise the raw numbers underneath the images for further data convergence, research and extension activities.

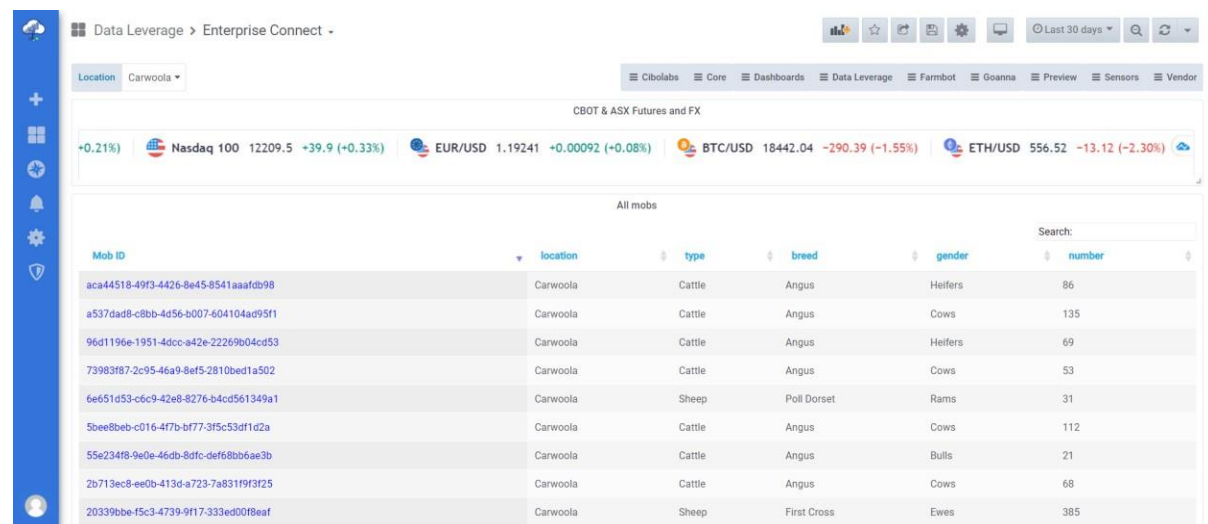
<https://www.datafarming.com.au/>

<https://www.farmlab.com.au/>

4.1.2 Enterprise Connect

The second Connect option to be used within the project is Enterprise Connect, which connects all data at a mob or enterprise (Wheat, Canola, etc.) level allowing for benchmarking and clearer gross margin costs and inputs.

Enterprise Connect is designed to align the data against the production system (essentially pivoting the Paddock data) to focus on ensuring that the production system and the associated activities and data is linked as a Farmer would expect to review the data.



The screenshot shows the Enterprise Connect interface. At the top, there's a navigation bar with 'Data Leverage > Enterprise Connect'. Below that, a location dropdown is set to 'Carwoola'. A secondary navigation bar includes 'Cibolabs', 'Core', 'Dashboards', 'Data Leverage', 'Farmbot', 'Goanna', 'Preview', 'Sensors', and 'Vendor'. A market ticker displays 'CBOT & ASX Futures and FX' with indicators for Nasdaq 100, EUR/USD, BTC/USD, and ETH/USD. The main content area is titled 'All mobs' and features a search bar and a table with columns for Mob ID, location, type, breed, gender, and number.

Mob ID	location	type	breed	gender	number
aca44518-49f3-4426-8e45-8541aaafdb98	Carwoola	Cattle	Angus	Heifers	86
a537dad8-c8bb-4d56-b007-604104ad95f1	Carwoola	Cattle	Angus	Cows	135
96d1196e-1951-4dcc-a42e-22269b04cd53	Carwoola	Cattle	Angus	Heifers	69
73983f87-2c95-46a9-8ef5-2810bed1a502	Carwoola	Cattle	Angus	Cows	53
6e651d53-c6c9-42e8-8276-b4cd561349a1	Carwoola	Sheep	Poll Dorset	Rams	31
5bee8beb-c016-4f7b-bf77-3f5c53df1d2a	Carwoola	Cattle	Angus	Cows	112
55e234f8-9e0e-46db-8dfc-def68bb6ae3b	Carwoola	Cattle	Angus	Bulls	21
2b713ec8-ee0b-413d-a723-7a831f9f3f25	Carwoola	Cattle	Angus	Cows	68
20339bbe-f5c3-4739-9f17-333ed00f8eaf	Carwoola	Sheep	First Cross	Ewes	385

FIG 6: Enterprise Connect Interface

This interface allows the user to interact and quickly review all data that is associated with that mob. This page also a stream of Chicago Board of trade (futures) and Currency cross trades to be quickly viewed, so that users can keep up to date with global trends or influences.

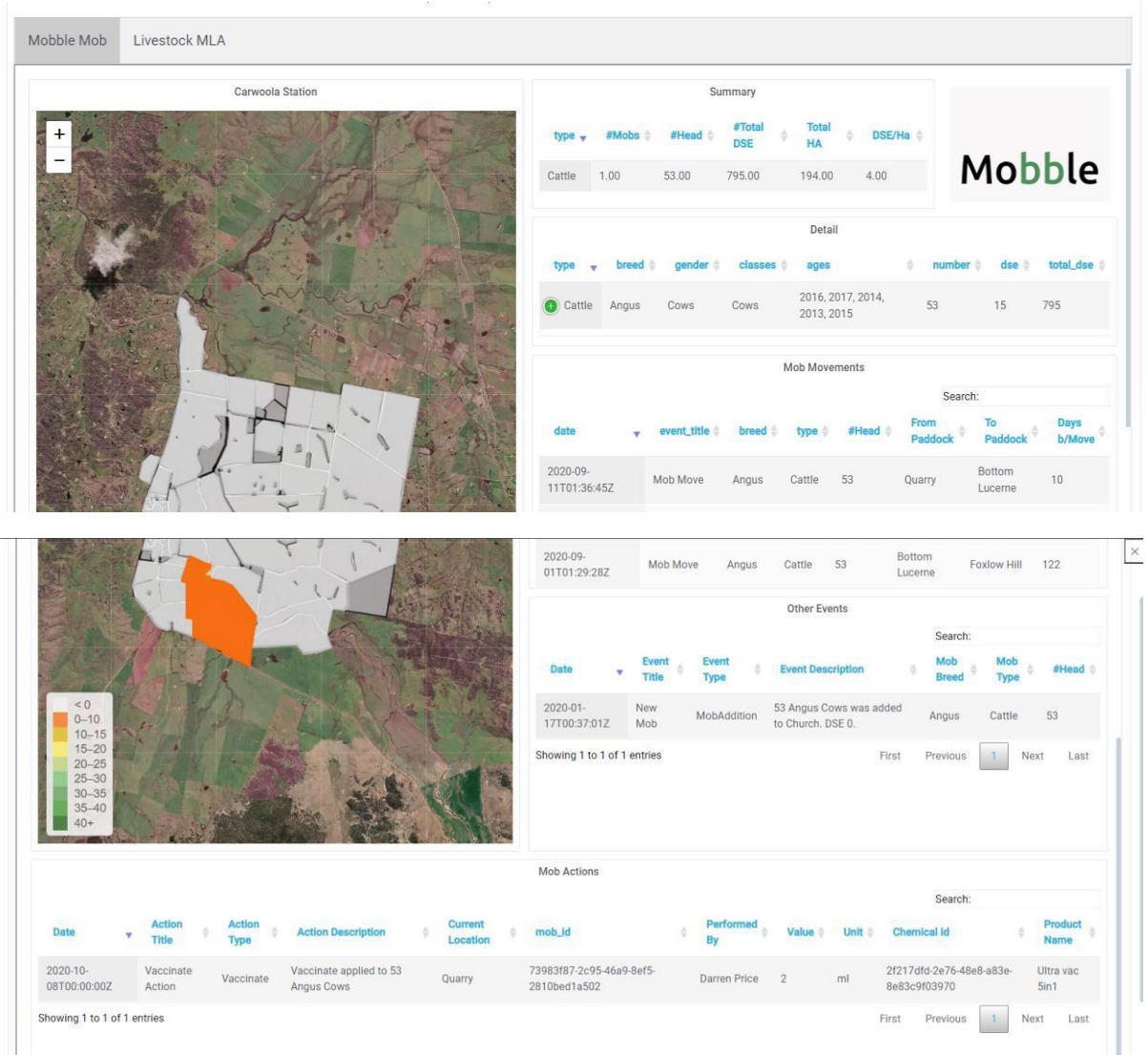


FIG 7: Shows a concise list of data points that have been gathered from the Mobbie Livestock Management App. These details can be used in multiple other research, development, extension and benchmarking services, as well as Animal welfare (animal husbandry, deaths, etc.) and integrity outcomes (LPA animal treatments, mob movements and risk areas)

<https://www.mobbie.io/>

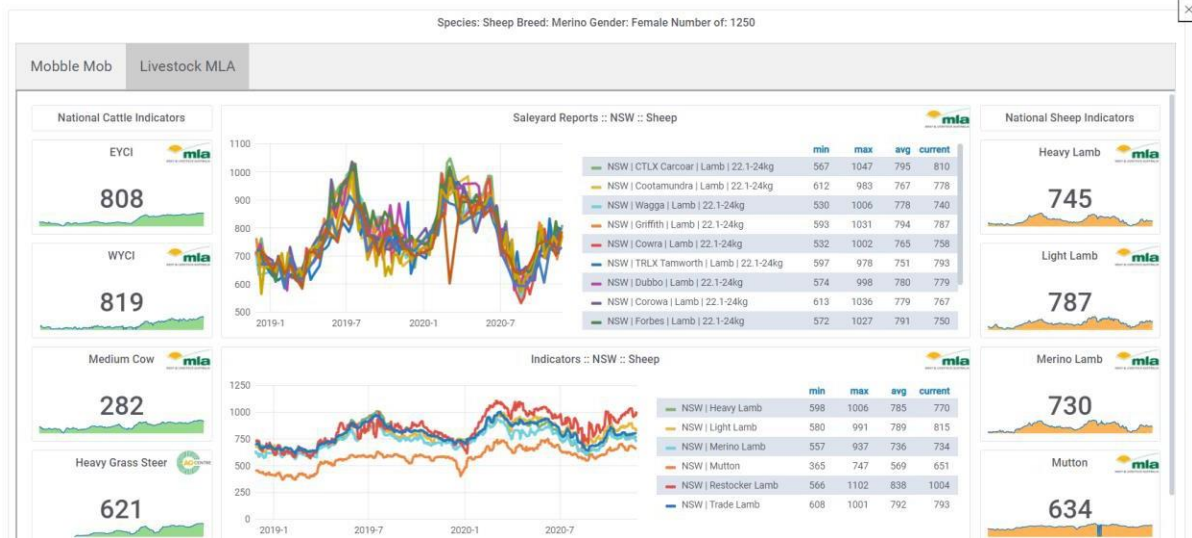


FIG 8: This tab connects MLA NLRS saleyard pricing for the mob, also providing the referenced pricing for the species and closest saleyard to that mob.

4.1.3 Compliance Connect

The Third Connect concept used to underpin the possibility of data convergence for research and extension is Compliance Connect. This concept utilises the last key approach that farmers and levy payers generally interact with their traditional data or 'Note pad and pens' approach. Compliance connect is built on a Calendar view with searchable filters to allow insight into activities, actions and outcomes that historically occurred.

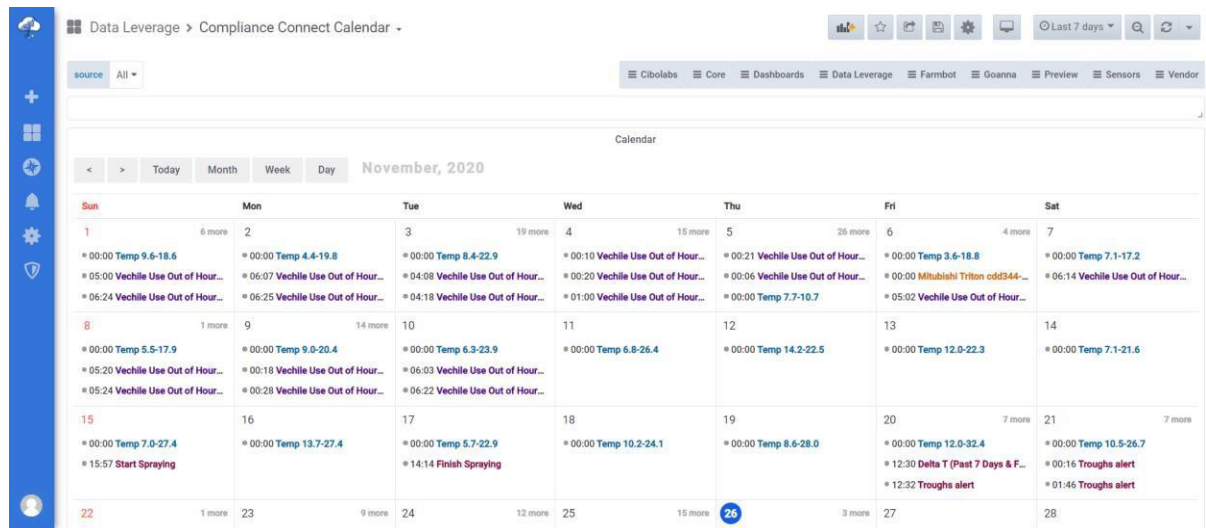


FIG 9: With 'ALL' data sets loaded into the concept we can quickly see the range of activities, alerts, notifications, annotation and outcomes that have been remotely recorded by disparate data solutions. Navigation is extremely easy to drill into a data set, by filter or date and time.

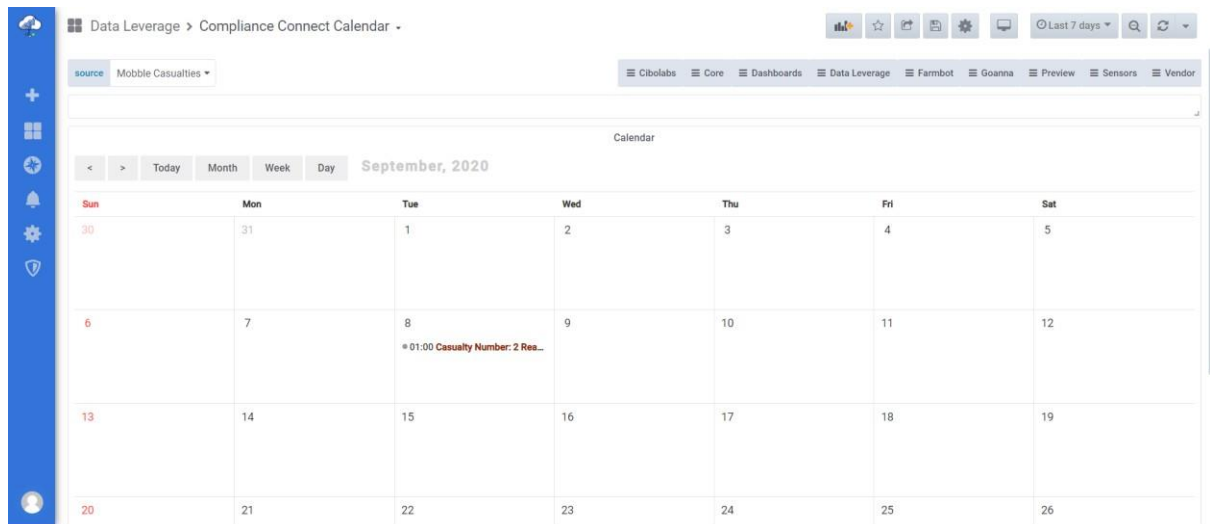


FIG 10: With only the 'Mobbie Casualties' selected we can quickly go back through time to see what the time series distribution of animal deaths was.

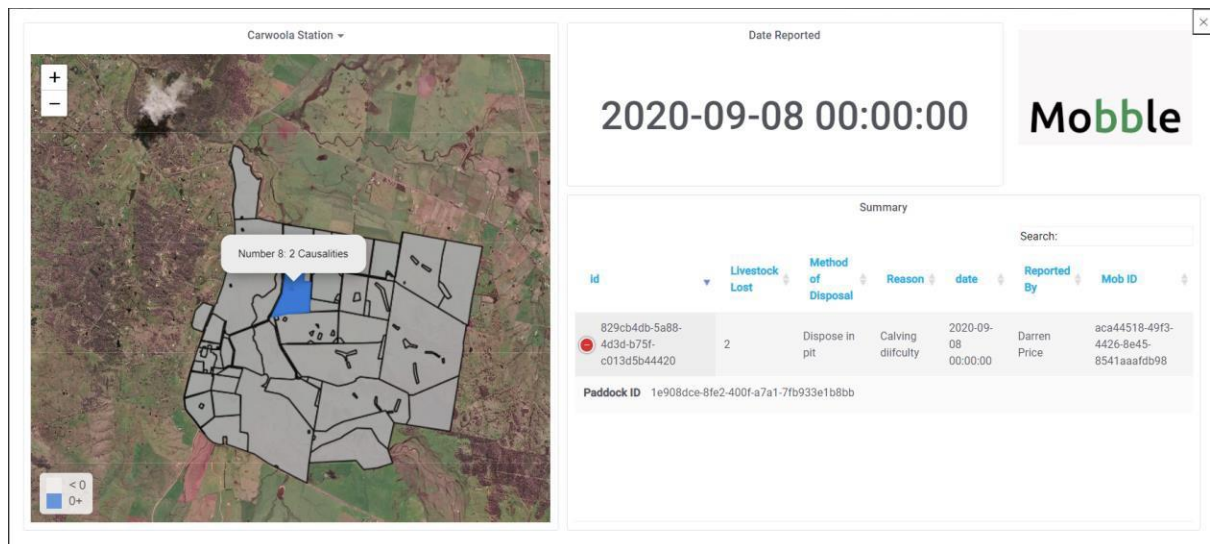


FIG 11: By selecting the deaths link, you can access a further layer of how they were disposed of, which paddock and the proposed theory of their death.

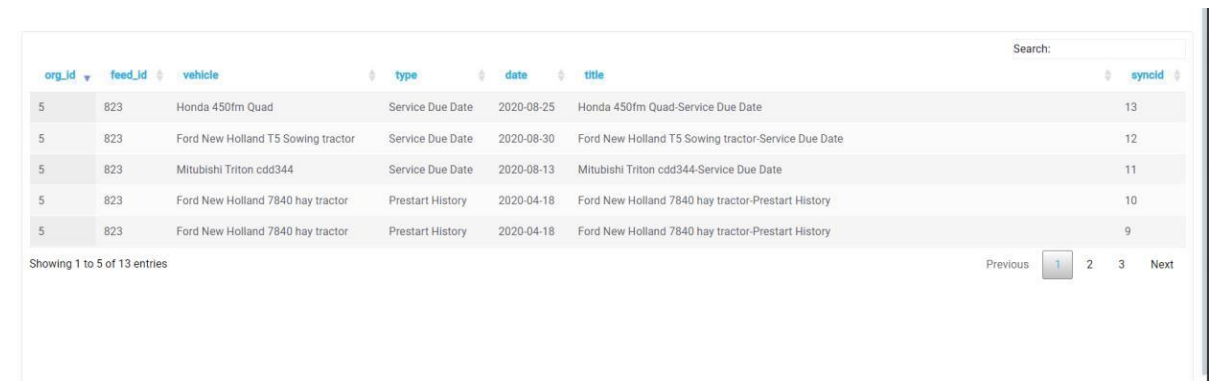


FIG 12: Other potential data could include links to Vehicle maintenance for Pre-start checks and service history, to assist with tracking of WHS and 'Overhead' cost assignments. <https://fleetcheck.nz/>

The Purpose of utilising the three ‘Connect’ services is to then allow demonstration of how tailored, localised and real-time RD&E services can be provided to levy payers within a POC concept.

It must also be stated that these results of this project rely heavily on great, reliable Australian (mostly) Agtech hardware and software providers. The data that is collected and shared by these providers is integral to Industry achieving affordable and effective decision support tools. Each solution or service has a specific focus and their ability to drill in and supply expert services around specific topics or areas, provides strong and reliable data sets to leverage and utilise within research and extension. It will be interesting to look at the reliability of larger services that may not have all fields populated within their solution and whether there is additional value?

The outcomes of the project are enabled by Pairtree utilising device or service specific data sets and then aligning these outputs through specific normalisation and mapping protocols to create the ability to converge the data in a meaningful way. The three key results that are enabled through this practice and body of work include:-

4.1.4 Research and Extension

Through the aggregated data within the project, Pairtree delivered two basic research collaboration POC’s and has included a third from some work done on a property in Central NSW. It was noted that Pairtree approached MLA and NSW DPI for some algorithms, but there was nothing that was accessible at the time.

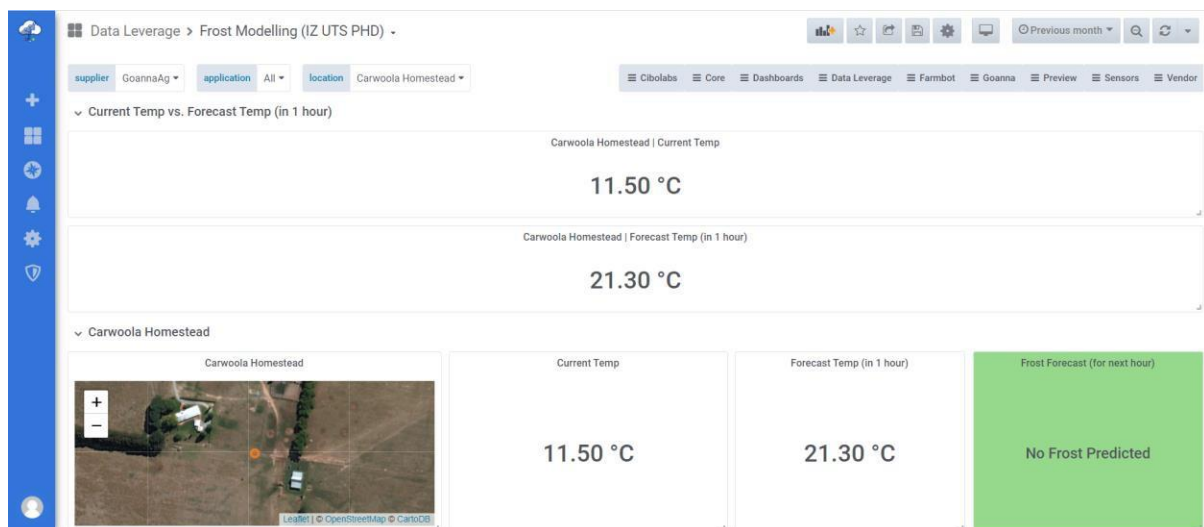


FIG 13: Demonstrates a collaboration with PhD student Ian Zhou, UTS, who had a viticulture frost prediction tools. Food Agility approached Pairtree to discuss whether there were options to assist Ian’s project and so, we provided a closed set of data that could be pushed to the algorithm and provide real-time computations ‘On-the-fly’ as requested by a user. Whilst the outputs were not particular to the red meat industry, the concept was proven that data can be pushed to third parties to provide leveraged data services and research extension.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1		avgairtemp	avghumidity	avgolarrad	bara2	barometric	daydegrees	daydegrees cumulative	cto	evapotranspiration	evapotranspiration cumulative	fieldvisiblity	kc	maxairtemp	maxhumidity	maxsoiltemp	minairtemp	minhumidity	minsoiltemp	ndvi	rainmm	windavgpdiph
2							0.98															
3																						
4																						
5																						
6																						
7			0.98																			
8																						
9																						
10																						
11																						
12								0.80						0.82		0.73	0.73				0.82	
13								0.96			0.96	0.97				0.94	0.87					1.00
14																						
15																						
16																						
17																						
18																						
19																						
20								0.96			0.96	0.97	1.00			0.94						
21																						
22																						

FIG 14: Is an output from Causality Activity Analysis (CAA) <https://www.causality.com.au/home/> which utilises the Principles of Cause and Effect within their algorithms, rather than just the usual AI type predictions methodologies.

“Causality - causation or cause and effect , Cause Entities data points - are related to Effect Entities data points - in terms of the measured influence by the cause - on the activity of the effect - over time... “

The above confusion table identifies the ‘Cause’ data points that correlate to the ‘Effect’ data points and their level of confidence. This ability to identify the cause and effect situations in this scenario (Weather station Vs soil probe data) seems quite trivial, but with a large and continuous data feed there could be some very interesting outcomes for industry.

Again, Pairstree has proven that with third parties (including industry researchers) data sets can be served as required to be ingested into specific models or algorithms to provide enriched decision support.

The third demonstration isn’t related to data from the Carwoola Digital twin, But is from a Wi-Fi IP Cameras by <https://zetifi.com/> on a project that NSW DPI ran for the ‘Farms of the Future’, Snowy Hydro funding. A third party approached Pairstree to test and understand how ‘Still’ camera images maybe used with image detection for alerting and monitoring. One once camera within the project was monitoring the driveway and taking still camera shots at 30 minute intervals and was picking up occasional vehicle movements. With only 365 images from a couple of 1000 images, the learning model was able to detect a vehicle presence or absence of vehicles in the images.

('absent') [99.6% confident of no vehicles]



FIG 15: Image without vehicle (absent)

('present') [99.8% confident that a vehicle is in the driveway]



FIG 16: Image with vehicle (present)

Predation and security will be key opportunities within this option.

4.1.5 Specific Agtech solutions

With numerous specialised agtech and digital Ag solution and service providers providing specific sets of information (data) to the farm managers, there is a clear result that leveraging of this data can increase the Value Proposition of all services.

Generally, Agtech providers feel that they must expand their services to get more customers and provide a 'complete' package. The findings within this report and the demonstrated data centralisation and convergence methods demonstrate that this assumption is no longer the case. A key result of this project allows solution and service providers (big and small) to collaborate with other complementary providers services to build out more tailored services for farmers and supply chain participants.

4.1.6 Farmers

Similarly with Agtech providers, Farmers can also benefit from agtech providers collaborating, whilst focusing on very specific problems and building a wealth of knowledge and services around maximising outcomes within that use case.

This focusing of agtech providers, then allows a clearer Value Proposition for the providers to the farmers. This in-turn creates greater flexibility and choice for farmers when selecting their suite of services for their operation.

Other Key results that are demonstrated within this project are that specific topics can easily be delivered from IoT devices that are designed for alternate purposes. For example we have chosen the Oyster GPS trackers, which are designed for locating vehicles. The data leverage project proposed two theories to test and provide Work Health and Safety monitoring aspects.



FIG 17: Vehicle Overspeed concept, where the Motorbike was limited to speed threshold of 50 Km/hr for safety. There was an alert and location noted of when the bike broke the speed threshold.

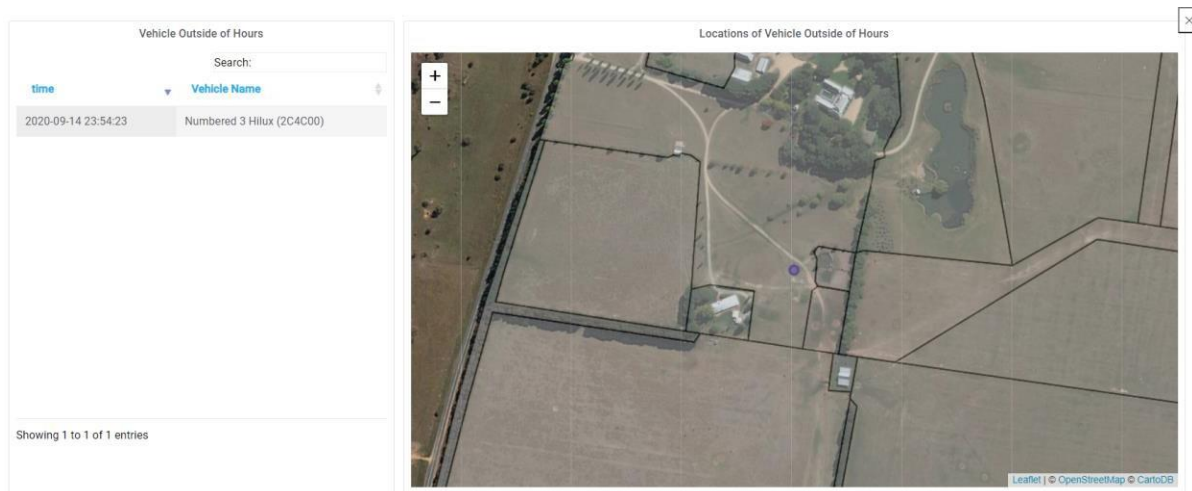


FIG 18: Vehicle movement outside of hours, this concept was monitoring vehicle movements outside of the general work hours of the business 7 am to 7 pm. This allows insight into either theft or times that lone workers may be operating plant and equipment and their last known position.

4.1.7 Uptime report

The Uptime report is a culmination of ‘Data Convergence’, which can provide industry with significant benefit overtime. As connectivity, battery health, ruggedness and installation ability all limit the capacity of Agtech and IoT to provide Long-term benefit. By considering that Data convergence is simply also aligning data for monitoring a ‘Heart-beat’ of the device, Pairtree can provide accurate insights into the daily, monthly and beyond uptimes and data capture. The approach below is sympathetic to the device (ie – if it pings once per day then it has a ‘Seen’ or was ‘Up’ for the day, regardless of its usual reporting schedule) and then calculates as a percentage of time where it was ‘Up’ or ‘Down’ to enable objective measurement of the devices. This report was then also run for the ‘Provider’ and the ‘Device type’.



5. Conclusion

The conclusion of this project is that ‘Agtech Data’ can be leveraged and utilised for research and extension activities.

For disparate data sources, there is a significant body of work to curate, normalise and make available the data in a usable format. Once the data is within a ‘usable’ format then large benefits to industry and levy payer can occur. Through-out this project and within the Milestone reports the integration and collaboration issues have been highlighted regarding the complexity of issues that must be overcome to allow industry to fully utilise and leverage the potential of Agtech & digital Ag.

There is still a significant body of work to determine which research works will add the most value to the levy payer in these circumstances, also how to best serve the data as decision support tools that are targeted and useful at critical times.

The interesting side outcome of the findings is that multiple small Agtech companies can contribute to larger benefits and so farmers and levy payers have choice in how they record and monitor their operation. Farmers can now utilise larger solutions with a few smaller agtech services to support the overall operational requirements. Or select a suite of smaller targeted providers to achieve a similar result. Flexibility and choice, will allow greater improvement and utilisation of the technologies as the value proposition and interactions will be clearer and more beneficial for the farmer.

5.1 Key findings

- Research and extension computations can be computed on the fly with localised real-time data sets from the farm that the levy payer is operating within;
- There is a significant process to curate, normalise and make available disparate data sets for wider industry use, but it is possible.
- There is considerable work still to do, within identifying key research extension options and the best User interface (UI) or User Experience (UX) to propel adoption.
- That Farmers (levy Payers)+Agtech solution providers both benefit from data centralisation

and convergence. Saving industry costs, time & physical & financial resources, whilst also providing flexibility of choice and greater value proposition for each solution.

5.2 Benefits to industry

This project has tested and proven that there is potential to supply meaningful research and extension services to levy payers, through tailored and customised approaches. A key benefit to industry will be that localised (on-farm or specific supply chain) data can now auto populate extension services. Essentially 'The Last Mile' or delivering directly to the consumer (farmer) is always the hardest step to deliver, this project has shown that there is capability there to deliver, the question is now, 'HOW TO'?

Also that visualisations or recommendations from the extension can be tested in a MVP type approach with iterations of the same outputs to be tested by the user for better User interface (UI) and User Experience (UX) outcomes, thus creating potentially greater adoption levels.

With Industry spending considerable investments in research annually, it is important to ensure that extension and adoption do not limit the opportunities that the research has created. Generally the outcome has to be to create a new App, which may not be the best option for extension and actual adoption. This project has provided the ability for auto-population of research variables and also a centralised and targeted resource to deliver new and old research.

6. Future research and recommendations

There are numerous research opportunities from this projects direction that can potentially positively impact the red meat industry. These may include, but not limited to:-

- Identify key industry calculators, algorithms and computations that may be tested under licence for localised real-time decision support,
- Identify key industry problems where multiple data sets are required to provide insight or operational support to levy payers,
- Review internal supply chain data sources to consider new services to levy payers
- Review UI and UX preferences for industry specific bodies of work and how they can be re-delivered, tested and improved upon. Is there elements of Gamification that can assist uptake?
- Review the different red meat species and production systems to develop more tailored extension services. Essentially utilising geographic location of sites to drive dynamically targeted and timely (seasonal) suites of services that levy payers can easily access.
- There are a number of 'Smart Farms/ demonstration Farms' that are exploring similar concepts for Industry or State based review and commentary. Pairstree is working with a number and it would be beneficial Nationally to see how the data from these many sites can be cross utilised for greater farmer and supply chain review, access and direction.

7. Acknowledgements

Pairtree would like to thank Meat and Livestock Australia, for providing the Carwoola Test bed, for industry and Australian Agtech to understand the value propositions and insights of Agtech to productivity and research and extension.

Pairtree would also like to acknowledge Carwoola Pastoral Company (CPC) for making their properties available to the Redmeat 2018 Digital Forum.

Thank you to Mr Darren Price for assisting with the Digital Twin and reviewing and engaging industry for external review within the leveraged data sets within the project.

Pairtree would also like to acknowledge the value of the underlying hardware and software that have enabled this project to consider the opportunity of data centralisation and data convergence.

7.1.1 Software Providers



7.1.2 IoT Providers

