



Final report

Making Real Farms Smart – Mixed Sheep Ag Tech

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Abstract

The project enabled Kunmallup Pastoral Co. - a Western Australian Mixed Sheep enterprise - and Origo to develop, implement and assess an autonomous on-farm connectivity and IoT farming operation support system that provides high-speed on-farm services not dependent on the Internet. The project aim was to quantify both the social and economic benefits of the well-planned use of IoT technologies and allow broad extension and evaluation by other producers.

There have been no major changes to the on-farm Origo farm technology up to the final report period, however the system has been expanded.

As seen from the Producer, Kunmallup Pastoral, the project has been a success. This is both seen from an operational, sustainable, social and profitability perspective. Origo can also report that it has contributed to better understanding of producer requirements and implementation in extensive livestock producer operations.

Executive summary

Background

This project enabled Kunmallup Pastoral a Western Australian Mixed Sheep enterprise and Origo to develop, implement and assess autonomous on-farm connectivity and IoT farming operation support system that will provide high-speed on-farm services not dependent on the Internet

Kunmallup Pastoral Company has been selected based on agreed criteria set out in milestone 2 of the research project schedule. In summary, the company consists of;

- Mixed Sheep & Grain operation
- Operating across ~9400ha
- Comprising four main properties around the Woodanilling area of Western Australia:
 - Kunmallup ~5700ha
 - Stronach ~620ha
 - Summerfield ~2100ha
 - Delyamine ~1000ha

Objectives

- The farming system, Financial Benefits and Smart Farming Methods - Impact on farming practices and business has been very positively impacted, both influencing profitability, sustainable water use, pasture management and social life.
- Water Management cost savings and reduced incidents, with an approximate uplift of 63%. impacts with regard to reduction and work of cost in “mop-up” after incidents in the water system is even greater.
- Weather - a microclimate weather station network provides
- Data greatly improving the management of pastures including decisions on time for grazing.
- Internet Performance - even with variability in Internet performance and service from Telstra, the implications both for the business as well as for schooling and social life is very positive.
- Implications on social life, both the ability to be able to support farm-sitters when incidents involving crucial water resources are involved, to remotely control water assets as well as the ability to work and providing schooling on-farm with Internet services “as-if-in-Perth” has been very important successes in the project.

The above is provided and documented by the producer (Bindi Murray, pers. comm. 28 May 2021).

Methodology

The project utilised a standardised methodology, the two last points were iterated four times during the project period:

- Discover Current Workflows
- Refined requirements
- Completed the design and planning of Internet Protocol Network and Origo.ag Agriculture Technology products and IoT network.
- Deployment and Testing of Internet Protocol Network and Origo.ag Agriculture Technology Products and IoT Network.

- Adaptation of Internet Protocol Network and Origo.ag Agriculture Technology (hereafter AgTech) based on testing results.

Results/key findings

Kunmallup reports that the project has been a success, as it provides management of its critical water resources, and not just monitoring. Secondly, the provision of hyper-local weather that is critical for both pasture management and its grains production.

- The farming system, Financial Benefits and Smart Farming Methods - Impact on farming practices and business
- A total of 63% uplift in efficiency to Water Management when implementing Automation.
- Further benefits in the use of high-resolution Weather - Climate Data
- Increased benefits of the Internet with performance comparative to semi-urban areas in Australia
- Profound benefits and implications on social life.

Benefits to industry

- Foundational changes to the farming system in terms of ability to manage variation and limiting factors in the farming system.
- Automation resulted in an immediate uplift in efficiency.
- Access to Internet services, as we are taking for granted in urban areas, is foundational and critical to the Producer.
- Realising the journey and utilising learnings to constantly improve and achieve targets using technology as a tool in the farming system, not a "nice to have" or a gadget.
- The project indicates strongly that it enables Producers to achieve 'economy-of-scale'.
- It is strongly indicated that Bindi and Kunmallup are utilising an analytical and "Operations Centre" approach to monitor and control their water assets.
- Uptick in awareness, nationally and locally.

Future research and recommendations

- The findings with regard to Internet Services provision and Mobile Internet and Mobile Voice services are crucial for producers as there are no other alternative to the current mobile services provider in regional and remote agricultural areas.
- It is important that the learnings and experiences from this project is utilised on a regional, state and national scale.
- To emphasise the journey from reactive and incident driven farming to an analytical and "Control Centre" approach.
- To utilise the learnings in this project for R&D in:
 - The importance of automation and remote control in water management systems in livestock production.
 - Importance of high-resolution weather observations in grazing systems.

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1. Background

This project will enable a Western Australian Mixed Sheep enterprise and Origo to develop, implement and assess autonomous on-farm connectivity and Internet of Things (hereafter IoT) farming operation support system that will provide high-speed on-farm services not dependent on the Internet. The project will describe both the social and economic benefits of the well-planned use of IoT technologies and allow broad extension and evaluation by other producers.

Origo will engage with the Southern Dirt Grower group to engage a mixed sheep enterprise to participate in this project. The region which the grower group is a part of has the highest density of sheep in Western Australia. The mixed sheep enterprise will maintain ownership and control of their farm data.

This project builds on the knowledge of P.PSH.1112 (Murchison House Station), where knowledge will be taken and transferred from a pastoral goat enterprise to a mixed sheep enterprise.

See: <https://www.mla.com.au/research-and-development/digital-agriculture/connectivity/>

1.1 Kunmallup Pastoral Co

Kunmallup Pastoral Company has been selected based on agreed criteria set out in milestone 2. In summary, the company consists of;

- Mixed Sheep & Grain operation
- Operating across ~9400ha
- Comprising four main properties around the Woodanilling area of Western Australia:
 - Kunmallup ~5700ha
 - Stronach ~620ha
 - Summerfield ~2100ha
 - Delyanine ~1000ha

1.2 Outcome

The implementation of AgTech at Kunmallup will see an increased knowledge and availability of local weather information that is expected to improve planning, decrease the effort involved in managing water for livestock and cropping activities.

As identified in the analysis, the direct benefit of this implementation is reduced effort such as driving to water tanks to check levels, driving to water tanks to check rainfall capture, checking local weather services and then driving to paddocks to verify before spraying. Improved efficiencies along with reductions in labour and input costs will be analysed and assessed against costs to install and maintain installed technologies.

Simple dashboards will be created to provide easy real-time access to all data information and data flows across weather and water monitoring devices.

- Efficiencies in managing crucial water resources, the ability to manage increasing variation in weather patterns, the importance of high-speed Internet services, and the social impacts of Internet services and AgTech on a mixed sheep operation.
- These questions are crucial for all livestock producers, as they are the foundation for a livestock operation to be competitive and sustainable in a modern world.
- The results are provided in reporting to MLA and both Kunmallup and Origo hope that it will be used by MLA to increase awareness and sound utilisation of information technology in the red-meat industry.

2. Objectives

Phase 1

A livestock enterprise will be selected based on the agreed selection criteria. These criteria include:

- Selection of Producer in an industry category (mixed sheep enterprise) based on a distribution across the livestock industry in WA,
- Producer's ability to contribute to regional extension in cooperation with grower groups,
- The Producer agrees to;
 - use a structured change management process to integrate Ag tech in their workflow to gain operational efficiencies and
 - invest cash in Ag tech to improve their operational efficiency.
 - allow site to be available for producer tours, field days, case study and publication of results in MLA extension programs.

Phase 1 will include an evaluation of candidate producers and have a stop/go decision point.

Phase 2

This phase starts with a review to establish the Producer's current workflow and operating costs. It will then identify improvements to workflow by use of Connectivity and IoT to make workflows more efficient including key performance indicators. These measures will then be used in quarterly reporting (phase 5) to evaluate how changes to workflows can change efficiencies as well as potential for further improvements. Phase 2 will evaluate and prepare plans for AgTech measures with regards to connectivity and IoT to be installed.

Phase 3

This phase installs the most appropriate connectivity solutions to provide internet coverage and data handling across the Mixed Sheep operation, both at central points of operation and across the whole operation based on identified requirements.

Phase 4

This phase installs IoT devices to leverage the benefit of whole of Mixed Sheep Enterprise operations connectivity, using IoT Mesh network, Wifi, 3G, Public IoT networks, and satellite connectivity methods as appropriate.

Phase 4 will also deliver;

- An agreed monitoring, reporting and evaluation template for quarterly reporting required for phase 5 of the project. This will include relevant benchmarking data points that can be used to assessed impact of project.

When Phase 4 is completed the project team from Origo will work with the Mixed Sheep Enterprise management to provide quarterly reports for both them and MLA on how the system is performing and identify any issues that need to be addressed under a potential project variation.

Phase 5

Reporting and monitoring for duration of project based on agreed template developed in phase 2.

3. Methodology

3.1 Discover Current Workflows

Meetings were held with Bindi Murray (property owner) to establish requirements through an iterative process.

3.2 Refine Requirements

Through follow up conversations, these requirements were refined into specific work processes that could be costed for time and labour.

This allowed consolidation into the three main focus areas of water management, weather monitoring and livestock management that fit project parameters and meet farm manager expectations.

3.3 Complete Design and Planning

3.3.1 Network Enable

NBN "Sky Muster" satellite services are currently used to provide internet connectivity to both the Kunmullup and Summerfield offices. The long distances and contention that come with any satellite

connection mean that latency is, comparatively, the worst of any possible NBN connection. Download and upload speeds are reasonable once they get going, though, and it's a massive improvement for areas covered by NBN satellite that previously had no internet.

Installing suitable devices at the Kenine TV Tower on the main Kunmallup property will allow access to 4G technology provided by either Telstra or Optus to eliminate latency and bandwidth issues experienced with the NBN Sky Muster service.

The Kunmallup and Summerfield offices will be connected to the 4G services via dedicated wireless links to improve daily operations. Adding link to Stronach's block will implement backbone connectivity across all landholdings required to facilitate AgTech (IoT) data flows.

3.3.2 AgTech Deployment

AgTech will be implemented in two key tranches: fixed infrastructure and mobile animal tracking.

Furthermore, fixed infrastructure will be divided into three sub-streams: infrastructure, weather and water.

3.3.3 Infrastructure

The internet backbone provided high bandwidth, which is generic and independent on the limited Telstra Internet access services available at the time. This independence enables Kunmallup Station to upgrade to other Internet access services as they become available, such as Starlink.

AgTech devices are required to be installed in remote areas of farms and produce relatively limited amounts of data. To meet this criteria, Origo's devices are built with integrated batteries and solar chargers that allow them to be installed as completely self-sufficient devices and utilise a wireless communication system that allows adequate information to be relayed without consuming high amounts of power. This has shown to be a very successful method to provide Ag Tech services.

3.3.4 Weather Monitoring

To provide information intended to enhance both cropping and grazing activities, a 6m weather station was installed on each property. These devices will detect temperature and humidity at ground level, 3m above ground and 6m above ground as well as general rainfall, wind speed, wind direction and UV.

Due to the size of the main Kunmallup property, 3 additional smaller stations will be installed to gather data that will be used to identify temperature, humidity and rainfall variability across the property.

This configuration of devices will be used to establish exposure factors for livestock as well as assist with planning and operations throughout the cropping activities.

This methodology was successful as it provides more relevant information for a mixed livestock and grains farming systems as they provide better information for pasture management in addition to features for the grain growing operation.

3.3.5 Water Monitoring and Control

The main Kunmallup property has two water systems for stock, spray and yard water. Each system is fed by its own bore and the systems are separate but able to be interlinked. These systems have some very basic controls with pressure shut off and electricity supply timers and are operated and observed manually and history has demonstrated that maintenance on this system can often be very time consuming.

Delyanine was originally two water tanks that were rain fed. To provide information on available water for activities as well as track rainfall capture, a tank level device was installed to keep track of the water in both tanks. Since the start of the project Kunmallup have been able to recommission a bore hole on the property and link it through the two existing tanks to provide replenishable stock and spray water and also fill the two large tanks as a fire fighting reserve. The original level sensor has been relocated to the new header tank and a flow sensor added to measure and monitor bore output.

The southern areas of the main Kunmallup farm are fed from an electric bore that is currently controlled using a manual clock timer device. To operate this unit, the level of tanks being fed needs to be known so that the pump run time can be calculated. Often this is just estimated ("guesstimate") that results in under or over filling. A tank level device will be installed on each of the legs that are fed from the bore that will provide up to date information to farm personnel on water in the system that can be used to determine pump run time. In addition to this, flow sensors at the bore manifold and a remote control will be provided to the bore pump so that it can be switched on and off remotely as desired.

Water in the northern parts of the main property is managed by a bore pump that is controlled by pressure sensors and a header tank that can be difficult to monitor and troubleshoot. Adding devices at the bore manifold to measure water flow will provide key information to ensure the system is well managed.

The Origo remote control, automation and monitoring system methodology has changed this part of the operation with increased profitability and ability to sustainably manage limited resources.

3.3.6 Sheep AgTech Development

As identified, significant benefit can be gained from intelligent devices on live sheep.

There are currently limited available devices that are suitable for use on animals the size of sheep. The objective of this component of the project will be to complete review of available technologies and devices with potential of being able to adapt one, if found, to sheep.

Due to available resources, this part of the project was spun off into a separate MLA project.

4. Results

4.1 The farming system, Financial Benefits and Smart Farming Methods - Impact on farming practices and business

During the project, Kunmallup has been actively using remote controls and automation in their water system, whereas before, this was completely manual and required travel and manual operation. The impact on water management has given an uplift inefficiency/value of approximately which provides an efficiency uplift of approximately 63% (Bindi Murray, pers. comm. 28 May 2021).

The most significant change has been that Kunmallup Pastoral can now maintain the system themselves, both in terms of troubleshooting as well as regular maintenance, and installation of new systems.

A weakness in the Digimesh IoT network going to Summerfield has highlighted the importance of redundant links in an operational IoT network like this. Maintenance and upgrades have been performed and further upgrades are planned. The network is performing as expected.

4.2 Water Management cost savings and reduced incidents

Before					
Category	Item	Item units**	Cost per Unit	No of	Total
Water Management	Weekly Fuel	\$ Per km	0.16	621	\$ 99
Water Management	Weekly Maintenance	\$ Per km	0.45	621	\$ 279
Water Management	Weekly Staff cost	\$ FTE Day	300	3	\$ 900
Water Management	Weekly Incidentals*	\$ Per week	1683	1	\$ 1,683
Water Management	TOTAL Summer	\$ Per Week			\$ 2,962
Water Management	TOTAL Summer	\$ Per 6 months	\$ 2,962	26	\$ 76,985
Water Management	Fuel	\$ Per km	0.16	246	\$ 39
Water Management	Maintenance	\$ Per km	0.45	246	\$ 111
Water Management	Staff cost	\$ FTE Day	300	2	\$ 600
Water Management	Incidentals*	\$ Per week	788	2	\$ 1,577
Water Management	TOTAL Winter	\$ Per Week			\$ 2,327
Water Management	TOTAL Winter	\$ Per 6 months	\$ 2,327	26	\$ 60,493
AVERAGE TOTAL ANNUAL COST (rounded down)					\$ 137,478

Summer						
Route	Trips	Km	tot km	Fuel per 1Km	Cost per Litre	Cost per Km
Kun+del trough	3	83	249	0.16	1	0.16
SF Bore& trough	3	77	231			
Stronach water	1	55	55			
tank/bore check	2	43	86			
			621			

Incidentals calcs			
troubleshoot time	1.5 month/ 6 months		10000
rebuild managent	4 days per hill tank loss incident	@ 500/day	
full tank loss incidents per summer	6	cost	12000
rebuidls required after spray water use	2	cost	12000
pump replacement house bore	3k/3years		1000
^ feed due to water constraints	8750		8750
			43750
			per week 1683

Winter						
Route	Trips	Km	tot km	Fuel per 1Km	Cost per Litre	Cost per Km
Kun+del trough	1	83	83	0.16	1	0.16
SF Bore& trough	1	77	77			
Stronach water	0	55	0			
tank/bore check	2	43	86			
			246			

Incidentals calcs			
troubleshoot time	0.75 month/ 6 months		7500
rebuild managent	0.5 days per hill tank loss incident	@ 500/day	
full tank loss incidents per winter	4	cost	1000
rebuidls required after spray water use	4	cost	12000
pump replacement house bore	3k/3years		0
^ feed due to water constraints	8750		0
			20500
			per week 788

Table 1. Water Management cost before project

After

Category	Item	Item units**	Cost per Unit	No of	Total
Water Management	Weekly Fuel	\$ Per km	0.16	306.6	\$ 49
Water Management	Weekly Maintenance	\$ Per km	0.25	306.6	\$ 77
Water Management	Weekly Staff cost	\$ FTE Day	300	2	\$ 600
Water Management	Weekly Incidentals*	\$ Per week	385	1	\$ 385
Water Management	TOTAL Summer	\$ Per Week			\$ 1,110
Water Management	TOTAL Summer	\$ Per 6 months	\$ 1,110	26	\$ 28,863

Water Management	Fuel	\$ Per km	0.16	175	\$ 28
Water Management	Maintenance	\$ Per km	0.25	175	\$ 44
Water Management	Staff cost	\$ FTE Day	200	1	\$ 200
Water Management	Incidentals*	\$ Per week	558	1	\$ 558
Water Management	TOTAL Winter	\$ Per Week			\$ 829
Water Management	TOTAL Winter	\$ Per 6 months	\$ 829	26	\$ 21,564

AVERAGE TOTAL ANNUAL COST (rounded down) \$ 50,427

CAPEX Amortised over 5 years (ex R&D) 65,000 13,000

TOTAL ANNUAL EFFICIENCY SAVINGS \$ 74,051

* Incidentals includes parts and tools

** Estimated average

Summer

Route	Trips	Km	tot km	Fuel per 1Km	Cost per Litre	Cost per Km
Kun+del trough	2	83	166	0.16	1	0.16
SF Bore& trough	1	77	77			
Stronach water	1	55	55			
tank/bore check	0.2	43	8.6			
			306.6			

Incidentals calcs

troubleshoot time	0.75 month/ 6 months	7500
rebuild managent	1 days per hill tank loss incident @ 500/day	
full tank loss incident per summer	1	cost 500
rebuidls required after spray water use	2	cost 1000
pump replacement house bore	3k/3years	1000
^ feed due to water constrints	8750	0
		10000
		per week 385

Winter

Route	Trips	Km	tot km	Fuel per 1Km	Cost per Litre	Cost per Km
Kun+del trough	0	83	0	0.16	1	0.16
SF Bore& trough	0	77	0			
Stronach water	0	55	0			
tank/bore check	0.2	43	8.6			
			8.6			

Incidentals calcs

troubleshoot time	0.25 month/ 6 months	1500
rebuild managent	0.25 days per hill tank loss incident @ 500/day	
full tank loss incident per winter	1	cost 1000
rebuidls required after spray water use	1	cost 12000
pump replacement house bore	3k/3years	0
^ feed due to water constrints	8750	0
		14500
		per week 558

Table 2. Water Management after project implementation

4.3 Weather - Climate Data

It is clear from the managers statements that they have transitioned from having to live with variability to being able to manage variability. This manifests in:

- Seeding order changed from where it has been too wet to where it is favourable to seed.
- Get the grazing right where pastures will bulk before soil temperature falls.
- It has been using 'Pastures from space'; however, it has been challenging to use as it is not per pasture/paddock.
- NDVI (vegetation index) shows the result, whereas rainfall shows where pastures and paddocks grow.
- Rainfall distribution is essential and will review weather stations to see if they can get to a point where Rainfall Distribution maps can be generated.
- The importance of understanding heat load can also be seen as this could give information about when pastures stop bulking up.

The variation in rainfall has been visible and felt like a change over several years. However, it has not been possible to quantify and locate these changes to action changes in the farming system due to lack of data" (Bindi Pers. Comm 6 January 2021).

It has also been useful in the wet winter that was 2021. It was a winter like those of the 1970s, and the real-time and trend weather data as to rainfall temp assisted in getting the full spray program achieved in very, very wet conditions. We have been able to enjoy the fruits of the wet year without creating a weed burden hangover for years to come" (Bindi Murray, pers. comm. 30 January 2022).

No further changes to the use of Weather and Climate data. The system functions as intended.

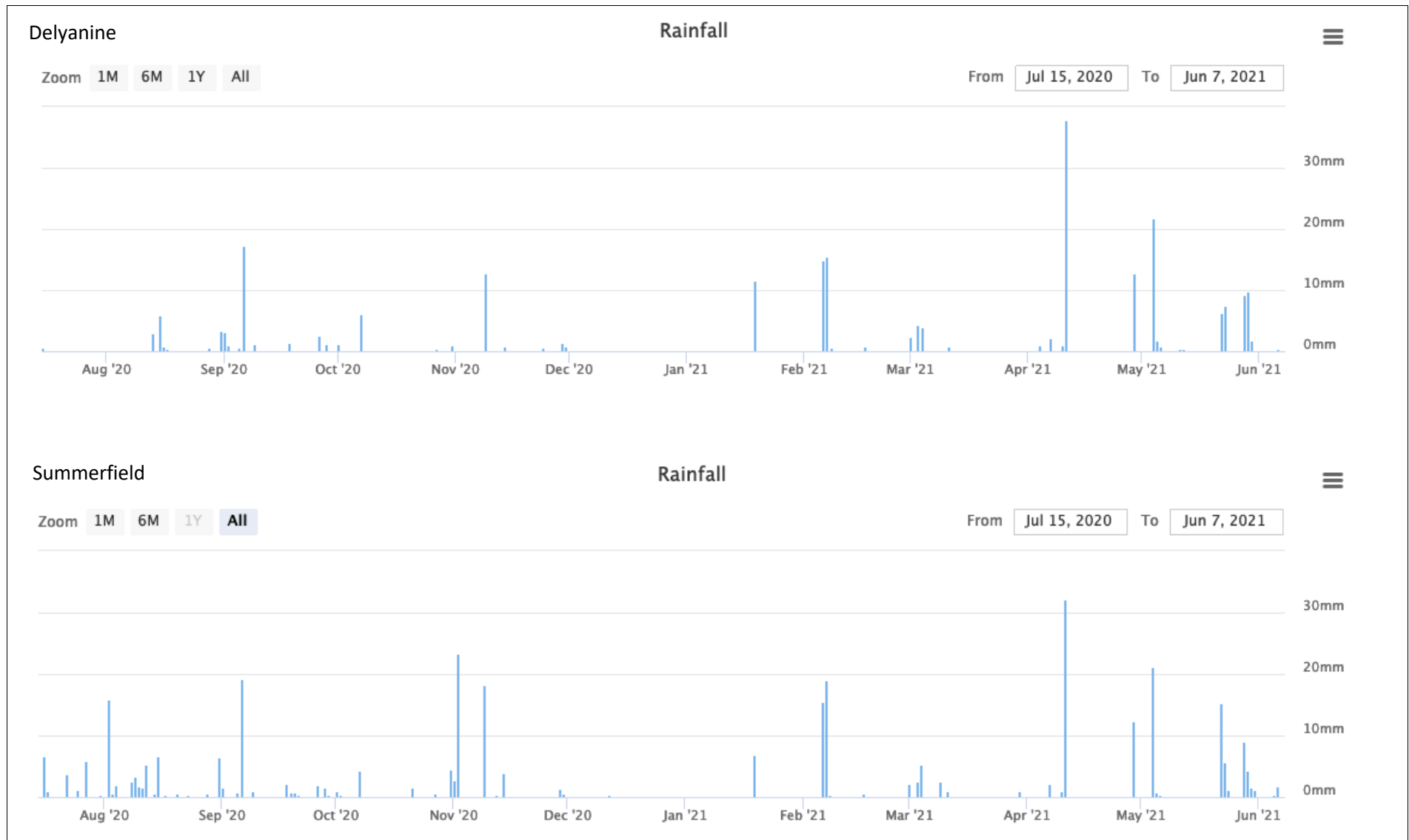


Figure 1. Updated example variation in rainfall between two of the farms and weather stations, "Delyanine" top figure and "Summerfield" bottom.

4.4 Internet Performance

Telstra Mobile Broadband Services provide Internet Service; see Figure 2,3 and 4 on the next pages for results.

- Please note the variance in download speeds in the last reporting period, this signifies greater instability. This is very notable in periods with expected greater traffic than normal, such as during seeding and harvest. Also, during the abnormal Covid-19 period.

When the network services provided by Telstra works, it provides the following:

- Internet works even when mobile phones do not connect to the mobile network.
- Can use Zoom and other Internet videoconferencing services without interruption, limiting the need for extended interstate meetings.
- The school children have been able to use WebEx as provided on the school Laptop without interruptions. Bindi's son has had full participation without interruptions.
- Expansion of Wi-Fi Network to another house.

Reasons around the service deterioration issues are discussed below in section 6.4.

During periods of service deterioration, the service cannot be used:

- Please note that the figures are presenting daily averages, minimum and maximum.
- Latency (“Responsiveness”) of Telstra network services spikes to 400-500 m/s which will make it unusable for Teleconferencing and other services that requires latencies in the range of 100 m/s, as has been seen previously. From May 2022 to August 2022, the latency signifies usage saturation.
- Outside periods of instability, the network has a downward trend with regard to download with averages before 2022 above 40 Mb/s now down around 32 Mb/s. In the period from May 2022 to March 2023, this trend is significant with the average now around 23 Mb/s.
- The trend for upload is not as strong, previously near 40 Mb/s and now down to around 35 Mb/s.

As observed in the last report, the latency has slipped, but there are two major considerations:

- Very low latency during instability.
- Downward trend for download speeds.

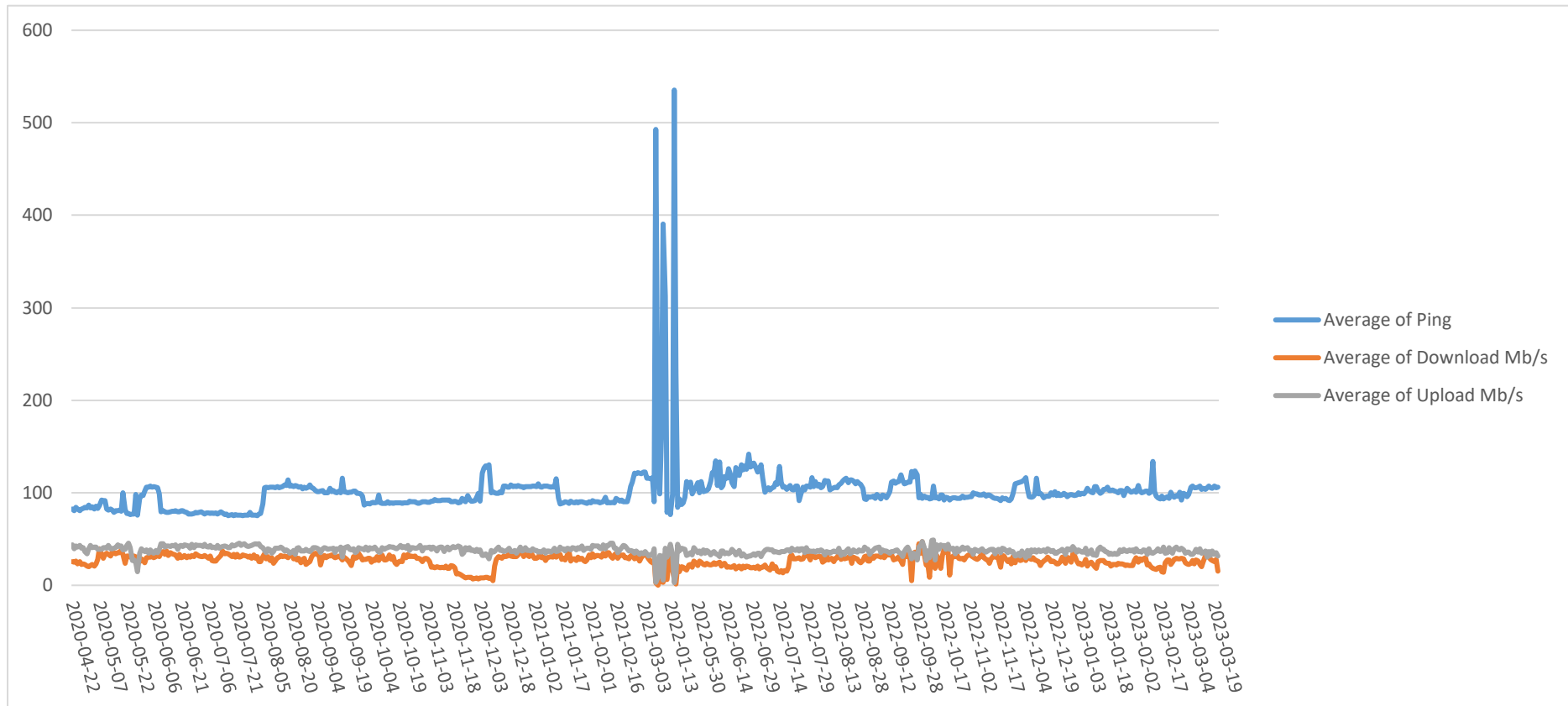


Figure 2. Average speeds, Internet performance data from start of project to Milestone Final Report.

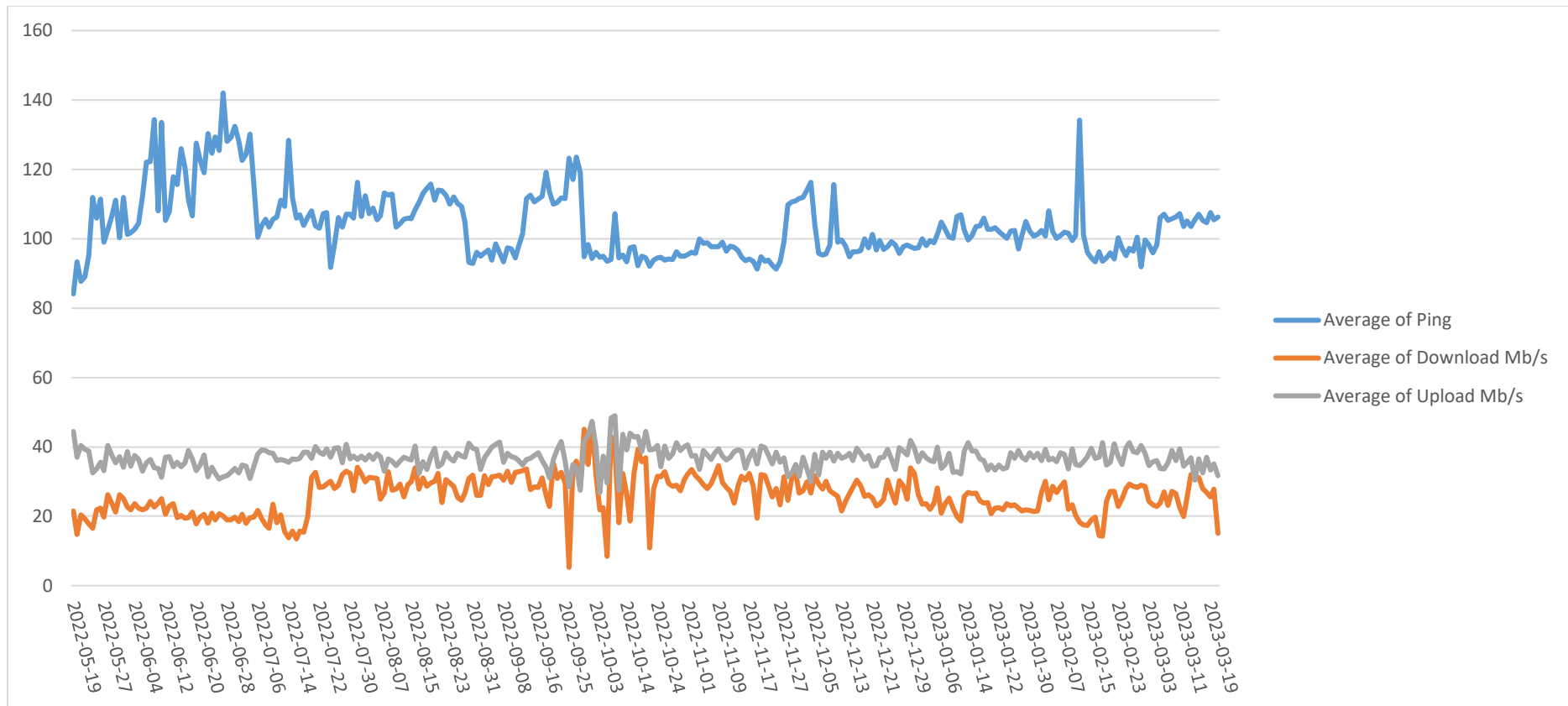


Figure 3. Average Speeds, Internet performance data in the last reporting period up to the final report.

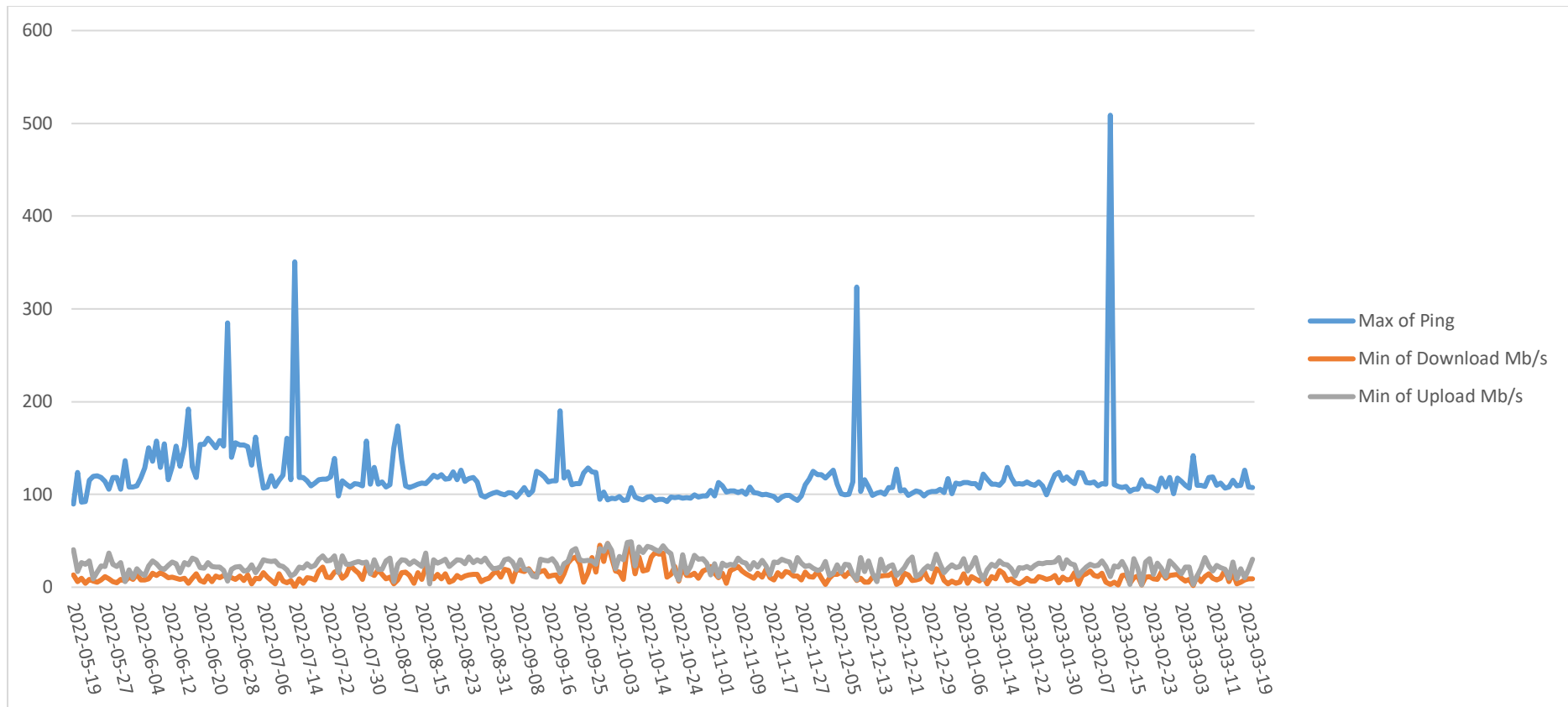


Figure 4. Minimum Speeds and Maximum Latency (Ping), Internet performance data in the last reporting period up to the final report.

4.5 Impact of better Internet Access Services

There is a downward trend with regard to download speeds and the outages have become more frequent and service has been less stable, however, implications have only been for interactive services, during periods of instability.

As the children have grown up there is more usage, however, this has not impacted on the required performance for the farming enterprise, as the usage is normally at different times. Bindi has been able to present at an international conference from her home office at Kunmallup.

The family has now eased up and data budgeting and allowed the use of entertainment services such as Netflix, and this has not to lead to any issues for the wider use of services:

"In terms of the faster better internet speeds it has meant that I am no longer the data police in our house. We would not have been able to undertake the home schooling required under covid with our satellite system. Our family had very limited private data use on our satellite connection. My husband once streamed Netflix while recovering from surgery at the start of the month. We were shaped and I had to pay bills and send emails by tethering my mobile to the PC for the remainder of the month. It also had functional issues and the hardware often needed to be reset. It is hard to quantify the difference, but I don't think about my data speed or internet performance anymore whereas "I'm sorry we are on satellite broadband" used to be a common phrase around here. I have not however told my children that our Internet is any better..... as far as they are concerned, we are still on satellite!!" (Report Milestone 8, Appendix 1).

Please note from the results that entertainment versus work-related usage has changed from 50/50% to 60/40%,

The reduced need to travel interstate for engagements in sheep industry bodies has meant a lot about being able to engage without disruptions to the Kunmallup operations, especially during the COVID-19 pandemic related restrictions.

This result is very much relevant for section 1.3 Implications on social life. The results are very much in line with the results from MLA Project P.PSH.1112 Murchison House Station project.

The tables below have been updated and provided by Bindi".

Before

NBN SKYMUSTER

Source: <https://www.whistleout.com.au/Broadband/nbn-sky-muster-satellite-plans>

Category	Item	Item units	Cost per Unit	No of GB	Total	GB Per month	Price
Internet Access	Daytime - Office hour & Day/Evening Quota 7am-1am	Average GB per day	-	1.1	1.10	40	20.0
Internet Access	Nighttime - Quota "off-peak" Quota 1am-7am	Average GB per day	-	3.9	3.93	120	20.0
Internet Access	Daytime - Office hour & Day/Evening Quota 7am-1am	Average Cost per day	\$ 0.61	1.3	0.80	40	24.5
Internet Access	Nighttime - Quota "off-peak" Quota 1am-7am	Average Cost per day	\$ 0.20	3.9	0.80	120	24.5

Category	Item	Item units	No Of	Total	Av. GB Available
Internet Access	Daytime usable availability to family	Average GB available Per Family member	4	0.28	1.10
Internet Access	Daytime usable availability to staff	Average GB available Per Staff member	3	None	None
Internet Access	Nighttime usable availability to family	Average GB available Per Family member	4	0.98	3.93
Internet Access	Nighttime usable availability to staff	Average GB available Per Staff member	3	None	None

Estimated average speed 5MB/s total monthly available daytime quota 40GB for \$1.6 per day

Table 3a. Impact of Internet performance before and after project implementation as of Milestone 8.

After

Mobile Broadband with on-farm Wifi

Source: Origo Quarterly Reports and Data collected from MHS

Category	Item	Item units	Cost per Unit	No of GB	Total	GB Per month	Price	Monthly Cost/CAPE X 5 years	GB Max Per day	GB Monthly Average*
Internet Access	Unlimited All day	Average GB per day*	-	21.7	21.7	Unlimited	35	250	346	663
Internet Access	Unlimited All day	Cost per day	\$ 9.34	21.7	9.34	Unlimited	35	250	346	663

Category	Item	Item units	Per Cent	No of	Total	Av. GB Per Day
Internet Access	Actual usage family private	GB Private	60%	7	1.86	13.04
Internet Access	Actual usage work	GB business	40%	4	2.17	8.70

* Based on usage statistics

Average speed is 14 MB/s with average total monthly usage of 663 GB for \$9.34 per day, unlimited data

Table 3b. Updated Impact of Internet performance before and after project implementation as of Milestone 8.

1.3 Implications on social life

Implications look to be profound and can be divided into six categories:

1. Reduced stress and increased feeling of control in both sheep and grains operation.
2. Participation in national and state agriculture industry bodies with less pressure and stress, even during the COVID-19 pandemic.
3. No disruptions to school participation due to better Internet connection.
4. Increased use of entertainment for relaxation and recovery.
5. Expansion of WiFi network to another house, mostly for office use.
6. School usage has increased during the project period as the kids have grown, the performance is adequate for this increased requirement for capacity.

1.4 Additional value adoption

1.4.1 Expansion of Water Management System - fundamental for water security

Kunmallup has been able to bring on-board staff, both temporary and permanent, which means a lot when the management is away from the farm. Bindi can also guide and manage remotely and assist staff when away.

The IoT system is now a fundamental part of managing water resources and providing water security.

As Kunmallup Pastoral is a mixed cropping and sheep operation, it is now possible to plan spray water as well as stock water without time and resource consuming travels and organisation. This is especially important where rainwater is captured for spray and stock water, where usage is a finite resource and needs to be planned carefully.

The system has enabled the Summerfield property to expand the livestock operation in a water-secure manner. In addition, a new tank has been installed with water level and flow to troughs installed. This indicates that the technology has enabled Kunmallup Pastoral to increase scale without considerably increasing cost ("economy of scale").

"Also, the same is valid for the Delyanine farm, except that at Delyanie we have been able to add a low yielding but very high quality bore that also serves as a redundancy for drinking water for the other farms " (Bindi Murray, pers. comm. 30 January 2022).

1.4.2 Weather forecasting and observations

Origo.ag has discussed the need to combine weather forecasting and observations in the same platform. Kunmallup sees this as a very important addition.

This would be important for livestock management during lambing as well as for pasture management, and the Kunmallup grains operation.

1.4.3 The process with regards to increasing understanding and adoption

Kunmallup and Origo has been working with MLA and the Southern Dirt grower group to contribute to extension activities and Origo contributed to a "Southern Dirt Water Summit" during the project period. The event was very well attended and had good engagement during the Q&A and site visit despite very challenging weather and a hailstorm during the on-farm section.

We hope that further extension activities can be funded to ensure that the positive results from the project can be used to the benefit of producers regionally and nationally.

Bindi is reporting that there has been a substantial uptick in interest from producers, both from her national network in the industry and locally. She is able to demonstrate and prove, just by using her Smartphone how Kunmallup is using the Origo.ag technology in the Kunmallup mixed farming system.

Bindi and Origo discussed the farming group co-operations, exemplified by Beaumont Group, Munglinup Group as Facey Group, how local cooperation can add value both for small and large producers.

5. Conclusion

The project is successfully concluded and is in line with the agreed project contract.

5.1 Key findings

- As the project and implementation matures and becomes part of daily operation, we see that it is getting close to the "efficiency ceiling".
- The most significant change is the Kunmallup Pastoral ability to service, troubleshoot, do regular maintenance and simple installation tasks, and not be dependent on a technician.
- A critical observation is that the structure and systematic approach Kunmallup uses in their operation is crucial in the uplift of efficiency, as data-based decisions require systematic methodology in day-to-day use and planning to reach its full potential.
- Expansion of the Origo.farm system on farm with an additional XTS Tank Top Monitoring system will create redundant links, the system is currently operating as expected.
- Kunmallup is able to expand system and as they have now bought a new property, they can keep their operational cost down, as they do not need to add additional staff.
- The property manager states that it cannot be undervalued the way Origo.ag IoT technology enables Kunmallup to recover quickly and efficiently from a catastrophic event such as a major water leak. In the past this has meant many days of wasted travel and staff time, just to check that stock water is available at all watering points, in addition to the initial repair. Now, Kunmallup can discover the incident quickly, repair and watch the status of the water system on the Origo.ag Dashboard.

- The project progress has been heavily impacted by COVID-19 effects. As the Kunmallup farming operations have had to work through lockdown, availability of staff and to ensure that elderly parents are being protected. The planned extension activities have also been impacted as field days and events have been cancelled or postponed.
- Despite the challenges with regards to the COVID-19 and the earlier implementation stages, the Kunmallup project has reported positive results for the mixed sheep operation, which will be necessary for the wider industry and in particular, in managing a large sheep operation with complex water infrastructure.

Even with the delays, the project milestones have been achieved, the project a success and has delivered results:

- The farming system, Financial Benefits and Smart Farming Methods - Impact on farming practices and business
- A total of 63% uplift in efficiency to Water Management when implementing Automation.
- Further benefits in the use of high-resolution Weather - Climate Data
- Increased benefits of the Internet with performance comparative to semi-urban areas in Australia
- Profound benefits and implications on social life.

5.2 Benefits to industry

The project provides essential information with regards to the successful utilisation of Ag technology to achieve both financial and socio-economic benefits to a large mixed sheep producer, in conclusion:

1. Foundational changes to the farming system in terms of ability to manage variation and limiting factors in the farming system.
2. Automation resulted in an immediate uplift in efficiency.
3. Access to Internet services, as we are taking for granted in urban areas, is foundational and critical to the Producer.
4. Realising the journey and utilising learnings to constantly improve and achieve targets using technology as a tool in the farming system, not a "nice to have" or a gadget.
5. The project indicates strongly that it enables Producers to achieve 'economy-of-scale'.
6. It is strongly indicated that Bindi and Kunmallup are utilising an analytical and "Operations Centre" approach to monitor and control their water assets.
7. According to Bindi, the project has been part of her ability to show and tell in the livestock organisations she is part of, and she has seen and uptick in awareness, nationally and locally.

6. Future research and recommendations

- The findings with regard to Internet Services provision and Mobile Internet and Mobile Voice services are crucial for producers as there are no other alternative to the current mobile services provider in regional and remote agricultural areas.
- It is important that the learnings and experiences from this project is utilised on a regional, state and national scale.
- To emphasise the journey from reactive and incident driven farming to an analytical and "Control Centre" approach.
- To utilise the learnings in this project for R&D in:
 - The importance of automation and remote control in water management systems in livestock production.
 - Importance of high-resolution weather observations in grazing systems.

7. Appendix

Bindi Murray – Kunmallup manager, Written and Personal Communication 28 May 2021 and 6 January 2021, Milestone Report 8 Appendix 1.

1. Change in system:

The first issue that I struck in trying to compare the old system with the new system was as with everything change is inevitable. Our physical and managerial systems have changed from the beginning of the project to now. Some of this change is due to unrelated long-term evolution but many of the changes have been either informed or enabled by the information or time savings from the Origo system. I will try to show this evolution component in the areas below as well as in the following description of the systems. Our previous water system had 2 separate, but interconnectable, bores on one property providing water security for 15000 sheep and lambs and approx. 3800ha of crop. The 2 systems are somewhat complex with header tanks with visual level markers feeding sub tanks and lines and a combination of electrical timers and electrical pressure switches providing a level of self-management. At this point in time the system is now 4 bores on 4 properties providing water security for 17500 sheep and lambs and 3900ha crop. We also have been able to better manage the grazing on at least 1000ha through trough supply for winter grazing and also for confinement/break of season pasture deferral, which has meant we can meet good practise weed control in the cropping side and ewe management in the sheep side. Previously this has been a tussle of choosing one at the detriment of the other.

2. Increased understanding and confidence in technology.

I had dabbled in remote camera and weather stations previously and am reasonably computer literate but did not have the knowledge to understand what options were to deliver cost effective savings to my desire for more information or more efficiency. I know that one cannot understand the inner workings of everything around them but in a location such as ours and with animal welfare related systems I have always felt that I need to know enough to make sure the design is fit for purpose, interrogate data that comes from it and avoid critical failures. I am so glad that we staged the install as it allowed me to develop my understanding of the capability the wifi backbone provides, and the devices can deliver. We have actually changed the system in light of this understanding and the development of the water system at the delyanine and summerfield farms were done with effective remote monitoring as the backbone of the system, as has the placement of tanks and extension lines on the original system at kunmallup. It has moved from how can technology do what we do better, to what more can we do with this now that we have digital capability.

3. In terms of the faster better internet speeds it has meant that I am no longer the data police in our house. We would not have been able to undertake the home schooling required under covid with our satellite system. Our family had very limited private data use on our satellite connection. My husband once streamed netflix while recovering from surgery at the start of the month. We were shaped and I had to pay bills and send emails by tethering my mobile to the PC for the remainder of the month. It also had functional issues and the hardware often needed to be reset. It is hard to quantify the difference but I don't think about my data speed or internet performance anymore whereas "im sorry we are on satellite broadband" used to be a common phrase around here. I have not however told my children that our internet is any better..... as far as they are concerned we are still on satellite!!

4. More accurate data.

From the beginning of the project to now the impact of summer rainfall on our business has increased. We have been getting more small cell intense rainfall events and with declining winter rainfall these are becoming more useful. Prior to the weather station network we relied on manual recording and one DPIRD monitoring station on one farm. Our actual rainfall information was very granular and there were some big holes. We now use the stations to look at the amount and timing of rainfall across the blocks and have changed the order of seeding in the last 2 years based on the info. This allowed us to take advantage of moisture from early rainfall events. It has also allowed us to identify which dams could increase their water capture with catchment improvements and which ones are dry because there has simply not been enough rainfall.

5. Increased monitoring

The monitoring routine was previously based on fixed monitoring of the delivery end (troughs etc) 3x per week in summer and incidental monitoring of the system (tank indicators and pump running times) the rest of the time. The system monitoring was not really enough but was what could be done. It was not uncommon to wake up in the morning to find that there had been a critical failure in the rock bore system and that the header tank was empty and due to a burst in a low pipe, troughs were empty and there was not enough water to flush the toilet in 2 households and the workshop. It also meant that monitoring could not be done from anywhere else, after dark or during harvest and vehicle movement bans. My standard routine is now to check the system at approx. 6am and 11pm and whenever possible in between. This takes 2-3 minutes and can be done anywhere, even away from the farm!!! We have not had a critical failure causing total loss of the header tank in at least a few months. I was also able to spot a leak on another farm at 10pm and call to have the tank isolated on the spot until the issue was identified and repaired in the morning, saving 50000L of water, this could have otherwise gone unnoticed for 48 hours. The reduction in stress level and confidence to leave the farm without worrying if there has been a critical failure is huge.

6. Faster diagnosis.

The ability to look at water movement on the hour/day/week/month basis not only lets you see the rhythm of the system but also any changes to the rhythm. We decided to do something we have not done before this Christmas and left the farm for 48 hours without having an experienced staff member onsite to monitor the system. Of course, on the second morning I could see that there was a major issue and it appeared that not only was the house bore header tank empty the bore was not auto switching and therefore not pumping. By giving direction to the farmsitters over the phone, who had never been to the farm before, we were able to diagnose the location of the pipe that had burst, reset the auto switching that had been thrown out by a power failure, talk them through repairing the pipe and adjust the system to direct water to the sheep that were reliant on that system only for their water. These were the rams and this could have had a major impact of their preparation for joining if the situation had not been sorted. This took about an hour and a half to do over the phone.

7. The key to it is being able to see not only if there is one problem but a series of problems. This used to take a huge amount of time in the old system as you often had to diagnose each issue individually and then wait to see if the tank level responded and you had fixed the system, or if you had to go and look for another leak. In times when I can see there is an issue in either the morning or evening system scan I can tell which

line has an issue, if it is a minor or major leak and then recall if there are any sheep that rely solely on that water directly and decide to fix it immediately or isolate it. Previously I would see that an issue was affecting the header tanks and by that stage I needed to drop everything and attend to the diagnosis straight away. The flexibility that the faster more accurate diagnosis of system leaks and issues brings is great for job planning and routine.

8. Remote rebuilding

In the event of a major issue somewhere the system usually needs to be actively rebuilt. This means the reduction of flow to lines with the least need to speed up the building of water in lines of high need. This is less important in winter, unless during crop and pasture spraying, but critical in summer. This meant that I could basically rule out leaving the farm until any header tank affected had rebuilt to at least 30% in the event of a critical failure. I can now have more control over the flow in the rebuild, previously you could have the tap on, off or just a tiny bit on, now I can adjust the taps to apportion the total capacity, check that the system is constant and readjust when certain sections are properly full. I can also see if the system is not constant and see if there is a reoccurring/new problem.

9. Social aspects

The complexity in the old system meant that while you were on farm and there were no issues the system was fairly self-sufficient. It also has redundancy setups so that you could generally work around most issues. It did however mean that there were really only 2 people on farm who truly understand the system, and that someone changing settings without understanding the system could cause major issues. For the last 8 years the main responsibility for the watering system has fallen to me. Major failures have had me literally in tears as I know that they mean the system will consume all of my time for the next few days. I have had to decline numerous social, business and industry invitations and meetings as I knew I couldn't leave the farm. Its is frustrating to miss those opportunities when geographical isolation means those opportunities don't come every day, and often it was just so that I could watch a tank slowly fill with water. I am so glad that is no longer the case.