Final report

Developing an AgTech Savings and Benefits Estimator for the livestock sector

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Abstract

This report details the 'Developing an AgTech Savings and Benefits estimator for the livestock sector.' The report includes an overview of the project's objectives, methodology, conclusion and results, and recommendations for future activities to pilot and refine the estimator and additional research areas.

This project has been undertaken to develop a tool to help livestock producers who are unaware of the extent to which their on-farm processes and decision making might be transformed through digital tools and applications for water management, herd management and pasture management. This project is unique to others in addressing the issue of low AgTech adoption as there are currently very few tools which take into account individual farm business inputs and provide indicative AgTech savings and benefits estimates tailored to specific farming operations (E.g. based on location of farm, connectivity costs, number of head).

The primary objective of this project is to create an AgTech Savings and Benefits Calculator, referred to as the 'tool' or 'model' which gives users an indicative estimate of costs, savings and benefits for different AgTech solutions. These results are tailored to the intended use cases of individual farming operations. This includes:

1) Identifying the costs and benefit considerations of AgTech solutions, including both capital expenditure and operational expenditure.
2) Using data inputs from producers on their farm operations to build a model to estimate the costs of ways of performing the task with and without the use of the AgTech, and the cost of deploying and operating various types of AgTech.
3) Using the cost and benefits data to build an AgTech savings and benefits model to provide key insights such as net payback period to help inform the producer's investment decision making.

Executive summary

Background

This project has been undertaken to address the question many livestock producers have about what the costs and benefits of adopting AgTech to address their on-farm processes and decision making could be. An underwhelming understanding of the value proposition of AgTech is contributing to delayed adoption rates across Australian red meat producers of the benefits AgTech decision making tools and applications can deliver. This has led to missed opportunities for the sector.

The main target audience for this project are livestock farmers, particularly those who are likely to be unaware of the potential benefits of AgTech and may also even deem themselves incapable of asking the appropriate questions to determine the value proposition AgTech presents their farming business. The provision of an intuitive, functional AgTech savings and benefits estimation tool is intended to assist in livestock producers making decisions about adopting AgTech solutions.

The results of this research, namely a savings and benefits estimator for AgTech solutions, are intended to be used to assist livestock farmers implement AgTech solutions on farm by increasing their awareness and understanding of the potential costs and benefits. It is intended that using this tool farmers will better understand how AgTech solutions might unlock financial, social, and environmental benefits by using the technology to augment or automate tasks primarily in the domains of herd management, pasture management, and water management. There is also capacity for this minimal viable product tool to be extended to other agricultural sectors, as well as to increase the range of use cases the tool could support.

Objectives

The primary objective of this project is to create a tool which gives users an indicative estimate of the savings and benefits for AgTech solutions targeting specific use cases and individual farm circumstances. This includes:

1) Identifying the costs and benefit considerations of AgTech solutions, including capital and operation expenditures (capex and opex costs), using insights from MLA's AgTech trials at Carwoola and Romani, other relevant MLA projects, the Consultant's experience and insights and vendor research.
2) Using data inputs from producers on their farm operations to build a model to estimate the costs of ways of performing the task with and without the use of the AgTech, and the cost of deploying and operating various types of AgTech.
3) Using the cost and benefits data, build an AgTech savings and benefits model in accordance with parameters agreed upon with MLA and key stakeholders. The model will provide key insights such as net payback period to help inform producers' investment decision making.

Methodology

The project methodology involved:

- **Primary research**: focusing on insights and cost and benefits data from MLA's Carwoola, Romani, and Murchison House AgTech trials, among other relevant MLA projects. Interviews with AgTech vendors on how they calculate and communicate value proposition of their solutions to producers. KPMG experience and insights of AgTech and IoT business cases.

- **Desktop research**: scans of any existing ROI tools for agriculture or related industries, for example the EU Internet of Farms' IoT catalogue and various vendor ROI calculators.
- **Iterative Savings and Benefits model development**: after confirming model parameters with MLA, a functioning savings and benefits model ('estimator') was built in MS excel, informed by quantitative and qualitative insights from stakeholder consultation.

Results/key findings

A full overview of the project's results can be found in Section 4, below is a summary of the project's key findings.

- Water monitoring technologies represent the quickest wins for producers to see tangible benefits and demonstrate direct cost savings from investment. A secondary benefit is that users can reverse engineer the calculations to unpack thresholds or scale needed to be achieved for AgTech to make sense to integrate in their operations.
- AgTech devices have provided direct economic benefits, particularly pertaining to the re-allocation of labour, and qualitative benefits such as piece of mind and time released for other uses. Qualitative benefits were often referenced by users as the main observed benefits from deployment of AgTech solutions, with few users having tracked quantitative benefits accruing post deployment of the AgTech solution. These qualitative benefits also include better decision making, allocation of time and labour, and other productivity uplift areas. While the model does not consider these benefits directly, there is a strong imperative to explore the potential for future iterations of the tool to find ways to capture these more conditional benefits. This will likely come from increased stakeholder engagement and producer testing.
- More monitoring and evaluation of AgTech use case benefits is needed across Australian farming systems to improve the precision of the tool and awareness of value propositions AgTech can deliver.
- Other AgTech technologies such as satellite pasture management hold promise in future, however based on vendor conversations, their further early stage adoption and long-term measurement of benefits would be ideal to prove their value. The inclusion of more advanced satellite pasture management use cases in future iterations is a compelling proposition, which will also need to consider that benefits are dependent on a producer's use and interpretation of satellite data.
- The benefits of livestock and pasture AgTech considered in the tool were dictated by stakeholders' estimates of ROI or more specifically, time savings benefits, meaning the scenarios may not have the same degree of data accuracy than water monitoring solutions which have significantly more measurable benefits.
- Additionally there was a range of use cases for AgTech across livestock farms which were not what users originally anticipated at acquisition point. For example, producers noted that they did not anticipate benefits such as the use of water monitors to help detect contaminated water or hard water in their water pipes.
- A cost benefits indicative tool will be used not only to help farmers solve a specific problem but also to contribute to their awareness of the general benefits of AgTech and its varying use cases
- In order to maximise the tool's functionality, a number of assumptions have to be made by a user around 'typical' input costs and benefits of different AgTech solutions. For example, these include the average costs of labour and fuel on-farm. The tool currently prompts users with suggested values to use and allows users to override. These prompted values were based off the results from consultations and publicly available information. Allowing this functionality was important to enable users who have not obtained quotations to experiment with the tool in a meaningful way. Over time it is expected these assumptions

can be refined further. The tool also allows users to input an estimation of profitability increase per hectare or per head from implementing digital solutions. While some producers may not be equipped to make an informed estimation, this option is included to allow them to experiment with the dynamics within profit change, cost and benefit with different technology options.

Benefits to industry

The core benefits of the project for the livestock industry is to provide a minimal viable product AgTech cost benefit estimator tool that can be piloted to refine the model and solicit user feedback, to inform the potential development of an online tool with machine learning capabilities to refine the model based on farm location, livestock breeds and country.

For the AgTech vendor community the cost benefit estimator tool can support the awareness and confidence of livestock producers to investigate AgTech solutions and engage in more informed decisions about introducing AgTech solutions into their farming operations. This should lead to more informed buyers of AgTech solutions.

The benefits of the project for MLA include research insights on the indicative costs, benefits, and overall experiences with AgTech discussed in consults, a tool that can used to support extension services to red meat producers, and an opportunity to develop the tool into an online calculator to enable delivery of industry average costs and benefits to help users base line their assumptions against other red meat producers experience with technologies. Furthermore, the tool provides MLA with an opportunity to engage with AgTech vendors to encourage them to review and enhance the value propositions of their solutions to address livestock producer needs and expectations of the AgTech.

Future research and recommendations

This report includes key recommendations for future research and iterations of the model developed. Implementation of these recommendations will ensure the tool remains reflective of current industry conditions and experiences, has optimal precision and accuracy, and offers even more advanced functionalities. Examples of these recommendations include:

- Conducting a pilot program with a selection of livestock producers in different geographies running different farming systems to trial the AgTech Cost Benefits estimator and refine the precision of the tool for different user scenarios
- Exploring the preferred method of accessing this tool
- Exploring extension support services to promote awareness of the tool and help livestock producers access and use the tool, and explore the findings with them
- Using the tool and interviews with livestock producers, publish case studies to link to the tool to help future users learn about the benefits and experiences other producers have had with adopting AgTech

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1. **Background**

This project has been undertaken to address the situation that many Australian livestock producers are unaware of the benefits of adopting on-farm AgTech solutions.

Many farmers are not adequately aware of the extent to which their on-farm processes and decision making could be improved through digital tools and applications (AgTech). Understanding the value proposition of AgTech is one of the key barriers to adoption by farmers in Australia and limiting the industry's access to efficiency and production gains, risk mitigation insights and time off farm.

How can we increase Australian livestock farmers' adoption of AgTech on-farm by increasing general awareness of its costs and benefits?

This project is aiming to address the issue of finding a way to enable farmers to be confident and financially secure in their AgTech investment decisions by showing them an estimation of potential costs, benefits, and considerations. Related questions the project intends to answer include identifying the main drivers of AgTech costs and benefits, barriers to adoption, and potential use cases for different solutions and devices.

The main target audience for this project is livestock farmers, particularly those of slightly older demographic brackets, who are likely unaware of the potential benefits of AgTech and may also even consider themselves incapable of addressing this issue.

Livestock farmers very often are generational farmers with low propensity to change the way their farms operate. Therefore, the provision of an intuitive, functional AgTech savings and benefits tool is intended to assist in their trialling of AgTech solutions on-farm. The tool, however, is intended for use by livestock farmers of a range of ages, geographic locations, farm types, etc. To address this range, a number of key user personas have been created to inform the development of the tool by providing an end-user vision (see Figure 2). At a higher level, Figure 1 below also shows the different user groups who will interact with the tool, including consumers as well as owners or managers of the tool, and a potential role of AgTech vendors in future iterations.

Figure 1: Target user landscape

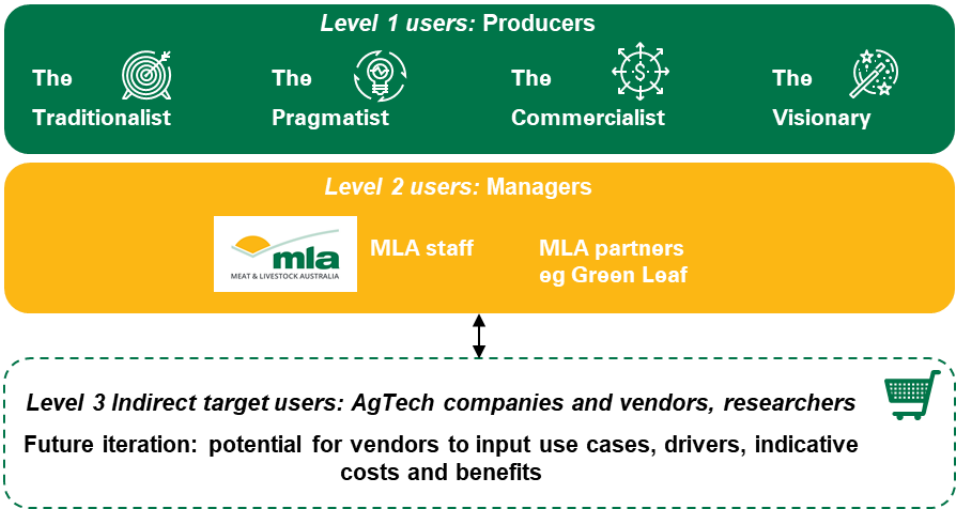
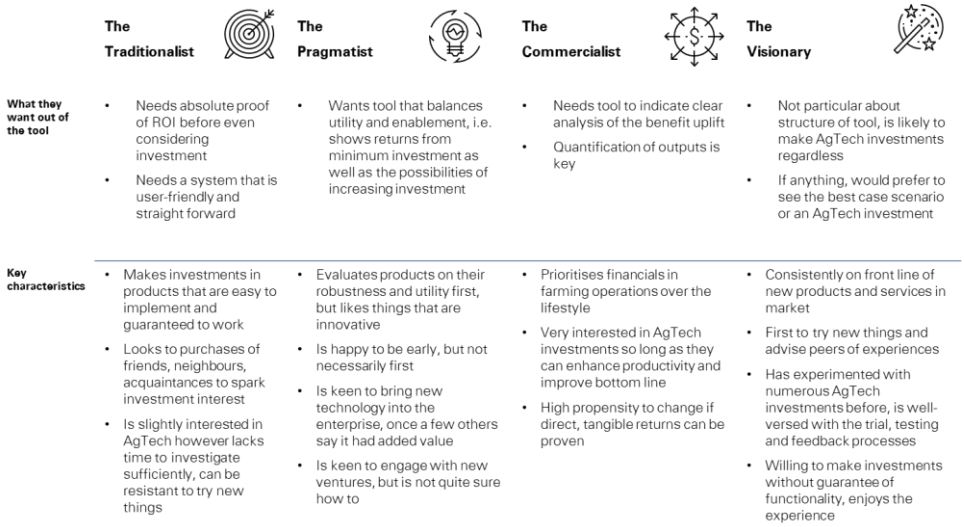


Figure 2: AgTech ROI tool user personas



What the results of the research/survey will be used for:

The AgTech savings and benefits estimator will be used as a tool to help livestock farmers better understand the benefits of AgTech and how certain devices can be integrated into individual farm scenarios.

The tool is intended to bring to light the range of considerations around AgTech including capex and opex costs, connectivity compatibility, economic, social, and even environmental benefits. While the tool does not attempt to extensively measure qualitative benefits such as social and environmental impacts, it does help to increase producers' understanding of the potential for AgTech investments to result in benefits beyond just financial factors. The intention is to broaden livestock farmers' general awareness of AgTech benefits and therefore, in time, increase rates of adoption and contribute to a greater level of technological maturity across the industry.

2. Objectives

The primary objective of this project is to create a tool in which producers can input a number of high-level data points regarding their farming operations, (e.g. farm size, connectivity, desired Jobs to be Done), and receive an indicative return on investment (including costs and benefits) for the implementation of a certain AgTech solution. This will improve producers' understanding of the potential benefits of AgTech devices in the context of their individual farming operation.

This objective has been broken down into steps to enable its achievement:

1) Identify the costs and benefit considerations of AgTech solutions, including capital and operation expenditures (capex and opex costs), using insights from MLA's AgTech trials, other relevant MLA projects and vendor research.
2) Use data inputs from the producers on their farm operations to build a model to estimate the costs of ways of performing the task with and without the use of the AgTech, and the cost of deploying and operating various types of AgTech.
3) Using the cost and benefits data, build an AgTech savings and benefits model in accordance with parameters agreed upon with MLA and key stakeholders. The model will provide key insights such as net payback period to help inform producers' investment decision making.

3. Methodology

3.1 Overview of approach

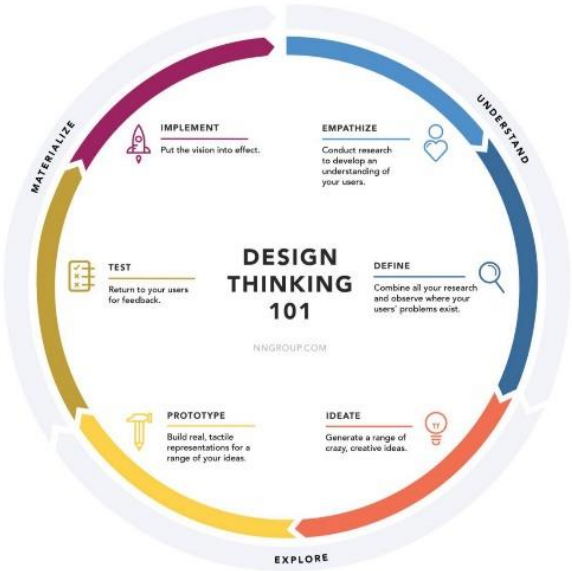
The methodology used to complete the project is outlined below.

Table 1: Summary of project methodology

Step	Detail
1	Desktop research (see detail below)
2	Consult with Carwoola & Romani (see detail below)
3	Use insights from steps 1-2 to build draft savings and benefits model
4	Validate product & connectivity costs with supplementary market sounding data
5	Test draft model with Murchison House
6	Reached out to AgTech vendors to get a sense of the value proposition they communicate as part of their sales strategies, validate costs and benefits data as well as relevant use cases
7	Go back to MLA AgTech trial operators to 'stress test' different model components such as product and connectivity costs as well as use cases
8	Test model with the Consultant's internal sector experts and a select group of livestock producers
9	Finalise model to reflect the current industry experiences of stakeholders engaged, with the most up-to-date information, functionality, and useability for industry that is possible for the first iteration of the tool.

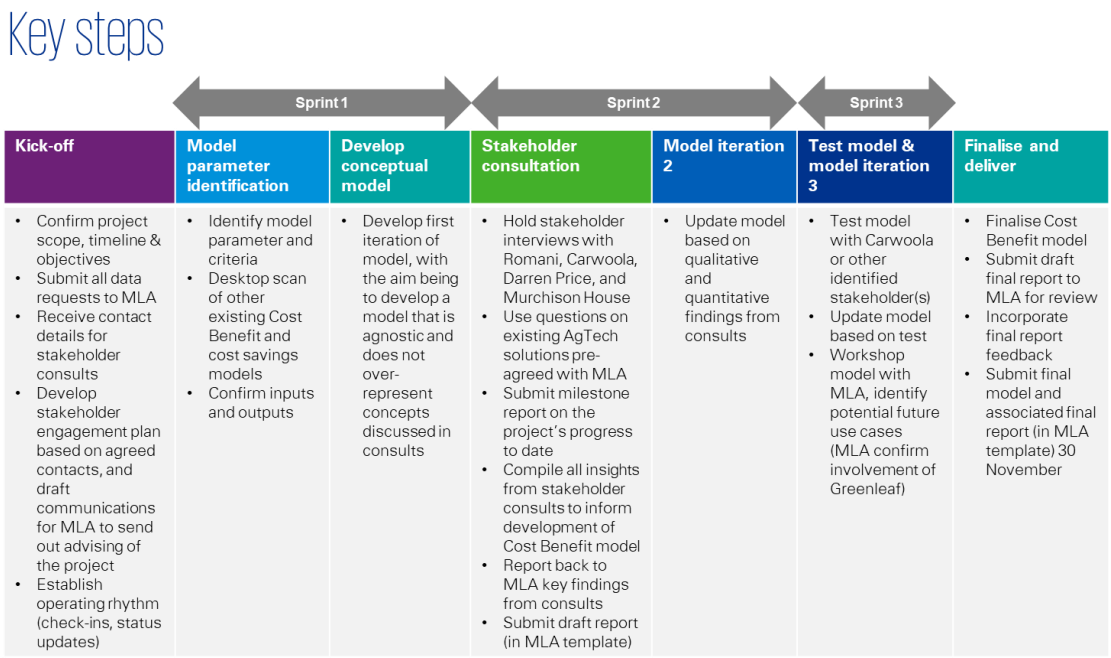
The project followed an iterative, design led thinking approach as outlined in Figure 3 which leveraged primary and desktop research, as well as industry stakeholder consultation.
Primary research focused on insights and cost & benefits data from MLA's Carwoola, Romani, and Murchison House AgTech trials among other relevant MLA projects.

Figure 3: Design thinking approach leveraged in milestone



The project was broken into three sprints which progressively and iteratively develop a cost savings and benefits model as detailed in Figure 4: Project key steps.

Figure 4: Project key steps



3.2 Detailed approach

Desktop research was a key methodology for the initial stages of the project.
Desktop research has involved scans of any existing technology cost benefit tools for agriculture or related industries, for example the EU Internet of Farms' IoT catalogue, Farmbot's water monitoring solutions web-based cost savings tool, Ceres Tag benefits of livestock traceability tags. Further, the team has conducted deep dive explorations of existing AgTech providers to assess potential inputs, costs and benefits to be used in the cost benefit tool.

Stakeholder consultation were an important tool for gathering qualitative and quantitative data of AgTech costs and benefits, in order to ensure the tool reflects accurate industry experiences.

Stakeholder consultations have been conducted with Darren Price, Price Consulting and previously the manager of Carwoola Station, as well as David Lee, current manager of Windy Station (Romani) Calum and Belinda Carruth of Murchison House WA. These consults have provided insight on firsthand experiences with varying AgTech solutions regarding costs, benefits, challenges, and logistics of implementation and operation. In following a design thinking approach, insights from consults were used to identify material AgTech themes and use cases, test hypotheses, and mapping principles with which the cost benefit tool will align.

The model was developed using an iterative approach with indicative AgTech use cases built in based on a number of data sources

A functioning model was developed in MS Excel using data inputs from desktop research and publicly disclosed MLA information, the Consultant's supplementary data, qualitative insights from stakeholder consultation, and desktop research of relevant AgTech costs and benefits (MLA reports, vendor information, other industry research). AgTech use cases were developed using these insights within the three main categories (as indicated by stakeholder consults): water monitoring, pasture management, and livestock management. Considerations were maintained within these three use

case categories because both primary and secondary research indicated these to be the most common and feasible AgTech solutions, as well as having the most measurable costs and benefits.

The model was updated daily based on any new insights derived from either research or stakeholder engagement.

In later stages of development, the model was tested with key stakeholders including Romani Pastoral Company, Green Leaf consultants, the Consultant's internal modelling experts, and MLA itself. This engagement challenged the thinking behind the model, tested its functionalities, use cases, assumptions and considerations, and validated its calculations and results. This validation was key to quality assurance and a tool that most accurately reflects current industry experiences.

Finally, consults with AgTech vendors were an effective way to finalise the model's data inputs, use cases and calculations, specific to a certain category of use cases.

Gaining these insights was especially important as satellite pasture monitoring presents a highly complex use case with costs and benefits that are challenging to definitively measure. Consults with industry experts enabled us to test thinking, obtain the best understanding of what questions the tool needed to ask to give accurate estimates, and any limitations in implementation or data assumptions that needed to be considered.

Interest from AgTech vendors to participate in the project was generally high, indicating an attractive future opportunity to involve them in the model's deployment in market. The tool is a valuable mechanism through which AgTech companies can promote the brand-agnostic value proposition of certain device, most importantly via independent, non-bias communications. For this reason it is believed that AgTech vendors' contributions regarding costs, benefits, and use cases would be valuable in future iterations (as explained in 6.1) and ensure the tool's inputs remain up-to-date and reflect current market conditions.

3.3 Limitations to approach

There were a number of key considerations and limitations to be acknowledged in developing the Savings and Benefits estimator which are explored below.

Throughout the project several data gaps and limitations were experienced which had to be addressed.

Accessing information from the consults at a granular, quantitative level was more difficult than originally anticipated. From the project's inception, it was established that consultations with the MLA AgTech trial sites would be the primary source of data to inform the model. While qualitative insights from the model have been highly useful and informed a large part of the project's results, there were challenges to gathering quantitative data in this format. Unfortunately, and understandably, stakeholders could not confidently give an immediate answer during the consults as to the specific costs and benefits they had experienced with AgTech (also mostly because they were not responsible for the costs). Further, given the farm managers consulted were participating in MLA trials, they were not involved in the opex aspect of AgTech (i.e. they did not pay the bills) and therefore may not have been fully aware of exact costs.

To overcome this limitation, the project has leveraged market sounding data on average AgTech capex and opex costs and benefits. The project also used information from select AgTech vendors on their average market prices. In recognition of the fact that identifying average costs in an increasingly crowded and constantly evolving AgTech market is a challenge, it has been recommended that MLA not just continually update AgTech prices but look to conduct a more detailed market sounding assessment of average capex and opex costs across the livestock industry.

Where possible, public data sets from vendors were used as a reference point.

It should be noted that AgTech experiences on Carwoola, Romani and Murchison House were results of MLA-funded trials and therefore should not be taken to directly reflect the current or expected experiences of all Australian livestock farmers.

First, the limited number of entities consulted in general may have created a bias due to small sample size. For future iterations it has been recommended that the tool be piloted with a larger cohort of industry and market stakeholders to ensure the tool's accuracy and relevance.

In addition, it has been noted that ROI was not indicated as the sole and primary purpose of these trials, as the aim was also to test different solutions to better understand how they can fit into certain farming scenarios regardless of cost. While ROI was a consideration in the trials, its priority arguably did not rank as high as it might in an everyday farming scenario, as indicated by stakeholders. While the users of the tool may also not necessarily hold ROI as the top priority when looking to purchase AgTech (i.e. they might be more motivated by social benefits like peace of mind), this nuance must be considered in using the trial sites as examples to represent the majority of everyday livestock farms.

While AgTech's impacts to the current state of operations were well-measured across the trial sites, fully objective data was limited, and some benefits were assumed based on subjective estimates by pilot trial operators.

Further, the managers of the trial farms were not responsible for the costs of the AgTech implemented on-farm, and therefore may not have sufficiently monitored ongoing opex costs as an everyday farmer might have. Therefore, opinions of devices' value for money and payback metrics need to be considered carefully in case of bias. For this reason, AgTech capex and opex cost assumptions were validated against several data sources to ensure they reflect the most accurate and updated prices.

In order to maximise functionality of the tool, several assumptions around AgTech costs and benefits had to be made.

Simple use cases inherently have underlying assumptions that drive the calculations of cost savings or revenue benefits. The more complex the use cases (for example multiple year pasture improvement), the more subjective or variable the potential savings or revenue improvements will be. This is because every farm is unique so it is difficult to assume how an AgTech solution would benefit all farms.

For this reason a simplistic model to calculate potential benefits and savings has been used, and does not necessarily reflect all real-world circumstances. Use cases in this iteration of the model are specific to just one technology type, while more complex iterations may include functionalities to analyse savings and benefits of multiple technologies.

The tool includes functionality where users can tailor inputs and assumptions according to their own circumstances, however no model will accurately reflect the complexities of real-world farming systems. This means that while users can choose to manually input criteria such as average hourly award rate or cost of fuel costs per litre, the tool's outputs cannot be taken as indicative of all livestock farmers' situations.

There are a number of indirect costs, benefits and considerations around AgTech investments that are difficult to measure, nor represent in a model.

Stakeholder consults made abundantly clear the social benefits of AgTech such as the 'peace of mind' or time taken away from the farm enabled by remote monitoring and surveillance. It is these kinds of results, as well as environmental or even mental health benefits which are notably difficult to capture in a tool like the one developed for this project. Other benefits which are a challenge to measure include healthier animals, cleaner water, or the reallocation of labour.

Further, it must be acknowledged that many AgTech devices are made significantly more effective with the provision of additional support structures. For example, the provision of data from something like a satellite pasture monitoring system is only as good as a user who can effectively interpret it. Many farmers rely on the support of private agronomists, producer groups, agriculture extension personnel or supplementary software applications to fully capitalise on its benefits. This insight is especially relevant given the current COVID-19 pandemic, which has hindered farmers' abilities to easily call for assistance or support with implemented AgTech devices. Again, capturing this kind of nuance in the tool is a challenge and should be kept in mind when interpreting results.

Connectivity is a particularly challenging component to capture in the tool's calculations.

Evidently connectivity is a vital part of implementing AgTech on-farm, however it is anticipated that there will be a significant variance in user knowledge around connectivity costs, on-farm connection capabilities, compatibility, etc. For this reason, the costs of a generic satellite connection have been used as a default in calculations. The user then has the ability to opt for more specialised IoT connectivity options such as LoraWAN, NB-IoT, Sigfox or on-farm Wifi. This is also a complex functionality given there will be a significant range in the amount of data required by different farmers. Therefore, some key assumptions had to be made:

- Calculations assume that the entire property is covered by connectivity, and not partial
- The entire cost of connectivity, where it is already present, would be included while finding cost and benefit
- For NB-IoT connectivity, it is unlikely that a user will exceed 5MB use in one year

3.4 Technology scope

A number of technologies were included or not included in the tool. Table 2 below shows these technologies, in which category of AgTech they were classified, and rationale for inclusion or exclusion. Above all, the intent was for the model to represent the technologies that are most feasible, sustainable, and of greatest benefit for Australian livestock farmers to implement.

The suite of technologies included in the tool were established primarily by asking the MLA AgTech trial site managers which three types of tech they believe to have the greatest benefit on-farm and have the most valuable use cases based on their experiences. Table 2 below captures technology and associated use cases deemed high value by the trial property managers.

Implemented on MLA AgTech trial sites, measurable costs and benefits, feasible for everyday livestock farmers

Table 2: Technologies included in tool

Technologies identified as in scope		
AgTech solution	**Use case category**	**Reason for inclusion**
Weather monitors	Pasture management	— Successful implementation on MLA AgTech trial sites — measurable costs and benefits, — Reported as having valuable use case(s) on-farm — Deemed feasible for everyday livestock farmers
Soil probes	Pasture management	
Fuel tank sensors	Water monitoring	
Ear tags	Livestock management	
Water level sensors	Water monitoring	

Water pump sensors	Water monitoring	
Electric fence sensors	Pasture management	
Weighting scales	Livestock management	
Surveillance cameras	All	
Centralised dashboarding solution	All	

**Note some devices may be classified into more than one use case category based on indirect benefits or use cases, for the purposes of this analysis devices were placed into their most immediately aligned use case category.*

In the consults we acknowledged that there were additional technologies than those listed above trialled. These have been listed below for completeness, however not included in the model because our model sought to complete a Minimum Viable Product (MVP) based on high value use cases, and these use cases and the associated AgTech were not deemed as sufficiently high value currently.

We acknowledge that further work and development may change this situation, for example if drone costs decrease or regulations relax, then this might increase value propositions over time. An estimator tool like this will include a wider suite of AgTech once a certain point of value and product lifecycle is achieved, the technologies are deemed ready for adoption and commercially feasible for a significant scope of farmers.

In the current version of the tool, three technologies were modelled, pasture management, livestock behaviour monitoring and water management.

Table 3: Rationale for scope of technologies excluded from the tool

Technologies identified as out of scope		
AgTech solution	**Use case category**	**Reason for exclusion**
Remotely Piloted Aircraft System (RPAS) 'Drone'	All	While RPAS, or 'drones' have seen examples of favourable CBA from recent research and pilot testing, they have not been included in this model given the benefits are highly difficult to capture, especially at a commercial level. Like some satellite pasture monitoring technologies, benefits are subjective and highly dependent on user capability and interpretation/use of results. This is an important area to consider in future iterations, especially as RPAS technology develops and becomes more feasible to implement for a wider scope of producers.
Remote weed spraying	Pasture	— Not currently applicable to MVP given focus on livestock sector however given this technology's immediate benefits remote weed sprayers should be considered to include in future iterations. — Not deemed as having high enough value within model's payback period, given significant capex and opex costs — Costs and benefits can be difficult to capture on both quantitative and qualitative level. However, as costs may decrease with further developments of the technology and
Satellite weed detector		

		feasibility of investment rises, satellite weed detectors should remain an option to include in future iterations of the model.

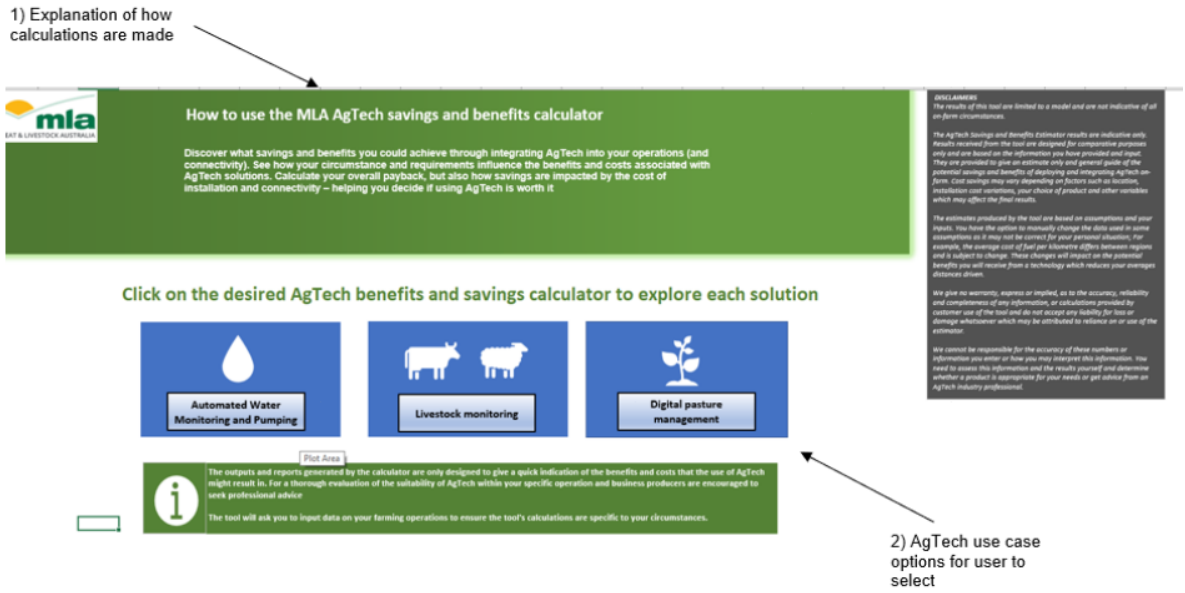
4 Results

4.1 Key findings in developing the AgTech Savings and Benefits estimator

The most important part of this model was the development of the Savings and Benefits estimator. This subsection steps through the elements of the tool that were built and features excerpts of the tool's functionalities.

4.1.1 Model landing page

Figure 5: Model landing page

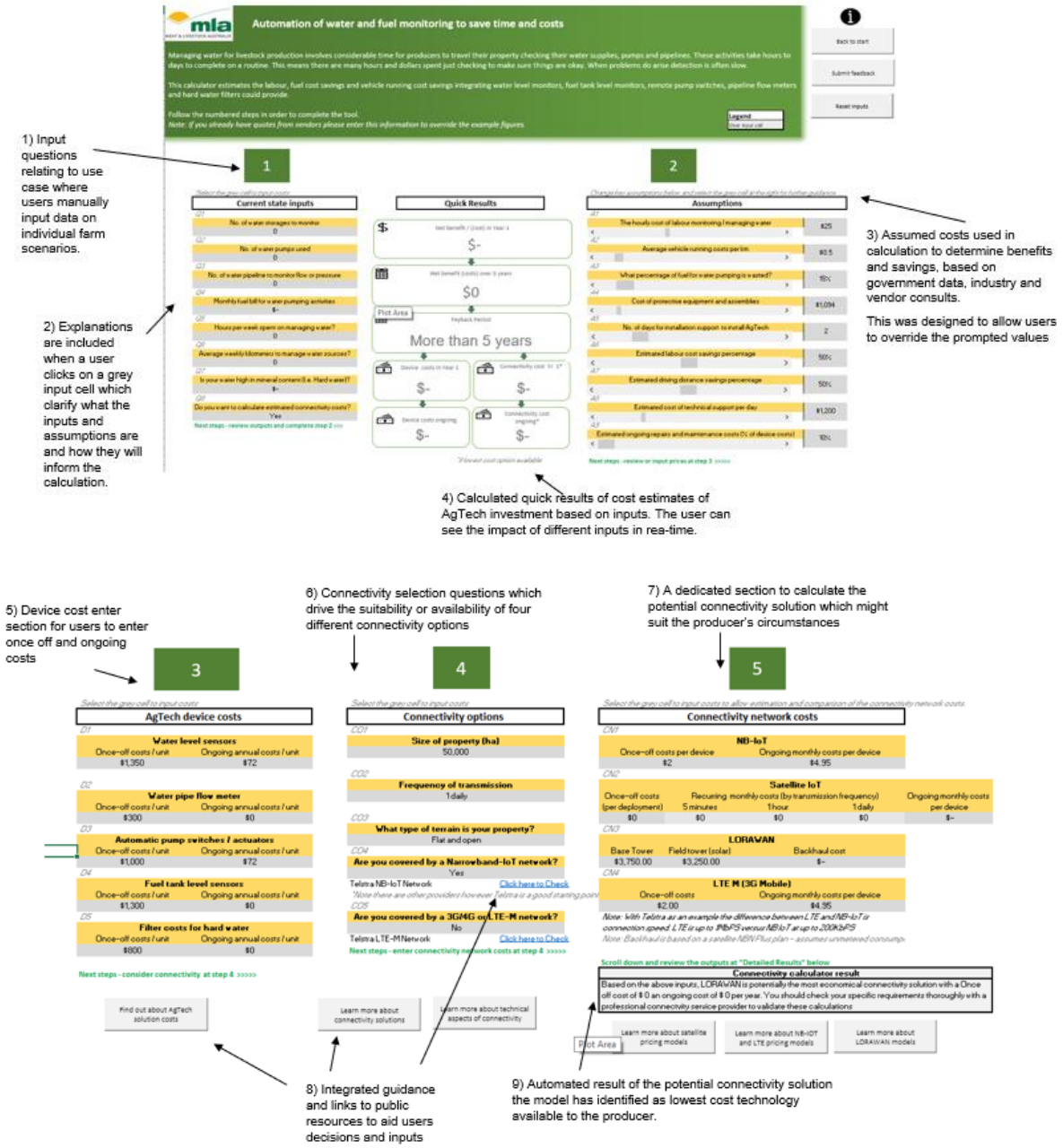


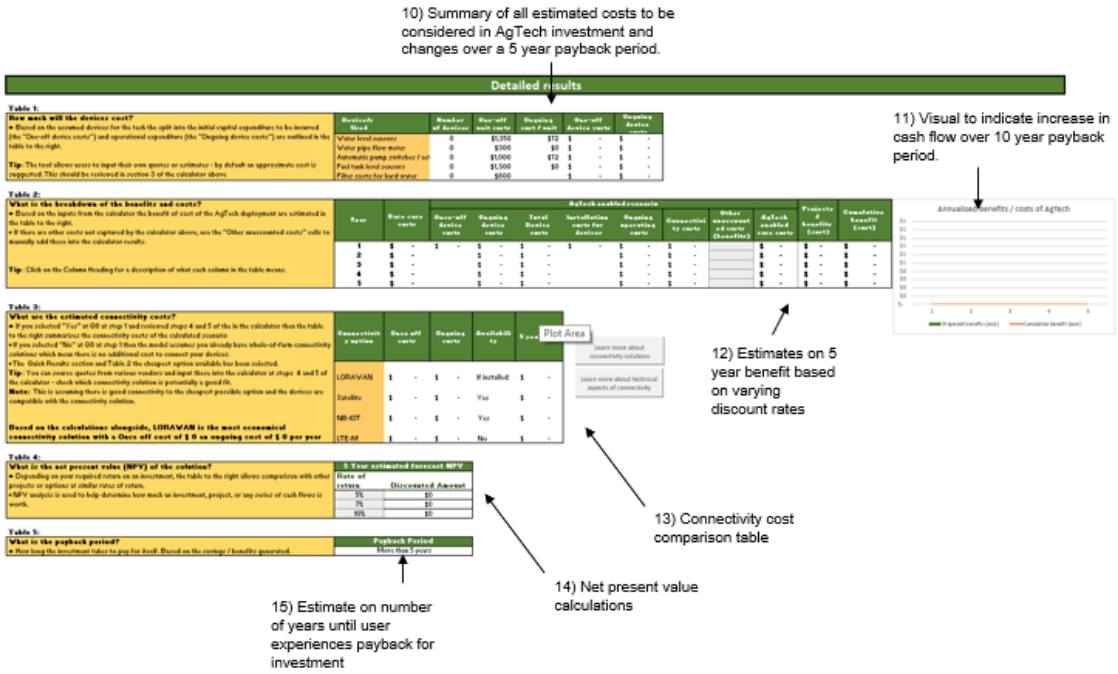
Output: What was built?
Figure 5 shows the tool's landing page. This is the first thing users will see when entering the tool. It is straightforward and accessible for all livestock farmers' levels of digital capability. Here is where users will be able to choose from the problems to be solved or jobs to be done on-farm with the possibility to augmented or automated by AgTech.

Outcome: What impact does it achieve?
The landing page was developed so that users could not only select the problem they want to solve or the job to be done using AgTech, but so they could also see all the other potential problems to be solved using AgTech of which they may not have been previously aware. The landing page is designed to be user-friendly to encourage exploration and discovery. Ideally users will test the tool by clicking on a range of use cases and therefore increase knowledge of AgTech costs and benefits.

4.1.2 Use case input page

Figure 6: Model use case input page





Output: what was built?

Figure 6 shows of one of the tool's AgTech use case input pages: Automate/digitise water monitoring, where a user will be taken upon selecting this use case on the landing page. This tool is designed to calculate an estimate on the costs and benefits of implementing water sensors on-farm, based on several data inputs asked of the user relating to his or her individual farming scenario (point 1 in Figure 6). Users can also elect not to input their own data should he/she be unaware, and instead assumptions will be used in the calculations.

Use cases were built using cost and benefit data from consults with MLA AgTech trials, supplemented by KPMG market sounding data, desktop research and consults with AgTech vendors.

Outcome: What impact does it achieve?

These use cases allow users to understand at a granular level the specific costs and benefits to be considered in making an AgTech investment to solve a problem on-farm. These variables, which in this case include reduction in fuel and labour costs, are communicated over a ten-year payback period. An estimate is also given on the number of years until the user will turn a profit on the AgTech implemented, as well as annualised cash flow over the payback period. This information is all highly useful for users in better understanding the factors to be considered in implementing AgTech, enabling him/her to make a more informed investment decision.

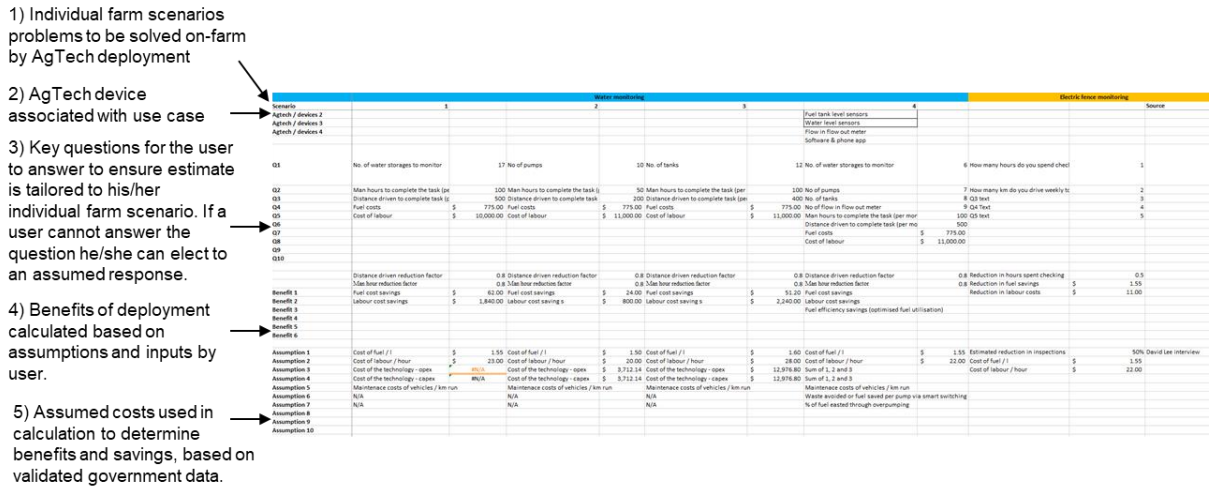
It is important to highlight that target use cases were developed with minimum complexity as top of mind. Given this is the minimum viable product each use case is associated with a single AgTech deployment and has a set number of benefits. There is not yet functionality to pick and choose which devices could be deployed in combination with others. Further work and a significantly more complex model would need to be developed to allow a fully 'mix and match' estimator to be developed. This is a compelling consideration for future work. Table 4 below demonstrates the levels of complexity with which use cases can be developed, noting that this model remains solely within the scope of the first level.

Table 4: Examples of complexity levels to inform future model iterations

Low complexity	Satellite pasture management achieved with satellite tool and software only
Medium complexity	Satellite pasture management achieved with soil probes as well as satellite tool and software
High complexity	Satellite pasture management achieved with soil probe, satellite software, livestock monitoring ear tags, real time walk over weighing systems.

4.1.3 Use case master - framework

Figure 7: Model use case framework



Output: what was built?

Figure 7 shows the use case framework or 'master' in which the calculations of costs and benefits for the different AgTech devices in scope were developed. As noted above, each use case starts with several questions to be answered by the user around his/her individual farm scenario, which is then used to inform the calculation of the benefits of deployment. The framework was designed to solve most use cases within 5-10 questions which the user will answer, draw out three key benefits, and outline 7-10 key cost and benefit assumptions depending on the use case.

Outcome: What impact does it achieve?

The framework was developed based on a key finding in this development stage of the model, which was that different use cases could have a variety of inputs. This increased or decreased the complexity of the model and the difficulty in getting an accurate estimate. The framework therefore is important and designed in a way that future users of the model can easily add new use cases, technologies, or deployments.

5 Conclusion

5.1 Key findings

Aside from the results and key findings outlined in Section 4, below is a list of the project's high-level, qualitative key findings to be acknowledged outside the development of the model.

Results/key findings

A full overview of the project's results can be found in Section 4, below is a summary of the project's key findings.

- Water monitoring technologies represent the quickest wins for producers to see tangible benefits and demonstrate direct cost savings from investment. A secondary benefit is that users can reverse engineer the calculations to unpack thresholds or scale needed to be achieved for AgTech to make sense to integrate in their operations.
- AgTech devices have provided direct economic benefits, particularly pertaining to the re-allocation of labour, and qualitative benefits such as piece of mind and time released for other uses. Qualitative benefits were often referenced by users as the main observed benefits from deployment of AgTech solutions, with few users having tracked quantitative benefits accruing post deployment of the AgTech solution. These qualitative benefits also include better decision making, allocation of time and labour, and other productivity uplift areas. While the model does not consider these benefits directly, there is a strong imperative to explore the potential for future iterations of the tool to find ways to capture these more conditional benefits. This will likely come from increased stakeholder engagement and producer testing.
- More monitoring and evaluation of AgTech use case benefits is needed across Australian farming systems to improve the precision of the tool and awareness of value propositions AgTech can deliver.
- Other AgTech technologies such as satellite pasture management hold promise in future, however based on vendor conversations, their further early stage adoption and long-term measurement of benefits would be ideal to prove their value. The inclusion of more advanced satellite pasture management use cases in future iterations is a compelling proposition, which will also need to consider that benefits are dependent on a producer's use and interpretation of satellite data.
- The benefits of livestock and pasture AgTech considered in the tool were dictated by stakeholders' estimates of ROI or more specifically, time savings benefits, meaning the scenarios may not have the same degree of data accuracy than water monitoring solutions which have significantly more measurable benefits.
- Additionally, there was a range of use cases for AgTech across livestock farms which were not what users originally anticipated at acquisition point. For example, producers noted that they did not anticipate benefits such as the use of water monitors to help detect contaminated water or hard water in their water pipes.
- A cost benefits indicative tool will be used not only to help farmers solve a specific problem but also to contribute to their awareness of the general benefits of AgTech and its varying use cases
- In order to maximise the tool's functionality, a number of assumptions have to be made by a user around 'typical' input costs and benefits of different AgTech solutions. For example, these include the average costs of labour and fuel on-farm. The tool currently prompts users with suggested values to use and allows users to override. These prompted values were based off the results from consultations and publicly available information. Allowing this functionality was important to enable users who have not obtained quotations to

experiment with the tool in a meaningful way. Over time it is expected these assumptions can be refined further. The tool also allows users to input an estimation of profitability increase per hectare or per head from implementing digital solutions. While some producers may not be equipped to make an informed estimation, this option is included to allow them to experiment with the dynamics within profit change, cost and benefit with different technology options.

5.2 Benefits to industry

The core benefits of the project for the livestock industry is to provide a minimal viable product AgTech cost benefit estimator tool that can be piloted to refine the model and solicit user feedback, to inform the potential development of an online tool with machine learning capabilities to refine the model based on farm location, livestock breeds and country.

For the AgTech vendor community the cost benefit estimator tool can support the awareness and confidence of livestock producers to investigate AgTech solutions and engage in more informed decisions about introducing AgTech solutions into their farming operations. This should lead to more informed buyers of AgTech solutions.

The benefits of the project for MLA include research insights on the indicative costs, benefits, and overall experiences with AgTech discussed in consults, a tool that can used to support extension services to red meat producers, and an opportunity to develop the tool into an online calculator to enable delivery of industry average costs and benefits to help users base line their assumptions against other red meat producers experience with technologies. Furthermore, the tool provides MLA with an opportunity to engage with AgTech vendors to encourage them to review and enhance the value propositions of their solutions to address livestock producer needs and expectations of the AgTech.

Table 5 below list the benefits of AgTech for industry which were identified throughout the project, which have been integrated into the tool. The application of the tool will increase awareness of these benefits.

Table 5: AgTech Benefits to be communicated through the project

Topic	Source	Results/benefits
AgTech adoption	Consults	-Despite challenges in the deployment of AgTech on-farm, there is (subjectively) an AgTech solution for every farmer. - Farmers need to be able to clearly understand the benefits of different solutions in order to determine that which best fits certain circumstances.
AgTech Benefits:	Consults	- Most common benefit of AgTech reported has been the reallocation or reduction of labour, with most solutions removing or significantly decreasing the need to perform regular manual checks of stock and equipment. - This is also then associated with the financial costs of decreased fuel consumption in cars, motorbikes, and other equipment used to perform these checks.

Topic	Source	Results/benefits
		- Social benefits discussed include peace of mind, the ability to have days and weekends off-farm, all stemming from the ability to monitor operations and infrastructure remotely.
Water monitoring AgTech solutions	Consults	Water monitoring solutions have been the most tangibly useful AgTech devices interviewed farmers have implemented.
Pasture management AgTech solutions	Consults/ Desktop research	-Significant interest in satellite pasture monitoring technology, with consults reporting that this sort of AgTech, despite still needing improvements, allows farmers to monitor pasture at a level that was not otherwise possible.
Herd management AgTech solutions	Consults/ Desktop research	-Ear tags: discussed value in deployment outside of their intended use case: while designed to monitor the health of individual livestock in the paddock, consultations indicated their preferred use to track sentinel animals or higher value livestock (such as stud bulls) during joining time in order to save time driving around searching for them. - Not only does this improve breeding rates, it is a use case that is much more feasible for everyday farmers given fewer tags required therefore decreased costs.

In the long term, the benefits of the tool will be the increasing of awareness of AgTech benefits and appetite to explore the possibility to integrate AgTech on-farm. In the long term this will contribute to the increasing sophistication of the industry as more members start to transition into an Industry 4.0 context.

6 Future research and recommendations

6.1 Future research

This report includes a number of key recommendations for future research and iterations of the model developed. Implementation of these recommendations will ensure the tool remains reflective of current industry conditions and experiences, has optimal precision and accuracy, and offers even more advanced functionalities. Examples of these recommendations include:

- Conducting a pilot program with a selection of (suggest 20) livestock producers in different geographies running different farming systems, and with (suggest 10) agtech vendors that supply water monitoring, livestock monitoring and pasture management solutions, to trial the AgTech Cost Benefits estimator and refine the precision of the tool for different user scenarios
- Exploring the preferred method of accessing this tool
- Exploring extension support services to promote awareness of the tool and help livestock producers access and use the tool, and explore the findings with them
- Using the tool and interviews with livestock producers, publish case studies to link to the tool to help future users learn about the benefits and experiences other producers have had with adopting AgTech

To determine if each recommendation should be a top priority for MLA to consider the following core criteria were assessed:

1) Does the recommendation improve the sustainability of the tool through how it operates, and enable the tool to maintain its industry relevance and reliability?
2) Does the recommendation increase the tool's functionality by improving the performance and experience of the tool for users?
3) Is the recommendation achievable?

Based on this assessment, Table 6 lists the key top five enhancements and recommendations for MLA to consider in future iterations of the model.

Table 6: Recommended enhancements for future iterations of the model

Name of enhancement	Summary / overview	Benefit to model operators or owners	Benefits to AgTech companies	Benefits to red meat industry (producers)
AgTech vendor input module	Vendors can input their own costs and benefit data, as well as use cases of their own devices. Use installation data to see where devices are deployed. Currently the model draws upon publicly available price information or guidance from vendors. A module allowing vendors to share data would allow for increased tool accuracy.	Updated information is available reflecting latest AgTech developments, increase user's awareness Enhances precision of tool through more accurate data.	New medium to communicate benefits and increase awareness, help to increase general appetite for AgTech across farmers. A further possibility would be to fully integrate the model with AgTech Finder (KPMG & Food Agility) to create a one-stop tool for	Greater tech uplift/adoption in general, increase awareness of options within AgTech market Enhanced visibility of a broad spectrum of tools

Name of enhancement	Summary / overview	Benefit to model operators or owners	Benefits to AgTech companies	Benefits to red meat industry (producers)
			people considering AgTech.	
Regional segmentation functionality	As use cases grow, they should be tailored to different geographic regions. This means a user will first select his/her region and will be given a set of use cases to choose from tailored specifically to the region they are from. Use cases may have different calculations and assumed data according to differences between Northern and Southern regions.	Increase use of tool given greater application to wider scope of users.	Greater adoption of AgTech based on more reliable information, greater trust in technology.	More accurate estimates according to an individual's region, meaning greater utility of the tool.
Producer input module / scenario development	Forum in which producers can input and discuss own AgTech experiences or create their own scenarios or 'uses cases' specific to their own farming operations.	Validate users' confidence in investment decisions, users may believe in a greater degree of truth from farmer accounts. Farmers' ability to create their own scenarios would maximise the tools' customisation functionalities.	Possibility to increase appetite for certain AgTech solutions based on experiences of farmers with similar circumstances/use cases. Also allows new means by which companies can promote the use of their device (albeit brand agnostic).	Encourages collaboration and support amongst livestock farmers, may increase AgTech adoption and overall sophistication of industry.
Free input box for additional costs and benefits	In future iterations we recommend that a new function is built into the results portion of the tool. A free-text box will allow a user to input an additional cost or benefit amount which they know should be included in the calculation, however may be too specific to an individual's farm scenario for the tool to address it in general. The results should then be increased or decreased according to this additional input.	Over time a further smart functionality could be developed which identifies those additional costs and benefits commonly entered by users. These noted costs and benefits could then be integrated into the main input questions of the tool.	Enables more accurate answers which will increase trust and adoption of AgTech devices.	Allows users to really tailor the tool to specific scenarios, increasing the accuracy of calculations and overall utility of the tool.

6.2 Recommendations

In addition to the recommendations for future iterations of the model listed above, we recommend a number of next steps for deployment of the tool and the project more broadly. These are listed in Table 7 below.

Table 7: Recommendations for the project's next steps

Recommendation	Overview of recommendation	Recommended actions
Pilot the model with a wider, more diverse range of industry participants	While we were able to validate the model with industry experts to an extent, our work was subject to timing, data and resource limitations. There is always capacity for a tool like this to be further improved by more testing with industry, therefore increasing its overall accuracy and relevance. The wider the scope of test users, particularly from a geographical point of view, the more reflective the tool will be of current industry experiences and conditions. We recommend that the model be tested and used by at least 20 industry participants and 10 AgTech vendors of different use case categories (water, pasture, livestock). This will validate the accuracy of calculations and help identify any missing value propositions/use cases to be added to model. Ensure that the model has been run through test demonstration farms where the different types of AgTech in the model have been deployed, and seek feedback from users as to the accuracy of the model compared to their own experiences. From an industry point of view, possible test groups might include: • Vic IoT trial program run by Agriculture Victoria • PIRSA Smart Ag farms South Australia • NSW DPI Farmers of the Future • QDAF Smart Farms Programs	— Create sample of producers across a range of geographies and topographies, farm sizes and past experiences with AgTech to pilot the tool and provide feedback — Modify the tool according to the sample's feedback — Test the tool with AgTech vendors to validate capex and opex costs — Compile robust data repository to sit behind the model and provide logic for calculations — Identify any new value propositions or use cases that may not be currently included in the model
Conduct regular assessment of accuracy of device costs and connectivity costs across AgTech market	The AgTech device capex and opex costs used in the model are up-to-date and validated by several sources. It is important to recognise, however, that these costs are continually changing and new vendors are constantly entering the market. This means that average costs used in the tool will need to be updated regularly, therefore detailed market scans of AgTech costs are recommended at least annually.	— Engage third party to conduct market scans on biannual basis to calculate average AgTech device capex and opex costs — Update the tool accordingly
Consider how more indirect costs and benefits can be incorporated in the tool	This iteration of the model focuses predominantly on direct, measurable economic benefits such as labour and fuel savings. To increase the tool's applicability further, exploration into how to reflect more indirect factors such as environmental or social benefits would improve the tool and further encourage AgTech investment.	— Engage third party to widen the costs and benefits considered in the tool — This will require more advanced modelling capabilities and further stakeholder consultation

Recommendation	Overview of recommendation	Recommended actions
More detailed documentation of AgTech experiences on AgTech trial sites	With AgTech trials moving forward, MLA should clearly outline an evaluation framework and mechanism for trial operators to use from implementation. This should be used Pre and post implementation of the AgTech measurement period. The type of measurement could be as simple as measuring a week's worth of labour and fuel costs before implementation and after implementation. The measurement framework should allow for better capturing of opex costs in particular, given this has been overlooked in other trials since operators are not the ones paying opex fees. This will increase the robustness of future trial measurement mechanisms and therefore the accuracy of data in the model.	— Create simple framework for trial operators to record costs and benefits of AgTech before and after implementation — Require framework to be submitted to MLA at the start and end of the trial, with regular updates throughout

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