final report

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Developing economic value propositions for increasing environmental performance through supply chain optimisations in the Australian red meat industry

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Final Report for MLA Internship

Raul Brens Jr

1. Summary of Project for Public Release

The project involved a scoping study to determine research, development and adoption pathways Meat and Livestock Australia (MLA) should pursue to increase environmental and economic performance using information systems. The project focused on understanding the status and ability to integrate four differing technologies in the Australian market. As an intern, I assessed each of the technologies along with their possible technological providers and presented their value to the red meat industry. I then chose one of the technologies and worked with a solution provider to undergo an application for funding of the project with MLA.

2. Summary of the Project Outcomes for the Industry Partner

The aims of this project were to work with current MLA providers to identify the opportunity areas MLA should pursue with regards to data capture, processing and analysis in grain-fed and grass-fed production systems along with red meat processing systems. The significance of this project has also been to discern and prioritise the opportunity areas through their economic and environmental benefits. The outcome has been an analysis of four different technologies, through their available providers, to understand their economic and environmental value in the Australian red meat sector. In addition, this project has been important in understanding how advanced both the technologies and the providers of the technology are in Australia. This information is important in MLA's decision to move forward with funding and implementation of these technologies.

3. Impact Statement for the Industry Partner

The impact this project has and will have is furthering our understanding of four different opportunity areas in the red meat industry which have not yet been explored. The intern, through independent research, will have an in-depth understanding of these opportunity areas and will communicate their findings to the Research, Development and Innovation (RDI) team to allow them to pursue adequate avenues for collaborative work and funding of these technologies.

4. Summary of the Educational Outcomes for the Intern

This internship has contributed to the academic development of the intern through enabling him to gain and polish new skills important in the private sector. Understanding the complexities of value propositions and business skills that do not come with a formal education such as soft business skills which come with negotiating and ensuring parties are content throughout the process. Negotiating is an important part of what the RDI team at MLA perform. Understanding the milestones for a company that would like to work with MLA but also understanding the necessities of the industry in which you work for allows you to negotiate between the needs of the red meat industry and MLA along with the technology providers.

5. Impact Statement for the Intern

This internship has prepared me for a potential future in the private sector. As a scientist, I came into the internship with the research capabilities. However, the work in this internship and the mentoring has helped me understand how expectations differ in the private sector from the academic. This is very important in creating a well-rounded candidate for employment in the private sector.

6. Summary of the benefits of the industry collaboration for the Academic Mentor

This internship allowed for a link and partnership with the corporate sector. Macquarie University has made it a priority to forging closer relationships with industry. This internship gives the academics a unique window to understand the expectations of their students in the private and corporate world. Thus, preparing current and future students to be competitive in a non-academic stream. As the mentor, I have forged a strong relationship with MLA, where we can discuss future research plans and avenues that meet the needs and piques the interest of both the scientists and industry partners. This is the first of hopefully many internships Macquarie University will be having with industry partners.

7. Summary of Research Findings

A. Project Background

Weeds are among the most severe threats to Australia's natural environment and primary production industries. Within the primary sector, they contribute to land degradation and reduction of productivity (NSW Department of Primary Industries NSW WeedWise). Throughout Australia, weeds are spreading faster than they can be controlled. Nationally invasive species account for 15% of all flora, and this figure continues to grow at a rate of 10 new species every year (Queensland Government Invasive plants). Weeds are pervasive, and because they often carry large quantities of seeds, they spread and proliferate. In addition, the conditions in which the farms maintain their land is an ideal environment that supplies the nutrients needed for the weeds to thrive.

Every year, the costs of weeds to producers in the primary sector are $50 million on combined herbicides and labour and an additional 1.5B/yr in overall direct costs and 2.5B/yr in lost production. New programs especially those involved in digital disruption, such as proposed here require a re-examination of the appropriate economic models to be used. For this reason, the sum of $20,000 will be included in the proposal to allow investigations at the initiation of the research into the best structure for modelling the total costs, but especially the benefits of the project to red Meat farmers. It is expected from data from the Cooperative Research Centre (CRC) for Australian Weed Management (Tech Series 12) that for every $1 invested and matched 50:50 from the private sector, a total by $2, gives a $20 return to farmers.

Every weed, every treatment, every farm and every environment will have different rates of return for the treatment. For example, for serrated tussock, a weed of national importance and widespread in NSW, was investigated by DPI/CSU. Spot spraying was 4-6 times more effective than boom spraying or no spraying. The cost of labour impacted the reported farm economics; however, the report further recommended that spot spraying continue to be investigated. This was because of the cost of labour in locating the tussocks and time spent spraying, limiting spraying to say 12 plants per minute was economically prohibitive. Autonomous drone spraying could potentially achieve about 60 plants per minute which would give LCA and economic returns equivalent to weed-free situations. Furthermore, the results would have significance to Chilean Needlegrass and African Lovegrass.

An example undertaken by the NSW, South East Local Land Services of the variables involved and impact on economic returns is given. It is obvious that spot spraying to restrict invasion would be the preferred approach. The impact of failure to contain a stand is shown below:

Table 1 Expected income from extra stock on 100 hectares – at a gross margin of $25. The ratio of GM to sales is assumed to be 1.5 (*DSE = Dry sheep equivalence)

DSE/ha	GM/DSE $	GM/ha $	GM/100ha $	Sales $	Number of cattle sold @$500 ea
1.5	$25	$37.50	$3,750	$5,625	11
2	$25	$50.00	$5,000	$7,500	15
3	$25	$75.00	$7,500	$11,250	23
4	$25	$100.00	$10,000	$15,000	30
6	$25	$150.00	$15,000	$22,500	45

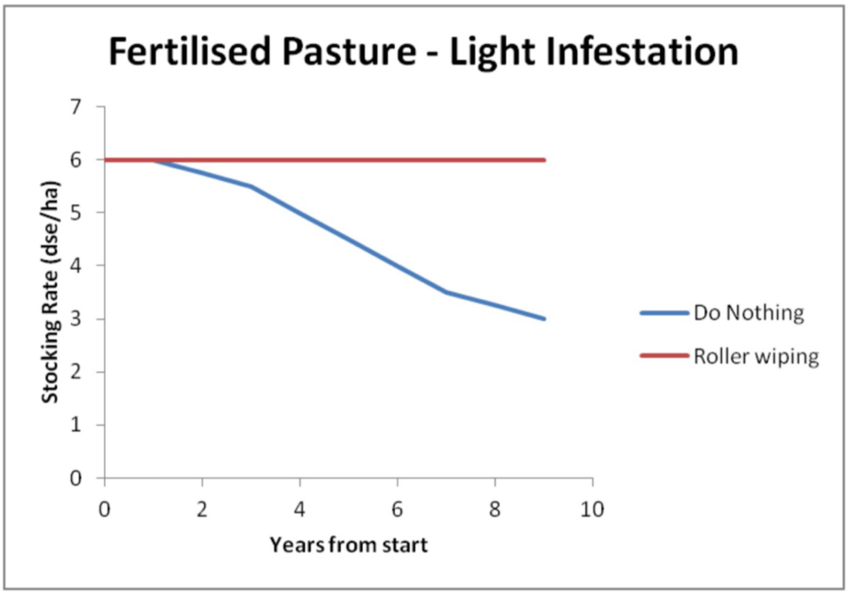

Figure 1 Estimated changes in stocking rates over time for Do Nothing and Roller Wiping on fertilised native pasture with a light infestation (Crosthwaite & Dorrough, 2014).

The economics of the farming system is described in Table 2 and Figure 2.

Table 2 Expected difference in net cash flow between control and No Control when key variables change by pasture type (Crosthwaite & Dorrough, 2014)

		Pasture type	
Variable		Fertilised $ difference	Unfertilised $ difference
BASE CASE	As above (table 10)	$6,180	$2,430
DSE / ha			
Fertilised	7	$8,680	
Unfertilised	3.5		$3,680
Gross margin	$30	$3,180	$930
Control cost/ha	$20	$5,850	$2,100
	$50	$6,180	$2,430

Note: The difference for DSE / ha refers to the maximum potential stocking rate gain from Control compared to No Control. This can result from a change in stocking rate for Control going up or No Control going down, or a combination of both. On unfertilised the marginal change is likely to be smaller.

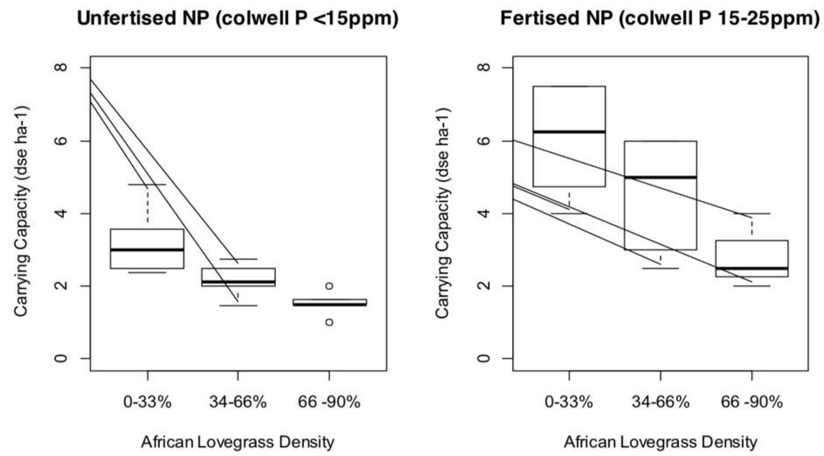

Figure 2 Estimates of the effect of African Lovegrass on pasture carrying capacity of the Bega Valley. Pastures differ in soil fertility (indicated by available phosphorus levels) and the level of infestation by African Lovegrass. The data in within the boxes show the range of estimates, within which 50% of all evaluations occur (25th to 75th percentile). The solid black line is the median estimate. The dashed lines indicate the spread of 95% of estimates. Estimates are derived from interviews and a survey questionnaire with farmers and farm advisors (Crosthwaite & Dorrough, 2014).

The numerical models illustrating the economic benefit of controlling weeds (African Lovegrass as the example) is shown in Table 3:

Table 3: Expected economic benefit of controlling ALG using roller wiping on 100 hectares. Costs are based on the use of a contractor. Estimates are derived from a ten-year discounted cash flow analysis with a gross livestock margin = $25 (Crosthwaite & Dorrough, 2014).

	Fertilised native pasture			Unfertilised native pasture		
	Do nothing $	After heavy infestation $	Before heavy infestation $	Do nothing $	After heavy infestation $	Before heavy infestation $
Annuity @ 5%	7,500	$9,115	$13,680	3,750	$3,272	$6,180
NPV @ 5%	$57,913	$70,387	$105,633	28,957	$25,263	$47,720
NPV @ 10%	$46,084	$49,479	$84,058	23,042	$16,074	$37,973

B. Research Method

This project implements a novel idea by Revolution Ag of developing a system that autonomously identifies and judiciously controls weeds by precise spot spraying. This technology will decrease the $1.5 billion overall costs and $2.5 billion annual productivity loss by increasing the yield and stocking rate of pasture over time. In addition to operational and productivity benefits, spot spraying will reduce the number of herbicides used on a pasture, directly benefiting the environment in and around the farms.

Revolution Ag will use a novel approach to weed detection. This method will implement the use of two unmanned aerial vehicles (UAV) outfitted with imaging technology and spot sprayers. The first of the UAV's will survey the land using hyperspectral and multispectral imaging and an RGB camera equipped with centimetre grade DRTK GNSS. The weeds will be detected and using the precise coordinates attained from the first imaging UAV, and the second UAV will be equipped with the appropriate herbicide to spot spray the exact location of detection.

Weeds are a major cost to red meat farmers, approximately $3B/yr. Currently, many weed infestations are either not addressed or inadequately addressed because of the difficulty of access or cost of spraying, or the requirement for contractors to do it. Furthermore, producers use high quantities of herbicides as they spray the entirety of the farm. This creates a need for a more environmentally friendly solution. New technology from China, for the application of chemicals, has the potential to reduce weed infestations on farms. The combined two new drone types for identification and spraying overcome many of the current deficiencies of weed control on farms by decreasing the number of herbicides used on the farm and increasing the number of weeds killed.

C. Intern's Contribution

As the intern on this project, I conducted all of the research and liaising with the technology provider and MLA. Additionally, in the first half of the internship, I assessed the four various opportunity areas (connectivity, process intelligence, the blockchain, and precision agriculture) for economic and environmental value. In the second half of the internship, I focused on researching the value proposition for the precision agriculture (UAV) in farm applications. I also prepared an MLA Donor Company proposal to get the precision agriculture project with Revolution Ag funded (a total of $227,198).

D. Research Results and Outcomes

The research outcomes in this study provided a comprehensive understanding of the benefits unmanned aerial vehicle in deterring and destroying weeds on farms. This technology, while new and in the beta stage, proves to be of economic and environmental importance to the red meat industry as outlined in Section A of this report. The outcomes of this study are yet to be determined as it will be carried out over the course of a year. Conclusive evidence of the efficacy of the technology will be determined by early 2019.

E. Future Research

The opportunities for further research in UAV weed mitigation are:

i. Researching weeds that are considered more intractable and difficult to control

ii. Scaling up of services to all (or a majority of) Australian red meat farmers

iii. Greater efficiencies in use of chemicals to reduce costs and deleterious side effects

iv. Design of new chemicals to better fit the new application technologies

F. Business Recommendations

The previous sections in this report discussed the use of precision agriculture and UAV for weed destruction and mitigation. I have submitted a proposal for funding of a pilot study with Revolution Ag to test this technology. I support further research in UAV weed destruction; however, as the project is at the funding stage there are no further recommendations for this specific project. Therefore, this section will highlight another opportunity area that I researched throughout this project that I believe is necessary for MLA to be leaders in. Throughout the research I have conducted in this internship the problem of traceability has continued to be presented as a problem with no real solution. Therefore, I do think an opportunity to be at the forefront of this problem through investing in blockchain solutions to traceability in the red-meat industry.

Blockchain technology is a tamper proof way of storing and moving verified information. Bitcoin has made the 'blockchain' term famous. However, this technology has a powerful platform that will become very important in the red meat industry. Blockchain technology is a constantly updated database of transactions simultaneously hosted on millions of computers. The data is decentralised with a process of verifiers and ledger, or databases, that concurrently updated across the users making the blockchain difficult to be hacked. In the red meat industry, there is currently a void and a need for traceability and as we move towards more digitized community traceability will become very important to consumers.

A number of food contamination cases abroad have shown the need for better traceability of our food. A particular case that has impacted purchasing of baby formula in Australia, is the foodborne contamination found in the Chinese baby formula. In 2008, China was a victim of the Chinese milk scandal which killed six children and hospitalized 54,000 children. Overall there were approximately 294,000 victims in China (Alcom and Ouyang, 2012). A key reason why this contamination was so pervasive was because of the poor records on food provenance. In not being able to track down the source China was unable to mitigated the threat. Since this scandal the public trust in food safety has not returned. This scandal has directly impacted Australian retailers who are being bought out of their baby formula stock to ship to China (Siegel, 2013). Forcing these retailers to place a cap on the number of units that could be purchased.

A Taiwanese e-commerce platform, Owlting, aims to regain that public trust in food safety by launching the world's first blockchain based app for tracing agricultural food products (Duhaime-Ross, 2017). They build a blockchain system for farms to trace from paddock to plate, by allowing the customers to scan a sticker on the meat product they are buying to access information from birth to processing. This will also mitigate any food safety issues because the affected food supply could be extracted immediately, unlike in the case of the Chinese milk scandal.

By 2019 the food traceability market will be worth $14 billion. Multi-nationals such as Nestle, Unilever, and Walmart are racing to design systems that can handle complex information flows, with the latter recently completing two food pilot programs (Duhaime-Ross, 2017). The Australian Department of Health reports 4.1 million cases of foodborne disease each year. That means that one out of every six Australian will be subject to foodborne illness each year. For food safety, a sticker with the blockchain technology will allow you to see where the animal product came from and it will allow you to pull the items from being sold much faster. The traceability will also allow you to clear the safe products faster, allowing the items to be sold and mitigation of wasted product and loss of money. Overall, investment in blockchain technology for the red meat industry is a necessary to ensure that MLA is paving the way for what will eventually be a technology that will be demanded by consumers.

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