Final report

BeefLinks: Facilitating a more productive backgrounding industry through grower support and data driven decision making

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Prepared by: Erin O'Brien
West Midlands Group

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1. Abstract

Backgrounding to add value to pastoral cattle along the supply chain is a well-established practice in the Eastern States of Australia. This project supported producers in the Northern beef cattle supply chain in Western Australia to consider the role that backgrounding could play in achieving greater value for pastoral properties and for the WA Pastoral Beef Industry. Animal performance data was collected along the supply chain from over 10 pastoral properties who sent animals to backgrounding properties, feedlots, and abattoirs during the 2020-22 years to identify the key drivers of animal performance in the supply chain. Average daily gain (ADG) was calculated for each animal at each step along the supply chain and this data was presented back to participating producers to encourage data-driven decision making on the most profitable pathway for their animals. While it was assumed that the transition process of moving animals from pastoral backgrounding properties was to have a significant impact on animal performance at backgrounding properties, there was no evidence that improved animal handling practices could alter the impact of transition. Instead, management practices and nutrition available to animals on the backgrounding property was a large determinant of animal performance in the first three weigh periods following entry. Total mixed rations and pelleted feed gave greater weight gain than pasture-based feeding systems across all years, while for pasture-based systems, ADG was generally highest and more consistent for animals in the August to February period (0.73kg/day) and low and variable in the April to July period (0.33kg/day). From this data, a range of tools were developed, road-tested, and presented to producers to understand and consider the best pathway for pastoral animals to maximise animal performance and returns in the pastoral beef supply chain. The increase in data collection, monthly benchmarking, and communication within the agricultural sector can be attributed in part to the success of the backgrounding project. This project has provided producers with valuable resources for monitoring their animals and improving their performance, which has led to a greater awareness of the importance of data-driven decision-making and collaboration within the industry.

2. Introduction

While the pastoral beef production system in Western Australia is predominantly focused on supplying the live export market, there is an opportunity to increase the profitability of pastoral beef production through pursuing market opportunities available in the higher-value boxed beef domestic and export markets. Currently, lighter weaners and cull cows are sent to the southern backgrounding properties in the agricultural region as a low cost and more reliable way of increasing animal liveweight before being moved onto a range of market opportunities, including feedlot, direct to abattoir, or sale for restocking properties.

The potential opportunity that arises from southern backgrounding is access to a variety of high value market opportunities. These opportunities are increasingly important as access to live export markets has been unstable. Cattle moving onto southern properties can also be more intensively managed for opportunistic sales into domestic and export market opportunities. An increase in the number of producers and properties being involved in the backgrounding sector is required to grow

the pastoral beef supply chain through greater utilisation of the feed on offer in the WA agricultural zone.

This project supported property managers to improve animal productivity by identifying strategies that reduce the impact of weight loss during transition from pastoral areas. The objective was to be achieved through supporting farmers to adopt data driven decision making processes, with the collaborative collection of data leading to a better characterisation of the backgrounding link in the beef supply chain.

In this project, a Beef Industry Development Officer worked with pastoralists and backgrounders to facilitate a change in production practices and to collect data for the benefit of this and other projects within the BEEFLINKS program. The project officer worked with backgrounding properties to develop strong relationships and support the sharing of information to: (i) facilitating improvements to production, and (ii) the collection of data to support changes in management.

Through working with pastoralists and backgrounders, mobs of cattle were identified originating from pastoral stations and transitioning to backgrounding properties. Some of these mobs were to be prepared for the transition from north to south through accelerated adaptation practices matched prior and post transfer from north to south. Priority was given to lines of cattle that can be followed throughout the whole beef supply chain to final slaughter.

This project built on the outcomes of completed projects 'P.PSH0949 – Easy As – Adaptation and transitioning procedures for pastoral cattle' (West Midlands Group 2019), 'GGRD 2015-0022 AGSC – Increased production for the beef/cattle supply chain in Western Australia' (Mingenew-Irwin Group 2019), and 'GGRD 2015-0057 AGSC - Building a robust lynchpin for higher value in the WA beef supply chain: linking pastoral beef to high-value markets through new backgrounding systems' (West Midlands Group 2019). The project is also supported by State NRM project 'CSGL18126 – Improved grazing systems for increased productivity and soil health outcomes' (West Midlands Group 2019).

The outcomes of this project include:

1. Documentation of the actual loss in animal weight experienced when moving from pastoral to backgrounding properties and identifying practices that reduce this weight loss.
2. Improving the understanding of factors that affect animal performance during backgrounding to drive greater industry performance, and to direct and capitalise on future pastoral investments (infrastructure, genetics, supplementation).
3. Increased awareness of the range of backgrounding models that are currently being used or could be used on a regional basis.
4. Supporting backgrounding systems through direct industry engagement that aims to increase production capacity by up to 12% (on baseline data) and contributes to an increase in the value of the WA beef industry.
5. Development of improved guidelines and tools for the movement of cattle from pastoral to northern agricultural regions in WA (with MLA assistance).
6. Ongoing co-ordination across industry groups that promotes N-S alliances for consistent beef supply in WA.
7. A clear involve and partner strategy and implementation plan designed, agreed to by MLA Project Lead, MLA Adoption Manager and UWA Project Team.

The industry outcome of this project will be an increase in the gross value of the backgrounding industry in the Northern Agricultural region of WA through increasing the volume of cattle being backgrounded each year. This will be achieved by increasing productivity per animal and per hectare to facilitate a greater number of animals moving through the pastoral beef supply chain. This will be supported by identifying higher value pathways for cattle moving through the supply chain.

3. Executive summary

Background

The Western Australian (WA) Pastoral Beef industry has historically been focused on supplying the live export market to countries such as Indonesia (MLA 2022) with cattle that are suited for growing out in feed lots overseas. The inherent paradox of this practice is that animals are exported to overseas finishing systems and much of the value of the animal missed by Australian Pastoral producers. As markets develop around the world, there is an increasing opportunity to boost the profitability of pastoral beef production through accessing higher value market opportunities such as the boxed beef market (both domestic and export). For an increase in industry value to occur, the supply of animals will need to be increasingly diverted from Live Export markets to the Pastoral Beef Supply Chain that links pastoral properties with backgrounding enterprises in the more WA Agricultural region, along with lot feeders and abattoirs.

One hurdle that has been identified as having a potential significant impact on animal performance in the transition from pastoral to backgrounding property is the loss of liveweight that is experienced by animals while being transported between properties. Through practices such as those outlined in Maynard and Revell (2017), it is believed that animals can become more familiar with being handled by humans through regular, intentional activities. While these practices are accepted as a proactive method of reducing the impact of transition, data to support the success of these practices are limited and shrinkage is still identified as a significant issue when transporting cattle between pastoral and backgrounding properties.

To increase the value of the Pastoral Beef Supply Chain, there is the need to quantify the impact of shrinkage on the performance of cattle entering the pastoral beef supply chain and to identify practices that are successful in reducing this impact. More broadly, there is little data to characterise the pastoral beef supply chain to understand the drivers of profitability for the supply chain and to determine where an increase in value can be derived. This project will address the gap in knowledge where there is little industry data that quantifies the loss of animal liveweight between pastoral and backgrounding properties and the impact that this has on animal performance further along the pastoral beef supply chain.

Objectives

1. Identifying current industry practices and benchmark productivity and profitability across northern breeder to southern backgrounding operations.
2. Supporting beef producers to adopt strategies that improve animal performance through the supply chain.
3. Engaging with background operations through MLA lead activities that result in practice change (business management, animal productivity, feed base utilisation).
4. Adoption of consistent collection (and storage) and interpretation of production data

to support decision making for backgrounding operations.

5. Integrating the communications plan with MLA, industry groups and stakeholders.
6. Developing and scoping the broader additional co-funded involve and partner activities across the broader BeefLinks Program in consultation with MLA Project Lead, MLA Adoption Manager and the UWA Project Team.

Methodology

- Ten producers were identified to participate in this project who currently send pastoral animals to backgrounding properties.
- A case study was completed for each property that characterised the type, timing, and number of animals being sent, animal handling procedures, and the decisions required when sending animals from pastoral to backgrounding properties.
- Animal performance data including weight, sex, feed type, transition score, condition score was collected through a series of on-farm visits with producers over the period 2020 to 2022.
- Data was collated, analysed, and new methods of reporting this information back to producers was developed.
- A series of report formats were sent out to participating producers for feedback on usability and their understanding of the information presented.
- The report format was refined and distributed monthly to deliver information back to producers.
- Other supporting tools including a decision tree and partial budget template were developed and validated by producers.

Results/key findings

- There were no practices identified in this study that lessen the impact of transition from pastoral to backgrounding properties on the average daily gain (ADG) of cattle.
- The magnitude in change in ADG was influenced by the time of year cattle were sent to backgrounding properties, with animals sent in the May-July period tending to have highly variable ADG compared to the August to February period.
- The flow of information along the pastoral beef supply chain was improved through the development of regular communication channels such as the monthly animal performance dashboard report.
- The low level of adoption of key technologies such as weighing equipment and EID tag readers required in this project highlights the need for further industry capacity building.

Benefits to industry

- To reduce the variability in ADG associated with animals being sent to backgrounding properties in the Northern Agricultural region of Western Australia, the following applies:
    - August to February is the period where weight gain is greatest in pasture-based systems.
    - Animals that are sent to backgrounding properties in the May to July period are likely to need feed supplementation, such as pelletised feed or hay, and this should

be factored into the economic analysis (via the partial budget tool developed in this project).
    - Animals that are less than 150kg liveweight entering backgrounding properties in dry seasons are best fed pelletised feed to assist with rumen function and to ensure positive liveweight gain.
    - Total mixed ration (TMR) feeding systems in an extensive environment (as opposed to lot feeding) can provide the greatest gains in animal liveweight but adds greater cost to backgrounding (which was not assessed in the current project).
- The use of the decision tree and partial budget tools by pastoralists to understand the pathways available for animals entering the pastoral beef supply chain will help to identify the pathway for maximum profit and the most optimal exit point for the pastoral owner to manage production risk
- Integration of the monthly animal performance dashboard report by pastoralists will allow them to make data-driven decisions on the most suitable pathway to maximise value and optimise the risk of finishing animals in the pastoral beef supply chain.

Future research and recommendations

The current project has begun the process of connecting all participants along the pastoral beef supply chain. This has not resulted in significant industry change to date, but will provide a platform for the following initiatives to be implemented:

- The delivery of facilitated workshops and ongoing support for pastoralists and backgrounding producers to trial and implement the tools developed in this project and which are ready for trial and adoption.
- Industry support for capacity building and investment into animal weighing equipment and skills to use it.
- Continued development of the relationships and trust required for the flow of information up and down the pastoral beef supply chain.
- A detailed economic analysis of the value generated at each step in the Pastoral Beef Supply Chain to understand where value is being created, the opportunities for efficiency gains, and to optimise the value being delivered to participants to ensure the long-term profitability.
- Continued encouragement of supply chain participants to participate in supply chain building activities, which largely need to work around sharing of information and trust.

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4. Background

The Western Australian (WA) Pastoral Beef industry has historically been focused on supplying the live export market to countries such as Indonesia (MLA 2022) with cattle that are suited for growing out in feed lots overseas. Animals destined for this market are mustered during the dry season in pastoral areas of April to September, often to coincide with the arrival of export boats to the region. Live export is the primary market for the first draft of animals during muster and this is a relatively simple and easy market to access for pastoral producers. A paradox exists where animals are exported to overseas finishing systems and much of the animal's potential value is foregone by Australian Pastoral producers. Producer preference for live export markets such as Indonesia (which are relatively low value compared to Japanese or US markets) seems based on factors such as simplicity, ease of access, and tradition. As markets develop around the world, there is an increasing opportunity to boost the profitability of pastoral beef production through accessing higher value market opportunities such as the boxed beef market (both domestic and export). For an increase in industry value to occur, the supply of animals will need to be increasingly diverted from Live Export markets to the Pastoral Beef Supply Chain that links pastoral properties with backgrounding enterprises in the more WA Agricultural region, along with lot feeders and abattoirs.

The inherent opportunity to send cattle south from pastoral properties to southern backgrounding properties is a practice that is already well-established in WA. Several pastoral businesses in the Pilbara region of WA have purchased their own backgrounding properties over the last 20 years with the view of value adding animals from the pastoral property (Mingenew-Irwin Group 2019). The focus of these activities does vary, from supplying a branded beef product (Yarrie Station 2021), to the more common approach of value adding cattle that are 'out of specification' for the Live Export market (West Midlands Group 2019). The latter approach can include resting or adding liveweight to cull cows before being sent to the saleyards, sending the smaller cattle after muster to manage feed, or to remove as many livestock from the pastoral property as possible during prolonged dry seasons and drought. The outcome of this activity is that the opportunity to develop productive backgrounding systems, and in turn a productive supply chain, is limited by the varied age, weight, and breed of animals entering the backgrounding property and the resulting varied markets that they are targeting.

One hurdle that has been identified in the transition from pastoral to backgrounding property is the loss of liveweight during transport and adaptation to the new feed base. On-road trucking is the main transport method, and this often means that animals travel up to 1200 kilometres between properties for periods up to 24 hours of travel time. Long transport time can have significant effects on short- and long-term health outcomes for the animals, including bruising, increased stress hormones, emptying of bowels and bladder, and the risk of respiratory infection (Grandin 2000, Knowles 1999). For the WA pastoral supply chain, the common issue cited by industry participants is 'shrinkage' which is best described as the reduction in liveweight commonly associated with animals fasting during the transport journey (Knowles 1999). Several methods have been trialled to overcome this and these can broadly be classified as nutritional, behavioural, or pharmaceutical approaches. Of these approaches, the most common used in the WA pastoral zone are behavioural training programs where cattle are desensitised to interaction with humans. Pastoral cattle are more sensitive to human interaction as they are often raised in the absence of being handled on the extensive Rangelands of the Pastoral region, and this increases the flight zone of animals (Grandin 2000) making them hard to handle and more prone to stress.

Through practices such as those outlined in Maynard and Revell (2017), animals can become more familiar with being handled by humans through regular, intentional activities. These include being held in the yard with access to hay and water, frequent moving between yards and facilities, and the use of visual and audible cues to locate feed (Maynard and Revell (2017). The development of stockmanship skills among pastoral property staff is also likely to reduce stress and lessen the impact of handling on the animals (Grandin 2000). These stockmanship practices were evaluated by Craig and Hindle (2019) where a line of cattle was split into two mobs at a WA-based pastoral station then handled in contrasting ways to evaluate the use of practices outlined by Maynard and Revell (2017) compared to a mob with a low amount of handling. There was little impact of either handling method on animal performance when they reached the backgrounding property, with several external factors identified as impacting on the study (low average daily temperature and severe weather conditions). In short, and despite the adoption of these practices by the industry, shrinkage is still identified as a significant issue when transporting cattle between pastoral and backgrounding properties (Coppin, A; Darcy, S; Forsyth, C; *pers.comm.*).

To increase the value of the Pastoral Beef Supply Chain, there is the need to quantify the impact of shrinkage on the performance of cattle entering the pastoral beef supply chain and to identify practices that are successful in reducing this impact. More broadly, there is little data to characterise the pastoral beef supply chain to understand the drivers of profitability for the supply chain and to determine where an increase in value can be derived. This project will address the gap in knowledge where there is little industry data that quantifies the loss of animal liveweight between pastoral and backgrounding properties and the impact that this has on animal performance further along the pastoral beef supply chain.

5. Objectives

The objectives of the project and the success at meeting each objective include:

1. Identifying current industry practices and benchmark productivity and profitability across northern breeder to southern backgrounding operations.

   Through relationships developed with producers in the West Midlands region as well as in the pastoral regions of WA, the project gained an in depth understanding of the movements of cattle throughout the backgrounding system. It was quickly understood that prior understanding of this system had been overstating the organization levels of this movement.

   A limiting factor in the project was the lack of appreciation for data collection by producers in the northern beef cattle supply chain. Attitudes against data collection were realized shortly after the project started and proved to be a major setback in the project and data recording. There is a common belief in the industry that data is not to be shared. The backgrounding sector was well recorded, but there was limited success with feedlots and abattoirs due to data privacy.

2. Supporting beef producers to adopt strategies that improve animal performance through the supply chain.

   There have been a core number of producers involved in the project over the last

three years, but also many producers and other industry representatives who have been involved in the knowledge sharing of the project. There is an alignment to PPSH.2100 Pastoral Partners Producer Demonstration program with the Gascoyne Catchments Group. An aim of this project has been to have clear communication channels open throughout the three years which have provided updates on the research and results compiled. Through building relationships and status in the industry there have been open and clear communications throughout the duration of the project. Updates on new ideas and trials occurring in the regions, as well as numerous field days and presentations have provided a space for producers to be supported by researchers as well as their peers to continue developing their production systems.

3. Engaging with background operations through MLA lead activities that result in practice change (business management, animal productivity, feed base utilisation).

   Early in the project it was identified through the case studies that the supply chain was very disorganized and there wasn't any structure to support any capacity building activities. This severely restricted the ability to deliver against this objective. There was a subsequent change in focus to build those linkages required to develop capacity building which has proved to be successful.

4. Adoption of consistent collection (and storage) and interpretation of production data to support decision making for backgrounding operations.

   At the beginning of the project there was a large range in the collection and use of data from property to property. Some of the properties with very little data collection have increased as the benefits of increased data collection have been shown through the work of the project. The tools that have been created in the last 6-12 months of the project work to support producers in decision making through the supply chain.

5. Integrating the communications plan with MLA, industry groups and stakeholders.

   The West Midlands Group has worked to integrate with many groups in the regions. This includes work with the Gascoyne Catchments Group, Mingenew-Irwin Group, Kimberley Pilbara Cattlemen's Association, relevant sponsors and worked in frequently with the University of Western Australia.

6. To scope potential additional co-funded activities across the integrated BeefLinks Program in consultation with MLA Project Lead, MLA Adoption Manager and the UWA Project Team.

   Involve and partner activities were not delivered as part of this project as the case studies completed at the start of the project identified a high level of disparateness in the industry which indicated that the involve and partner program would not be suitable at this stage.

6. Methodology

6.1 Producer engagement and case study development

The delivery of this project was centred around the engagement of a Beef Industry Development Officer (hereafter referred to as the 'Project Officer') to collect information and data collection and acts a conduit between pastoral and backgrounding region in Western Australia. The study area for this project was focused primarily on the Pilbara and Gascoyne pastoral regions and on the Northern Agricultural region which is the dominant region where pastoral cattle are sourced for backgrounding. Participants were identified from previous knowledge of their involvement in the WA Pastoral Beef Supply Chain, and more specifically the backgrounding sector. West Midlands Group utilised their current database of producers for both the pastoral and backgrounding categories, while Meat Livestock Australia (MLA) supplied contact details for feedlot and processors registered in the industry. The collection of background information from pastoral and backgrounding properties was achieved through the Project Officer engaging directly with pastoralists by visiting stations and conducting interviews, often while being embedded within the pastoral properties mustering operations. Many of the initial properties engaged in the project owned or operated both pastoral and backgrounding properties and this gave an insight into the linkages between animal handling procedures as the animals' transition from pastoral to backgrounding properties.

The data collection method was based around engaging pastoralists with conversation after time was spent building rapport and trust with the pastoralist by the Project Officer engaging in the mustering activities. From this, a greater amount of information was made available than has previously been able to and has been recorded in a case study format for each property. The case studies developed are attached in Appendix I and were used to guide the collection of data and to interpret the data during the project.

6.2 Animal performance data collection and analysis

6.2.1 Data collection

Data was collected from the pastoral beef supply chain predominantly during the 2020-2022 mustering seasons (April to November) on mobs of cattle that were identified at any point in the pastoral beef supply chain for inclusion in the project dataset. The opportunistic nature of mustering cattle on station properties meant that identifying animals in advance of muster for inclusion in this project was not always possible. Through continual engagement with pastoralists during the mustering season and building on the relationships developed during the collection of case study data, animals were identified at varying stages through the pastoral beef supply chain. This included engaging with pastoralists prior to sending cattle into the supply chain, with backgrounders on receipt of animals from station or other backgrounding properties, and with animals that had entered feedlots. Access to the data for these animals was negotiated with the animal owner at the time, and the life data of the animal was then traced back through the supply chain where possible to build the overall picture of animal performance.
When animals were identified, as much supply chain data (both current and historical) was collected to understand the factors likely impacting on animal performance (Table 1). This approach varied

from the original intent for data collection due to the lack of infrastructure (animal weighing systems on properties) and initial lack of interest by producers to collect and contribute data. This impeded the collection of data to directly evaluate the impact of transition stress on weight loss during transport. Animals entering the backgrounding phase of the pastoral beef supply chain were likely to be weighed when entering the backgrounding properties. The focus of this project moved towards identifying the differences in animal performance for the first four weigh periods following arrival at the backgrounding property. This typically reported the first four months of animal performance at the backgrounding property and time when differences in transition method would have an impact on animal performance.

Table 1**: Description of performance values calculated for each animal (EID tag) in the project**

Performance Value	Description
Exit weight	The weight of animal (where known) leaving the property of Origin
Induction weight	The liveweight of animal at entry to Destination (backgrounding) property
Number of Weigh periods	(The total number of weight recordings for an animal) - 1
Start weight	The first liveweight recording of each weigh period (variable = i)
End weight	The end liveweight recording of each weigh period (variable = i + 1)
Weight gain	(End weight – Start weight) for each period
Days	Number of days in Weigh period
ADG	Average Daily Gain (Weight gain / Days) per period
Weight range	Animals were categorised into 50 kg liveweight ranges between 100 kg and 450 kg.
Number of animals (n)	The number of animals in each Weight range
Month	The month that the Weigh period started in (1 = January)
Feed type	The type of feed that was used during the Weigh period (Pasture, Pellets, Full Ration).
Weigh property	Where weight was gained
Weigh location	Where the animals were weighed

6.2.2 Data analysis and interpretation

Where animals were identified at the pastoral station and destined for the backgrounding link of the supply chain, qualitative data was collected to describe the property. This data included origin, breed, sex, age, class, seasonal conditions at turnoff, date of turnoff, curfew period, and weight at station turnoff (where data was available). In addition, each mob of cattle was assessed for the level of preparation for animals that transition from pastoral to backgrounding properties. An index based on the 'Practices and procedures for profit, efficiency, and livestock welfare along the WA beef value chain' as developed by Revell and Maynard (2017). This technology ranked each mob of cattle from 1 being no adaptation or transitioning procedures (muster to truck scenario) to 10 being the full adaption and transitioning procedures (weaning to yards, familiar feeds, visual cues, stress-free stock handling, etc.,).

This simple measure was used to link animal weight gain at the backgrounding property to the transitioning procedures used during transport between pastoral and backgrounding properties. The transition process for this project included the first four weigh periods at the backgrounding property. This monitored the potential weight loss during transport and the pattern of liveweight

change as it was regained on the backgrounding property. To minimise effects of gut fill difference, each mob of cattle were weighed at the same time of day each time.

Data was analysed using the R Statistical program using the packages 'plyr' and 'dplyr' to manipulate the data into long format for temporal analysis of animal performance. The following steps were used to assemble the dataset for analysis:

1. Individual animal records were aggregated by EID number
2. The number of weigh periods were determined as the number of records minus 1 (n-1)
3. The Average Daily Gain (ADG) was calculated for each weigh period
4. Weight ranges were assigned based on the start weight of each weigh period. Weight ranges were <150kg, 150-250kg, 250-350kg, 350-450kg, >450kg.
5. All other co-variate factors were attached to each data record based on the start weight of each period

The data analysis also included the following parameters:

- Outliers for Average Daily Gain (ADG) records were removed where outside the range of >3kg/hd/day and <-3kg/hd/day that often were a result of short weigh periods and differences due to gut fill level of the animal
- Records with only one EID entry (one weight recording only) were removed as number of weigh periods was zero (n=0) where animals had just entered the dataset or other animals that were being run on the property were weighed in the same session
- Treatments groups with less than 10 animals were excluded from the presented results as this gave highly variable mean and standard errors
- Data was anominitised to remove property identifiers for the analysis where required (Link tables are available)

6.3 Development of tools and guidelines

6.3.1 Dashboard animal performance report

The data collected during the project was used to inform a range of decision support tools aimed to help pastoralists and backgrounders to better assess the risk and reward of sending animals into the pastoral beef supply chain. A pilot animal performance dashboard was developed by aggregating data into a monthly reporting format using the R Statistical program to provide a range of metrics that describe the performance of animals on a backgrounding property (Appendix II). An additional output from this analysis were .csv files of cohorts of animals that could be used by pastoralists and backgrounders to better manage animal performance. This package of information aimed to support pastoralists and backgrounders to make data driven informed decisions on animal management and served as a test product for producer feedback.

A second supply chain dashboard was developed from data collected in this project using the Microsoft PowerBI program where average daily gain from all animals was aggregated into monthly report for the prior 18 rolling month period (Appendix III). Comparison data was added for individual properties for each month to provide a high-level benchmark, with additional descriptive statistics

calculated for the last cohort of animals entered from the property. As with the prototype dashboard, each group of animals presented in the report were contained in a .csv file that could enable this information to be actioned by pastoral and backgrounding property managers.

The supply chain dashboard was published monthly in an industry newsletter that was circulated to all project participants to improve the connectivity of the pastoral beef supply chain.

6.3.2 Decision tree tool for producers and supply chain actors.

A map of the pathways for animals to enter and move through the pastoral beef supply chain (Appendix IV) was developed in the project using an online mind mapping tool (Miro, 2022). The information in the decision tree was based on data collected during the project on the movement of animals in the supply chain. This has been expanded in this report to include the driving factors for the movement of animals in the supply chain and the decisions that need to be made by pastoralists and backgrounders.

A decision tree (Appendix V) has been developed from these supply chain maps to identify the key decision points where pastoralists and backgrounders need to determine if they wish to continue to carry the risk of animal performance for the benefit of the reward (increased value capture). The decision tree captures the decisions at each point of the supply chain and the options available to pastoralists and backgrounders.

6.3.3 Partial Budget

A partial budget template was developed specifically for pastoralists to support the decision tree tool for identifying the most suitable pathway to market for cattle in the pastoral beef supply chain (Appendix VIII). The purpose was to assess the risk and reward of each pathway and the financial gain from each step of the supply chain.

7. Results

7.1 Case study analysis of pastoral and backgrounding properties

To develop a greater understanding of the northern beef cattle supply chain, case studies were developed from pastoral and backgrounding properties that were actively participating in the Pastoral Beef Supply Chain in WA. This collection of qualitative data describes the practices used by producers in the transition from pastoral to backgrounding properties to gain a better understanding of the opportunities and limitations within the supply chain. The broad categories covered in each case study include sourcing cattle, selection criteria, transition techniques, nutrition/grazing management, data collection strategies, markets, and barriers to production. Ten case studies were developed at the start of this project, and these were updated over the duration of the project as engagement with producers continued through on-farm data collection and general visits.

Producers were identified through many avenues of contact, such as industry contacts, previous event attendees, as well as past backgrounding project participants. These producers were engaged in the project through being sent an information pack (Appendix VI). The pack outlined the project activities and outcomes anticipated from the project. There was a large volume of feedback given by producers from this initial information pack that crystalised opinion on many issues within the

pastoral beef supply chain, including the lack of outcomes delivered from previous industry projects, and hesitancy to be involved in 'yet another project that will likely not delivery any value to the industry.' This was used to ensure that the project remained focused towards achieving tangible outcomes and delivering back to the producers in the project.

7.1.1 Source of animals entering backgrounding properties

The predominant source of cattle entering the backgrounding link of the pastoral beef supply chain was from stations that have purchased their own backgrounding properties as an extension of their pastoral business or have an established linkage with an existing backgrounding producer in the Northern Agricultural region of WA (Figure 1). There were some backgrounding producers who utilise trading models and sourced cattle annually from the market or through ongoing relationships with pastoralists. For example, two producers have adopted a combination of strategies, both receiving animals through direct linkages with pastoral stations while also sourcing additional cattle from the market to maximise farm production depending on seasonal conditions.

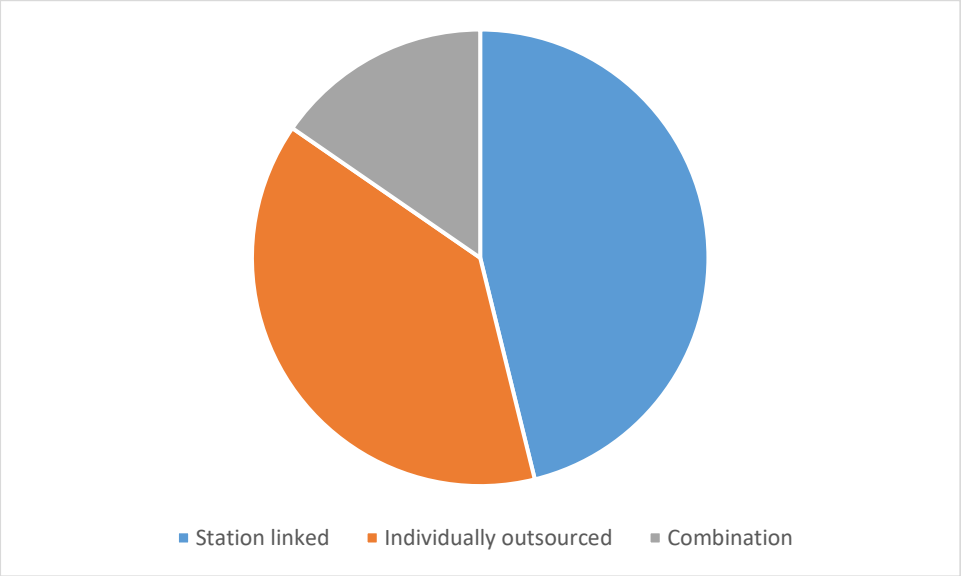

Figure 1**: Number of participants sourcing cattle from the three demonstrated supply channels (n=11 backgrounding enterprises)**

Station linked backgrounding properties are often organised as an extension of the main pastoral enterprise. They receive a broad range of cattle annually varying in confirmation, condition and numbers – a process driven by seasonal conditions at the pastoral property. There was little evidence of a specific selection criteria being applied to cattle destined for backgrounding properties as the management focus is placed on optimising the carrying capacity of the station. Overall, cattle being sent to backgrounding properties are generally weaners, between 2-36 months of age and often with a liveweight below the specification for entry to the live export trade (350kg). The dominant pathway to market for pastoral animals in this study was direct to the live export market where animals meet the specification (280-340kg liveweight). The consensus among pastoralists and backgrounders was that backgrounded animals would weigh between 180-300kg liveweight when

leaving the station and depending on the target market. However, producers highlighted the need in dry seasons to move animals that have a significantly lower liveweight of less than 180 kg to backgrounding properties to manage station carrying capacity and to optimise the animal health outcomes during times of drought. For simplicity of management, backgrounders choose to carry steers or heifers and not 'mickeys' (bulls) to avoid management issues when running mobs of cattle close together.

In contrast, properties that are not directly linked to backgrounding properties have the freedom of selecting animals that will be best suited to the aims of their production system and include traits/factors such as animals of a target weight and preference for higher efficiency breeds. Backgrounding properties who trade animals generally target weaners (steers and heifers), less than 24 months old, 200-240kg liveweight at entry with the expectation to reach a weight of 320-340kg liveweight as quickly as possible. One producer stated that their average daily gain of backgrounding cattle ranged between 0.3 to 0.5 kg/day although, some mobs of cattle grew at 0.9 kg/day during periods of peak production (e.g., Spring). Trading enterprises can operate on either a profit share, agistment, or direct purchase depending on the agreed terms between both parties.

There were some consistent factors that appeared to weigh heavily on pastoral producers' minds when deciding the quantity and quality of cattle to be sent to backgrounding properties. Seasonal conditions on the pastoral property seemed to have the greatest impact on how many animals are sent to backgrounding properties and how many are retained on the stations. This also affects the quality (conformation, condition, weight-age relationship) of the animals sent to backgrounding properties as it can be an easy way to increase the value of cull animals. Some properties opt to send heifers to backgrounding properties to grow out, mate, and send back to pastoral station the following year. Other properties will send cull cows to backgrounding properties to rest (i.e., 2-4 weeks) and regain condition lost on transport prior to being sent to the saleyards to optimise presentation and sale value. Overall, the use of backgrounding properties serves a broad function of adding value to off-specification (live export market) pastoral cattle in a range of ways and ownership structures.

7.1.2 Grazing and herd management at backgrounding properties

The case studies identified that all producers practice rotational grazing as their preferred method of grazing management on backgrounding properties. The definition of rotational grazing was quite broad but included a period of grazing followed by a rest period for each paddock and ranged from high intensity cell systems that strategically plan movements in advance to the movement of mobs based on a calendar or ad-hoc basis. The general practice was to move animals every 3 to 5 days depending on estimates of current and future feed availability during each season of the year. The pasture base of most backgrounding properties was a mix of annual or perennial pastures established in separate paddocks across the farm. Annual pastures are self-regenerating, often containing many species of weeds (capeweed, silver grass, barley grass) and productive annual species (annual ryegrass, sub-clover, serradella), while Rhodes grass and panic are the dominant perennial pastures across the region. The inability of annual pasture systems to provide year-round feed was highlighted as a barrier to increasing productivity, and the use of perennial pastures to provide out of growing season (April to October) feed was largely dependent on sporadic summer rainfall.

7.1.3 Data collection to aid in decision making

The collection, practices and processes, attitudes, and usage of data varied significantly between pastoral and backgrounding properties. Few participating properties weighed their cattle on departure from stations and cited issues with the practicality of this practice during mustering operations. The use of portable yards when mustering in remote locations and/or overall lack of infrastructure, and the perception of weight loss from overhandling animals were cited as significant barriers for cattle not being weighed at the station. Most managers of backgrounding properties were aware of the need for data collection to monitor animal performance but lacked the skills and confidence to integrate the use of this data into farm business decision making practices. In contrast, backgrounding properties who traded cattle used data to a greater level than others, and this was primarily driven by the need to quantify animal weight gain to maximise farm returns.

Some producers highlighted the importance of regular weighing to provide timely data that could help to manage cattle performance through the backgrounding system, while others deemed regular collection as detrimental to animal performance and judged the progress of animals 'by eye'. There was also concern expressed for the additional stress caused to animals during weighing and the effect of this on future weight gain. The current condition, layout, and overall efficiency of handling facilities was observed to be related to the producers' attitude to weighing, with good facilities lowering the negativity to frequent animal weighing. Properties that were observed to have poor infrastructure considered data collection as 'a lengthy process' and demonstrated greater reluctance to more frequent weighing. There was little adoption of more passive animal performance monitoring systems such as the use of a walk-over-weigh system.

7.1.4 Observations of pastoral practices during station visits

Throughout this project there were numerous visits to pastoral properties to understand more about mustering and animal handling practices on station, preparation of animals for transport, and management decision-making processes. The collection of station-based animal performance data required 2 to 3 trips per year to the Pilbara and the Gascoyne by the project officer to assist with data collection. This approach, while successful, limited the amount of data that could be collected from pastoral properties that did have weighing equipment. In contrast, data collection on backgrounding properties was significantly easier due to greater amount of infrastructure and ability for the project officer to be present and assist with weighing process on a regular basis.

A significant observation was that when trying to weight cattle on pastoral stations it was clear that physical and psychological stress occurred in animals during the mustering process. Many animals on pastoral stations are isolated for most of the year before mustering, where they go from no human or machine interaction to mustering; helicopters flying overhead, bikes, vehicles and horses following cattle, and animals having to walk long distances to yards, determining hierarchy along the way. While many stations employ low stress stock handling procedures across their properties, the clear contrast in environment and management conditions is still evident. Once in the yards, this was the point at which low stress stock handling procedures were employed to quieten the animals (if used), and these procedures then lead into practices that improve transition to backgrounding properties (if used).

Many of the visits to station were designed to elucidate the type of information requested by pastoralists when considering where to send their animals following muster. Some of the topics that were raised included:

- Feed type x ADG data: *What feed do should I be looking for and what ADG will be the likely result?*
- Pasture production measurement in each region – *How do I know what feed is available and if there is enough feed?*
- Seasonal conditions/rainfall update - *What are seasonal conditions like on pastoral properties and is there a risk of a bad season affecting ADG?*
- ADG information for each mob on property – *How do I keep track of animals that I send down for backgrounding to ensure they are gaining weight?*
- ADG for each line of cattle sent from station – *How are each truck load of animals performing?*
- Volume of animals traded each month – *How many animals are being traded in the system each month?*
- Breed X ADG – *What differences are there between different breeds for ADG on backgrounding properties?*
- Animal starting weight – *What is the ideal weight for animals to enter my backgrounding system?*

7.1.5 Post-muster animal handling and management practices

Almost all surveyed producers displayed knowledge of stockmanship practices that reduce animal stress prior to transport to backgrounding properties. The extent to which these guidelines were being followed varied between properties (Appendix VII). There are many individual tools available for producers to improve animal handling and performance, however there was insufficient clarity in their responses to determine why producers practiced some and not all the practices available. For example, the use of the 'travel lounge' to calm livestock and condition them to frequent handling was often used but visual and audio cues for animals to identify feed options at each property had a lower rate of adoption. There was high awareness of the impact of transition from pastoral to backgrounding property on animal liveweight in all participating producers, but few were quantifying the loss of liveweight during transport by weighing at exit of the pastoral property and entry to backgrounding property. Despite this, it was widely believed that transition stress was a significant issue that impacts animal performance when sending animals to backgrounding properties.

Each station varied in their adoption of the Rangelands Self-Herding practices and the execution of these all of these practices was limited. For example, the first step following muster and yarding could be to yard the cattle and leave them for a day or two without access to feed and water while they settle, and the muster is completed. Weaner training could be limiting to walking back and forth through the yards, being run through the yards without stopping in the crush, and introduction of animals to electric fences could all be used to shape animal behaviour when they arrive at the backgrounding property.

Management practices were often completed in close succession with training the animals; with many of these procedures undertaken to meet market specification. For example, some stations castrate the majority of male cattle whereas as other stations prefer not to castrate unless it is required. There appears to be a move towards poll cattle, but for horned cattle they are usually tipped or dehorned to fit market specifications. The impact of dehorning and castration can be seen

by observing these cattle, but more is required to understand the impact of this practice in the project data.

There was a minimum level of animal husbandry practices completed by pastoralists following weaning in the yards. This included:

- Copper selenium injection (Multimin or similar)
- Mineral supplement in water (Beachport liquid minerals usually)
- Access to hay in the yards (sometimes grain as well)
- Weaner training (to varying levels)
- Castration of bulls (improve management on backgrounding property)
- Dehorning/tipping horns
- Branding
- One lap of the yards/race/crush without any treatment.

7.2 Animal Performance data collection and analysis

7.2.1 Impact of transition on Average Daily Gain at backgrounding properties

To compare the practices used by pastoral managers before and during the transition between pastoral and backgrounding property, a rating system was developed. This rating was a qualitative assessment of properties' transition procedures that applied the 'Rangeland Self Herding' principles to pastoral properties practices. The transition score related to each group of animals in this study for the 2020 year are summarised in Figure 2 and range from 1 being no specific transition procedures to 10 being the implementation of best practice according to the 'Rangelands Self Herding' guide (Maynard and Revell 2019).

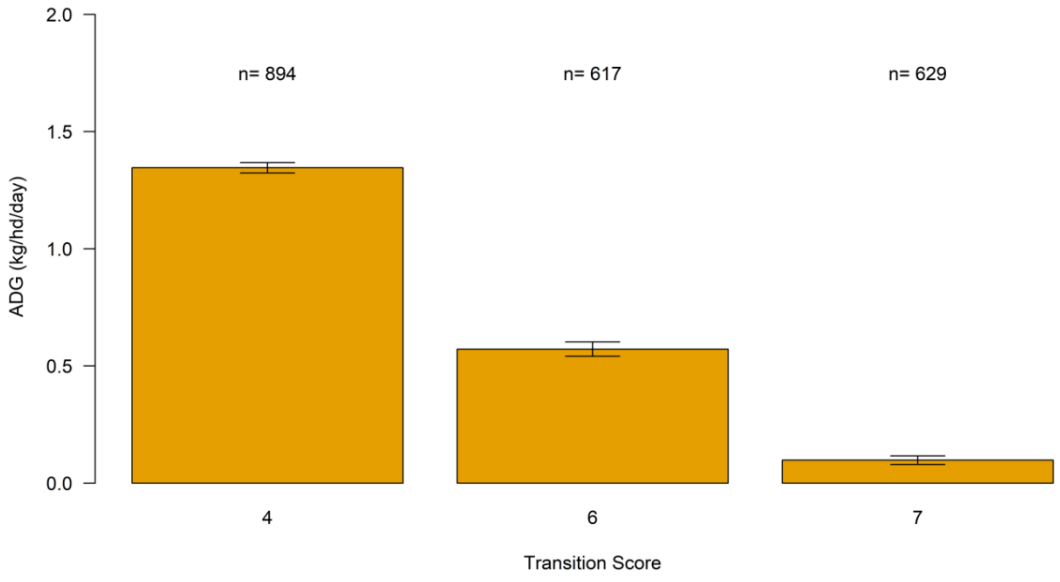

Figure 2: Average Daily Gain (ADG) of all animals followed during the 2020 season, categorised by transition score. Data is for weigh period 1 only as this is the period closest to the transition period and follows induction to the backgrounding property. Error bars denote the standard error of the mean of each liveweight range. n = number of animals in each live weight range.

The relationship between ADG and transition score was inverse to the expected relationship. Low transition assessments of 4 (few transition practices used) had a higher weight gain than animals that were scored 6 or 7 (more transition practices used). These results contradict the expected outcomes of the Rangelands Self Herding principles and suggests that there are other more significant factors that are impacting on animal production in backgrounding systems. This assessment is limited by understanding of the degree to which each animal handling practice impacts on animal performance in the supply chain, and further research in this area would allow ranking of each practice and prioritise adoption for producers.

7.2.2 Volume of animals in the Pastoral Beef Supply Chain

There was a variable number of animals being inducted onto backgrounding properties during the length of the project (Table 2). This is attributed to the highly varied seasonal conditions experienced during this period as well as market variability. During the 2020 season, many stations were heavily destocked reflecting drought conditions. In 2021, lower numbers of animals were sent south as the season in the northern pastoral regions was good with more feed on many stations. 2022 proved to be another good season in most of Western Australia which led many stations to hold on to more cattle to restock herd numbers. Cattle prices were strong for most of the year which encouraged producers to move animals on quickly.

Animals moving through the supply chain were often difficult to follow. There are many pathways that animals can take through the supply chain, and in most cases, lines of animals are split during backgrounding into weight groups, some are sold early or later, or are transferred to different properties or back to the pastoral property. Data collection later in the supply chain as animals were sold was hampered by differing attitudes among producers towards tracking animal performance. Whilst there is evidence of slow adoption by properties to keep better records, many animals are often sent to saleyards or to commercial feedlots without being weighed because they have run out of feed, or price is not specifically tied to individual animal weight gain. Finally, when animals enter commercial feedlots and supply chains, the commercial nature of these operations often hampers the collection of animal performance data for the life of the animal. The result of this is an incomplete dataset for many animals in the study.

There were 933 head weighed onto backgrounding properties during the 2020 year, with most of the activity occurring in September and October (Table 2). 2020 was a dry start to the season at backgrounding properties and little feed was available until August 2020 and this is likely to have delayed animal transfers to backgrounding properties until the September/October period. There were 571 head weighed onto backgrounding properties in the 2021 year which was significantly lower than in 2020. The weighing activity was dispersed across most months of the year in 2021 as there was many animals in the system from the previous year due to the high number of smaller animals sent to backgrounding properties in 2020, and summer rainfall which supported excellent growth of perennial pastures (where established). There was only 357 head weighed onto backgrounding properties in 2022 as excellent seasonal conditions and relatively low herd numbers

on pastoral properties meant that it was more cost effective to finish animals on station and not transfer to backgrounding properties.

Table 2: Number of animals entering backgrounding properties (Head) in each month for the period 2020 to 2022, and the monthly Average Daily Gain (ADG, kg/hd/day) for the duration of the project

Year	2020	2021	2022	Total
Count	933	571	357	1861
Average Daily Gain (kg)				
Mean	0.57	0.46	0.42	0.51
SD	0.96	0.68	0.5	0.81
Minimum ADG	-3	-2	-1.49	-3
Maximum ADG	3	2.86	1.77	3
Month				
January	0	70	0	70
February	0	89	41	130
March	0	43	0	43
April	0	24	0	24
May	13	62	44	119
June	131	57	0	188
July	134	0	116	250
August	38	160	1	199
September	229	1	0	230
October	232	51	114	397
November	77	8	41	126
December	79	6	0	85

7.2.3 Average Daily Gain (ADG) of animals on backgrounding properties

Data was collected in this study wherever it was available to understand the seasonal nature of animal performance in the backgrounding link of the pastoral beef supply chain. Figure 3 includes data for the 2018 to 2022 period, and this highlights the change in Average Daily Gain (ADG) between years. ADG for 2018 and 2019 was lower than the study years due to below average seasonal conditions on the backgrounding property and the type of cattle being sent to the backgrounding property. Most of the animals for 2018 and 2019 were cull cows that were sent to the backgrounding property to be spelled prior to sending to market or abattoir for sale. This was likely a short stay (2-4 weeks) to allow animals to recover from transition from the pastoral property and to gain some condition prior to sale. The large associated errors indicate that animal performance was highly variable in these years but may also be influenced by low numbers of cattle in these years (data not presented). Average Daily Gain in the 2020 to 2022 period was generally lowest in 2020, highest in 2021 and intermediate in 2022 and this broadly reflects the pattern of annual rainfall for this period.

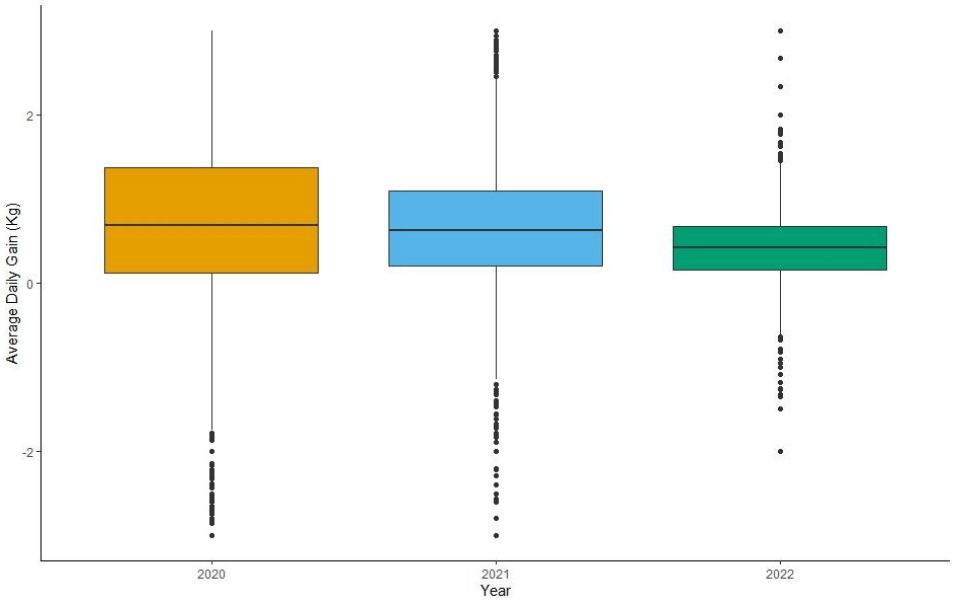

Figure 3**: Average Daily Gain (ADG, kg/head/day) for all animals in the dataset that have originated from the Pilbara region of Western Australia where most of the animals in this study were sourced from. Data is for the 2020 to 2022 period.**

Average daily gain (ADG) varied considerably from month to month across the 2020 to 2022 period in this project, as seen in Figure 4. A noticeable trend was that ADG tended to be below average in the April/May/June period in each year and above average in September to February period. The latter was strongly influenced by above average summer rainfall during the study period that supported excellent perennial pasture growth. The below average weight gain period in Autumn of each year is not unexpected as this is the period where pasture growth can be rapid but the amount of feed on offer is low for grazing cattle. Inter-seasonal variability also had an impact on feed availability during autumn, with 2020 being a very dry start to the season and causing a delay in effective feed on offer until August. In contrast, above average seasonal conditions in 2021 and 2022 led to improved ADG in Autumn but June and July likely tend to remain low weight gain months. As a result, it was recommended that animals are not transferred to backgrounding properties until at least July/August in any year to ensure above average (0.48kg/day) ADG is achieved. The impact on weight gain from low feed on offer can exacerbate the impact of transition between pastoral and backgrounding property and cause depressed weight gain (as seen in previous studies).

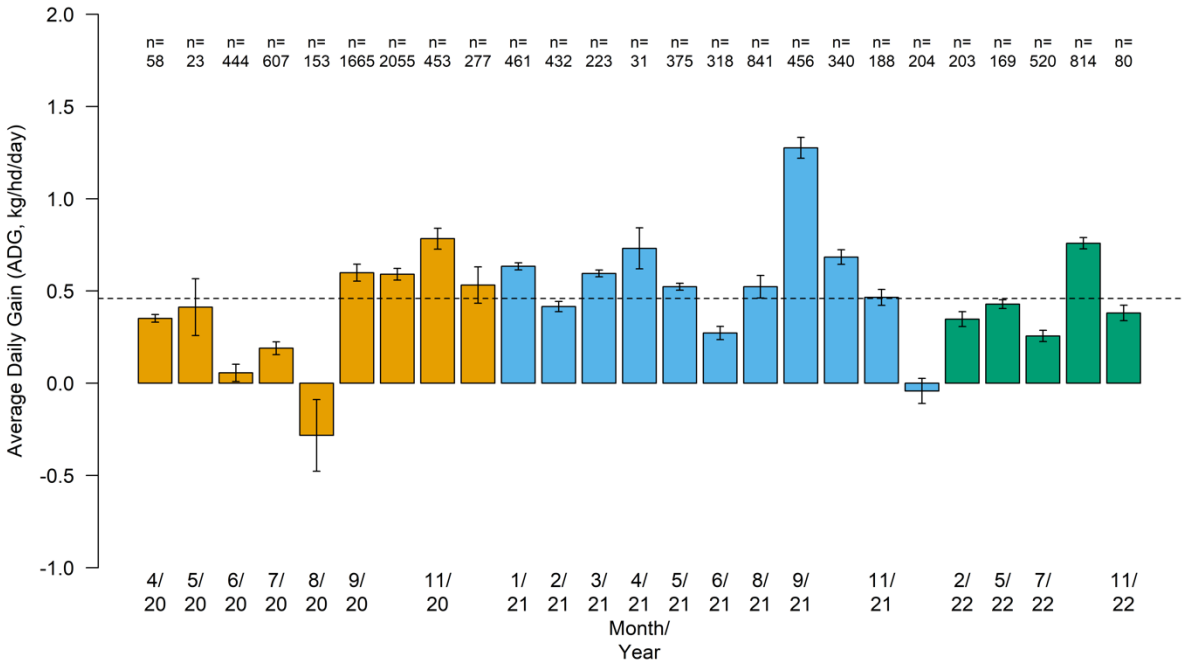

Figure 4: Monthly Average Daily Gain (ADG, kg/head/day) for all animals in the backgrounding step of the pastoral beef supply chain. Change in colours highlights each years' worth of data. Months with no data have been omitted for brevity. n= the number of animals weighed in each month. Dashed line indicates the mean Average Daily Gain across all months/years.

7.3 Factors affecting animal performance in backgrounding systems

7.3.1 Feed types used in backgrounding systems

The most significant factor affecting ADG on backgrounding properties was the quantity and quality of feed on offer in any year (Figure 5). For pasture systems, ADG was highly variable depending on the month of year, and in turn, the amount of rainfall received to drive either annual or perennial pasture growth. Mean ADG for pasture-based backgrounding tended to be closer to 0.5kg/day but varied significantly between positive and negative growth rates. Majority of backgrounding properties operate both annual and perennial pasture bases. Unimproved pastures generally include Cape weed, Rye grass, Broome grass, volunteer Blue Lupins, Radish, Paterson's Curse and Barley grass while improved pastures incorporated clover, serradella, Rhodes grass, various varieties of Panic grass, Vetch, kikuyu, Windmill grass and Tagasaste. Some producers were also sowing cereal crops such as barley, oats, and triticale through already established perennial stand to increase the production of that land through the dormant winter months. This has worked at varying levels of success with current rainfall averages however, as demonstrated by one producer, is possibly to gain grazing throughout the year, leave to fill, harvest grain, and continue grazing the stubble with fresh green perennials underneath.

In contrast, the use of a total mixed ration to background animals led to more consistent ADG which were generally greater than 1.0 kg/day (roughly twice that of pasture based ADG). The use of pellets to feed animals resulted in similar weight gains as pasture-based feeding systems, but this is significant as the animals that were fed pellets had a liveweight of less than 150 kg compared to

larger animals (>150kg) that were in the pasture-based feeding system. Pellet feeding was used to buffer smaller, rapid weaned animals that were transferred to the backgrounding properties in response to drought conditions on the pastoral stations but was discontinued when animals reached 150kg. Formulated feeds are used by some producers as a supplementary feed option and vary in composition. The pellets discussed throughout this report are Milne Early Weaner which is a nutritionally balanced pellet for feeding to pastoral calves and young weaners. It is a high energy, high protein ration, ideal for early weaned calves and young weaners, to enhance growth rates and rumen development (Milne Agrigroup 2019). The pellet consists of a minimum of 21% crude protein, 13 MJ/kg of metabolizable energy, 10% crude fibre (max), 1.1% calcium, 0.4% phosphorus and 60 ppm of lasolocid acid (Milne Agrigroup 2019).

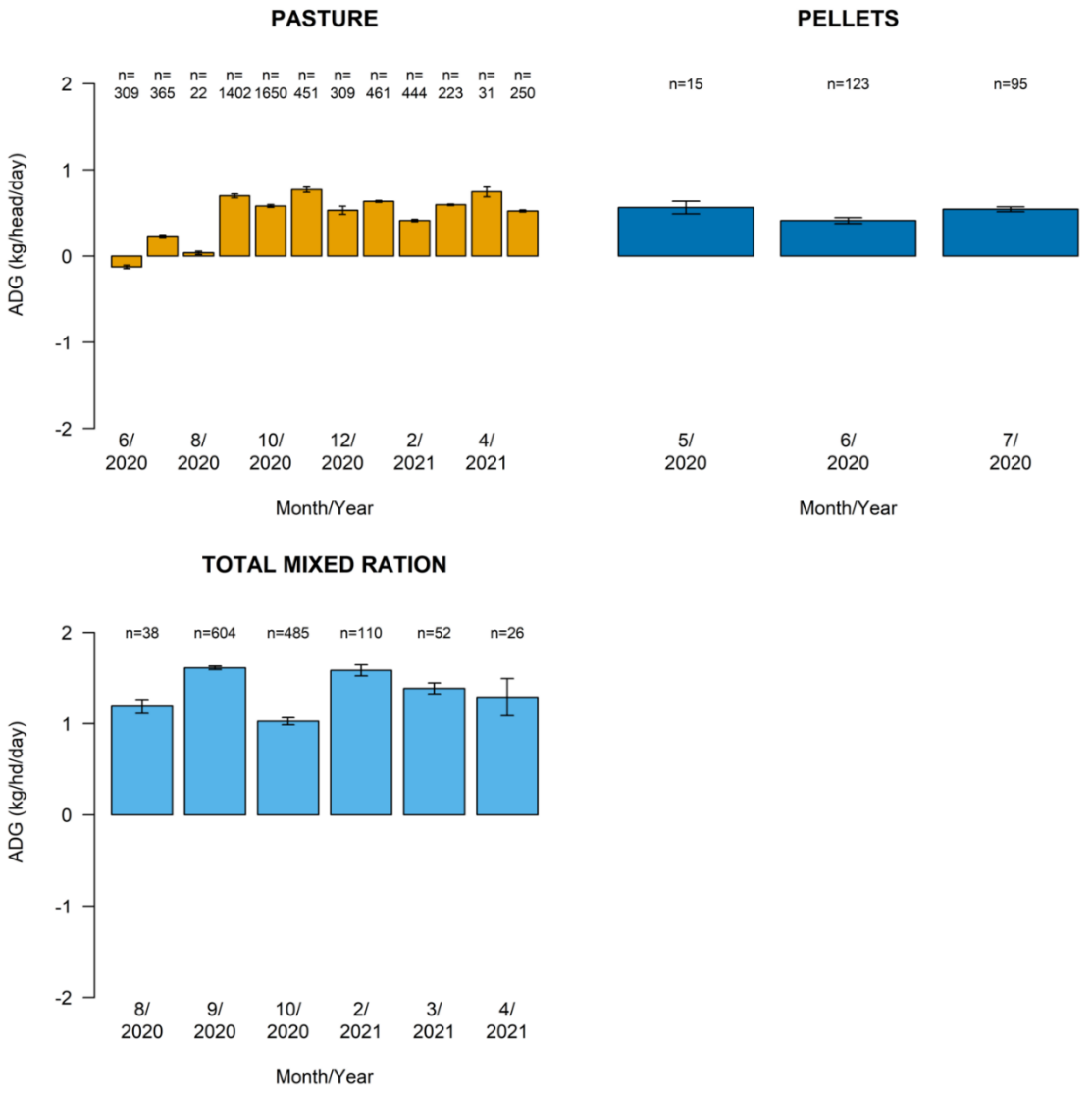

Figure 5: Average Daily Gain (ADG, kg/head/day) of animals being fed pasture, pellet, or total mixed ration feeding systems during the 2020/21 season by backgrounding producers. n= number of animals in each weight range observation. Error bars denote standard error of treatment mean.

7.4 Tools to aid decision making

The development of a suite of tools to support supply chain participants to make better decisions around the risk and reward of sending animals through the pastoral beef supply chain was based on the outcomes of the case study analysis of producers and the key outcomes are highlighted in Table 3.

Table 3: The decisions identified as being important for pastoralists and backgrounders when optimising the risk-reward of moving cattle through the pastoral beef supply chain

Decisions on Station	• Number, type, and quality of animals in comparison to market specification • Market pricing and market signalling • Anticipated seasonal conditions ahead • Availability of live export boats and contracts • Availability of contracts for both export and domestic markets • Ability to muster with seasonal conditions
Decisions on backgrounding property	• Starting weight of cattle and how long they will be on property • Anticipated need for supplementary feed • Total stocking rate and availability of land for backgrounding • Availability, type and quality of cattle available to background • Availability of contracts • Timing of seasonal conditions at both backgrounding and pastoral station (influencing month of transport of animals)

7.4.1 Preliminary dashboard report

A strong focus of this project was to support the growth and development of the pastoral beef supply chain. One aspect that was identified as missing by producers through direct engagement was the relevant and timely feedback on animal performance in the supply chain.

The pilot dashboard set of graphs was created in 2021 to help provide clear information to help understand and interpret the performance on their property (Appendix II). This dashboard was reviewed extensively by producers through a range of opportunities including presentations at events and in a monthly newsletter to provide a chance for producers to give feedback. The report contains graphs that highlight varying aspects of animal performance. The dashboard report was designed to convert the data collected from the project into information that can help producers make more informed decisions or allow them to monitor cattle more closely on their property. Each cohort of animals represented on the graphs are accessible by an accompanying .csv format file with EID numbers to identify any animals that they wish to change management.

These dashboard graphs are scalable and can present data for each individual property or used to summarise each link in the pastoral beef supply chain (e.g., station, backgrounding, feedlot, abattoir). The time-period is scalable to deliver reports at annual, quarterly, monthly, or weekly time steps and individual dashboard reports (with individual animal data files) are available monthly for each property as well as supply chain summary reports (without attached data) available publicly to help drive industry awareness of the productivity of the supply chain.

From the data collected, there is no clear link between transition score and cattle performance through the supply chain. Whilst many producers put time and resources into decreasing stress during the transitioning period, it has been seen that some animals do not perform as expected on backgrounding properties. The dashboard tool gives an overview of mob performance on a property, showing what percentage of cattle are gaining or losing weight, as well as what weight ranges are on the property and what percentage of animals have gained weight over their first weigh period. Seeing the information in a graph, producers can then dive deeper to access the EID's of animals that are losing weight, and then can make decisions on these animals. This gives the data required to separate the poor-doers for monitoring or sold off to reduce feed costs.

7.4.2 Updated dashboard tool

A second supply chain dashboard was developed with the help of an external data analyst from data collected in this project using the Microsoft PowerBI program where average daily gain from all animals was aggregated into monthly averages for the period 2022-current (Appendix III).

In these reports, the individual property ADG is benchmarked again the industry average and provides a clear comparison between the producer and others in the industry. The graphs in the report compare the property monthly ADG for the last 24 months against the average for all properties in the project The second half of the report displays the property's performance for the last month. In all the graphs in this report, producers can clearly see where each property lacks data, and this is envisaged to provide incentive to collect and share more data. From this report, producers can deep dive into their data and find which animals are gaining weight and which are going backwards, and from there can make different management decisions for the animals that are not performing.

The information presented in the updated dashboard report includes:

- Average Daily Gains by weight range – This provides a comparison of the producer's cattle performance for the month and the average for all properties in the project. It can be seen from the graph that is performing just below average for most weight ranges, with the trend being animal between 100 kg and 200 kg gaining weight at the fastest rate.
- Average Daily Gain by Feed Type – This includes the feed that cattle on the individual property have been on and compares this to the average for cattle in the project. For the previous month animals on this property have been on pasture and are on average gaining below the average ADG.
- Number of your Animals Weighed – This shows how many animals were weighed on the property in the previous month. This can be used to encourage producers to weigh more cattle.
- Clear and concise view of ADG.
- The percentage animals that gained weight – This is an interesting figure for producers to see what percentage of their herd is gaining weight. If a producer is keen to see which individuals are losing weight that data can be extracted for their information.
- It suggests if the gap between weigh sessions is too large for an accurate representation of ADG.

This supply chain dashboard has been included monthly in an industry newsletter that has been circulated to all project participants to improve the connectivity of all players in the pastoral beef supply chain.

7.4.3 Supply chain map for improved decision making

In speaking to pastoralists, the primary driver of decision making for matching market destination with animals is based on price and ease of execution (selling on-property versus freighting to backgrounding property). When selling to live export, no more management is required once the cattle move off the station, whereas backgrounding requires the pastoralist to own the cattle for another few months and continue to make management decisions for those animals at an external location. A pastoral beef supply chain map has been developed to better understand the movement of animals through the north-south beef supply chain (Appendix IV). The data collected during the project so far has helped to give clarity on how decisions are made through the system. This supply chain map will be sent to producers as well as relative industry representatives for feedback and further development.

A strong focus of this project is to identify and overcome the barriers to the development of the pastoral beef supply chain. One aspect that was identified as missing by producers was the relevant and timely feedback on animal performance.

7.4.4 Decision Tree Tool

A decision tree has been developed from these supply chain maps to identify the key decision points where pastoralists and backgrounders need to determine if they wish to continue to carry the risk of animal performance for the benefit of the reward (increased value capture). The decision tree captures the decisions at each point of the supply chain and the options available to pastoralists and backgrounders (Appendix V).

In speaking with producers during this project, it became clear that there was significant ambiguity around the optimum path that animals should take through the pastoral beef supply chain. While seasonal conditions and market prices and opportunities change over time, many animals are sent down with no real marketing strategy. In the best-case scenario, backgrounding managers do the marketing on behalf of the pastoralist (Forsyth C, *pers. comm*.) and in the worst case, animals are on-sold to the next buyer 'when the price is right' or in response to worsening seasonal conditions. The latter and common approach taken by many producers has a high degree of uncertainty in obtaining the most profitable outcome in the sale of the animal.

The decision tree anchors the flow of cattle to a defined pathway with set entry and exit points for supply chain participants where profit can be maximised on each transfer of animal ownership. This decision tree gives pastoralists the opportunity to recognise and hold the risk of ownership right through the supply chain to the abattoir, or to maximise profit for a given level of risk exposure by identifying the appropriate exit point for the transfer of ownership and realisation of value. Alternatively, it allows for supply chain participants to specialise in a specific link in the supply chain. Backgrounding properties are traditionally a good example of this, where properties will buy/sell or agist pastoral cattle to turn a profit. The decision tree further defines backgrounding into weight ranges and, identifies the niche market opportunity for supply chain participants to specialise in feeding of low liveweight animals in a pre-backgrounding enterprise model.

While this decision tree was created from the quantitative and qualitative data collected over the last 3 years of the project through direct data collection and through conversation with supply chain participants, further work is needed to ground truth the decision tree with producers and livestock agents in the coming months to validate the pathways for animals in the supply chain.

7.4.5 Partial Budget

To support a quantitative approach to decision making, a partial budget has been utilised to assist producers in determining the likely reward of changing their management practices (Appendix VIII). This tool sits within the decision tree for the pastoral beef supply chain to assist producers at each decision point and is pre-filled with the key income and costs that businesses should consider (at a minimum). The tool is flexible for producers to adjust and enter in their own costs and was created using knowledge gathered from station and farm visits. In this example, the question of whether it is more profitable to background animals or send them directly to the saleyard is the question that the producer is looking to answer. By comparing the extra income and costs saved, and extra cost and income lost, a net benefit/loss value can be determined.

- Tool to help producers decide whether a change to their system will prove to be profitable
- Fits in with the decision tree tool – at crucial stages

- Providing a tool that is created especially for the backgrounding system gives producers belief in the process

8. Conclusion

The overall outcome of this project was to identify factors that were limiting the growth and value of the pastoral beef supply chain in Western Australia (WA). The aim was to identify practices that were being successfully adopted in the pastoral beef supply chain to improve efficiency and encouraging adoption by other producers through the sharing of information.

This project was partially successful in achieving this outcome as data was collected and information was shared with the pastoral producer community. The impact of transition stress on animal performance was suspected as being a significant factor in animal performance in backgrounding systems and that this would need to be managed effectively to increase animal performance. Through the collection of data in this project, there was little evidence that demonstrated impact of transition stress on animal performance. There were no lines, breeds, or station source of cattle identified that performed comparatively better after they transitioned to the backgrounding property. Each pastoral property had a slightly different approach to preparing cattle for transition which was based on either previous experience, tradition, or through skills gained by completing a stockmanship course. Each property was assessed against the recommended practices for preparing animals for transition (Maynard and Revell, 2017) and a score (out of 10) applied to each property to represent the level of attention given to ensuring transition stress was minimised. A high score included practices such as access and acclimation to new feed sources and water, introducing animals to being handled, and use of visual and audible cues for identifying feed sources while a low score showed low preparation for transition with few of these practices being implemented. While it was hypothesized that there would be a positive relationship between transition score and average daily gain (ADG) on backgrounding properties, the opposite was found where low scoring animals performed better than the higher scored animals.

This could be interpreted in two ways. Firstly, data collection to measure change in animal liveweight between the pastoral station and backgrounding property was difficult to collect as there were few properties that weighed animals on exit from the station. As an observation, and despite the industry being acutely aware of transition weight loss by its visible nature, there was little efforts by pastoralists to monitor and manage this issue. There were very few lines of cattle that were followed in this project where animal liveweight when leaving the pastoral property was available. This was largely driven by the lack of infrastructure on pastoral properties to weigh animals on exit to accurately assess transition shrinkage and a general unwillingness to collect data on pastoral properties. The main reasons for the unwillingness included: a decrease in operational efficiency at muster time, use of portable yarding facilities, and a lack of capacity of staff to set up weighing equipment and collect data. In this project, it was found that producer attitudes could be changed through working one-on-one with them to set up the weighing equipment (where available) and demonstrating how to use the weighing system and collect the data. Data collection throughout this project, however, was always improved when the Project Officer was in attendance to help, and this indicates that further reinforcement of the value of collecting data needs to be supported.

Through the producer case studies it was evident that the industry has a strong awareness of the impact that length of travel was likely to have on liveweight during transition, and the properties who moved animals the greatest distance reported it as being a larger perceived issue. This impact reflects the common knowledge from research on this issue (Knowles, 1999, and others) where many studies have assessed the impact of travel on animal stress for around 1200 kilometres which is a similar travel distance that most animals travelled in this project. In contrast, producers rarely consider the issue of shrinkage in bodyweight for movement within a region as the distance is short (acknowledging that many factors change between regions such as feed type, average temperature, etc). Shrinkage during transport is a visible issue as animals are trucked 'full' and over the transport period the animal loses water and gut contents during travel through urination and defecation. From this study, there were no practices that were better than any other at reducing transition stress and this is consistent with previous studies that have focused on the use of more common nutritional (Jubb et al., 1993; Carter et al., 2000, Grumpelt et al., 2015), behavioural (Loerch and Fluharty, 2000; Grandin, 2000), and/or a pharmaceutical (Agnes et al., 1990; Cooke et al., 2013) approaches to reducing shrinkage and post transport weight gain in cattle.

However, independent of the success or otherwise of the behavioural practices that were implemented to reduce the impact of transition, preparing livestock for transport were perceived by pastoral and backgrounding producers as having other benefits. For example, preparing animals for transport by feeding hay and getting the animals used to human interaction had positive benefits for work efficiency and workplace health and safety. Rangeland sourced animals tend to have a higher flight zone, altering the way that animals are handled can have a significant impact on animal stress (Grandin, 2000). Previous studies (Craig, 2019) have been limited in comparing the effects of applying improved handling procedures on the liveweight gain of pastoral cattle, and this study used a population approach to try and overcome the complexities of implementing a treatment-control type research trial. The diversity in pastoral production systems, breeding and genetics, age, sex, can all impact on the performance of the animal in the backgrounding property and so a population type study was used in this case. Future work to identify the specific transition practices that impact on animal performance will need to address these variables in their design but would be the best way to identify successful and impactful practices.

Secondly, liveweight gain following transition is affected by other, more significant factors in the pastoral beef supply chain rather than transition stress. The performance of animals on backgrounding properties grazing pasture was closely related to the corresponding arrival month and the pasture growth rates for each month. The winter dominant rainfall pattern and the use of annual and/or perennial pastures species have the capacity to provide feed for a period of the year when significant rainfall occurs, but a broader feeding strategy is needed for the region to maintain year-round animal performance. Future work should focus in two areas to improve animal performance in backgrounding systems: improving pasture quality to maximise growth rates during the growing season, and the development of feeding strategies that ensure animals maintain a positive ADG during the summer/Autumn period while still on property. Addressing these two issues will decrease the time animals spend in backgrounding properties and increase the volume of animals being handled in the backgrounding step of the pastoral beef supply chain.

A surprising outcome from completing the case studies of the pastoral producers and through engaging with supply chain participants was the disparate nature of the supply chain. The pastoral beef supply chain is dominated by a few large commercial, vertically integrated production systems that have the capacity to grow and source cattle, background, lot feed, and slaughter pastoral

animals. This integration is an efficient, but a closed system of managing animals as well as the flow of information along the supply chain. Outside of this structure, there are some producers who have identified the opportunity to purchase a backgrounding property in the agricultural region, and other producers who background cattle and have a historical tie with the pastoral beef industry. These producers are heavily reliant on few industry livestock agents to share information and there is limited interaction between producers at each step of the supply chain.

The missing link in the supply chain was the connection of producers and information, between pastoralists and backgrounders, and with lot feeders and abattoirs. This was particularly evident when the ownership of animals changed and the information, while likely being available if requested, had no pathway to be shared back to the pastoralist to drive decision making. The limitation of this study was that a solution to sharing information along the entire length of the pastoral beef supply chain was not found as changes in ownership continue to restrict the ability to follow animals in the supply chain. Animals that are sent to backgrounding property are often drafted into weight ranges and distributed through existing mobs on the property (after a period of settling). From there, animals are sold or moved from the backgrounding property when they reach their target liveweight, when market conditions are favourable, when available feed is low, or a range of other management reasons. Lines of cattle are hard to follow and with animals not often weighed at sale/exit from the backgrounding property. While the information is likely available to producers, further work is required to develop the pathways for information to flow along the supply chain.

The development and distribution of a pastoral beef supply chain dashboard report that is sent out monthly to project participants is a step towards the sharing of information with all industry stakeholders. This was initially aimed at solving the problem of pastoralists needing information to make informed decisions about what, how many, and if/when they should send animals to backgrounding properties. Most importantly, to determine if the animals would gain weight and provide a commercial return for the extra effort. The information contained in the dashboard report was road-tested with pastoralists to ensure that the information presented was relevant and useful. Further additions to the dashboard report include year-to-date rainfall and pasture growth reporting to further the data available to pastoralists to make more informed decisions about the animals. The data contained in the report provides information that can assist with other management decisions within each property as the benchmarking nature of the report highlights the individual property performance relative to supply chain averages. Insights such as this can help to drive the productive performance of backgrounding enterprises and contribute to the long-term increase in value of the pastoral beef supply chain.

Further advancements in the dashboard report would report on the financial performance of animals being sent through the pastoral beef supply chain, but as identified earlier, the blending of differing lines of animals throughout the supply chain makes it difficult to determine when economic returns should be attributed to which property, especially between years as animals have taken up to 2 years to move through the supply chain in this study. The monthly reporting format of the dashboard report requires data to be collected, analysed, and reported to industry and this active management will need to be supported into the future. It is worth highlighting that the development of the dashboard report and the relationships built in this project were fuelled by regular visits to pastoral regions to build those relationships, and this is an aspect that should be strongly considered when developing future projects for the pastoral beef industry.

8.1 Key findings

- There were no practices identified in this study that lessened the impact transition from pastoral to backgrounding properties on the liveweight of cattle. Instead, management factors on the backgrounding property had a greater impact on animal performance on the property, including the amount and quality of feed on offer (nutrition) for the cattle, and the time of year in which the cattle were sent to the backgrounding property. There was insufficient data in this study to understand the effect of transition on animal performance along the length of the supply chain.
- The use of pasture-based backgrounding systems was a common way of providing nutrition for animals to gain weight in backgrounding systems. This system was largely based on annual and/or perennial-based pastures that supported up to 0.9kg/hd/day Average Daily Gain for the August to February period in each year. ADG was significantly affected by the time of year in which cattle were sent to backgrounding properties, with animals sent in the May-July period tending to have highly variable ADG compared to the August to February period. In comparison, where animals were supplemented with pelletised feed or fed a Total Mixed Ration that increased nutrient intake, animal performance was much greater compared to pasture-based systems. An assessment of the cost of feeding was not conducted in this project.
- The flow of information has been improved along the pastoral beef supply chain has been improved because of this project through the development of the monthly animal performance dashboard report. This was road-tested with project participants to improve the relevance and usability of the data contained in the report and is now delivered monthly to a growing distribution list.
- While this project focused from the outset at increasing the use of data in the pastoral beef industry, the low level of adoption of key technologies such as weighing equipment and EID tag readers means that data capture is not always available.

8.2 Benefits to industry

- To reduce the variability in Average Daily Gain associated with animals being sent to backgrounding properties in the Agricultural region of Western Australia
    - August to February is the period where weight gain is greatest in pasture-based systems.
    - Animals that are sent to backgrounding properties in the May to July period are likely to need feed supplementation, such as pelletised feed or hay, and this should be factored into the economic analysis (via the partial budget tool developed in this project).
    - Animals that are less than 150kg liveweight entering backgrounding properties in dry seasons are best fed pelletised feed to assist with rumen function and to ensure positive liveweight gain.

    - Total Mixed Ration feeding systems in an extensive environment (as opposed to lot feeding) can provide the greatest gains in animal liveweight but adds greater cost to backgrounding (which was not assessed in the current project).
- The use of the decision tree and partial budget tools to understand the pathways available for animals entering the pastoral beef supply chain will help to identify the pathway for maximum profit and the most optimal exit point for the pastoral owner to manage production risk
- Use of the monthly animal performance dashboard report by pastoralists to make data-driven decisions on the most suitable pathway to maximise value and optimise the risk of finishing animals in the pastoral beef supply chain.
- Development of closer connections between producers in the regions through conversation channels, field days and small producer focus groups.
- Continued engagement with the pastoral producers is required to build further trust and ensure this BeefLinks initiative is not just another project that comes and goes with little change in the industry. This will directly address the most common issue identified by pastoral producers when they engaged with this project.

9. Future research and recommendations

The current project has begun the process of connecting all participants along the pastoral beef supply chain. This has not resulted in significant industry change to date, but will provide a platform for the following initiatives to be implemented:

- The delivery of facilitated workshops and ongoing support for pastoralists and backgrounding producers to trial and implement the tools developed in this project and which are ready for trial and adoption. The animal performance dashboard report is a tool that can assist with farm business decision making processes at a producer level but also indirectly lead to an increase in the efficiency of the supply chain. The adoption of the decision tree and partial budget analysis tools will address the most significant need of pastoralists and backgrounders in understanding the pathways available for animals into the supply chain.
- Industry support for capacity building and investment into animal weighing equipment and skills to use it. Many properties lack the equipment, facilities, or capacity to undertake weighing activities and to collect a broad range of data from animals when they are handling them. One indirect outcome of the current project was a regular and trusted person who was able to troubleshoot issues when visiting properties and assisting in weighing cattle. A producer focused workshop to build capacity of producers and to overcome the (often small) barriers to adoption is needed.
- Continued development of the relationships and trust required for the flow of information up and down the pastoral beef supply chain. The current project has focused on the step between the pastoralist and backgrounding step of the supply chain, but to realise an increase in value for the pastoral beef industry, broader sharing of information will be required to optimise the performance of animals. This has been found to be most effective through on-ground activities where trust can be built in the project and where long-term relationships can be formed.
- A detailed economic analysis of the value generated at each step in the Pastoral Beef Supply Chain to understand where value is being created, the opportunities for efficiency gains, and

to optimise the value being delivered to participants to ensure the long-term profitability. In particular, the realisation of extra value created through accessing the higher-value boxed-beef market needs to create value for all participants in the supply chain for this approach to be supported all the way back to the pastoralist.

- Continued encouragement of supply chain participants to participate in supply chain building activities, which largely need to work around sharing of information and trust. The nurturing of a 'industry focused' mindset where all producers are working together to supply a market larger than the sum of them, rather than competing between each other.
- Nurturing of both smaller production systems and also larger corporate systems as their importance continues to increase in the supply chain.

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11. Appendix

Appendix are attached as separate documents due to their overall size.