Business case for investment in the adoption of stock containment feeding areas

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Executive Summary

Introduction

Stock containment feeding is considered an important practice for farmers wanting to manage retained livestock during drought, while avoiding degradation to the pasture, land and water resources. Yet surprisingly few farmers have dedicated containment facilities established, despite those who have them advocating the benefits. If it is assumed that containment feeding is a practice to build farm resilience, then there is a need to understand the current barriers farmers have in relation to adopting containment practices.

This business case examined the evolution of stock containment facilities on farms, the motivations, attitudes and abilities of farmers to install and operate them successfully and how adequate the current information, knowledge and technologies are to aid adoption. It involved a literature review, workshops and interviews with more than 170 farmers and suggestions for investment that would accelerate adoption.

The main barriers to adoption identified were:

- An attitude they could survive drought successfully without containment facilities
- The fear of making large capital investments that would be rarely used or did not work to their expectations when needed (wrong design for their business, costly)
- The risks associated with operating containment facilities, especially feed rations, animal health and labour.

These major barriers could be overcome by strategic investment in extension and research. A list of investment activities is suggested, that if adopted, would lead to a four fold increase in adoption after 10 years. This would result in an additional 9,650 farms having containment facilities suited to their farming business operational, and if used during drought, would achieve protection of 4.23 million hectares of improved grazing land across Victoria, South Australia and Tasmania.

Part I Background & situational analysis

National perspective

Since 1900, the Bureau of Meteorology has reported seven major droughts across Australia's agricultural regions, often persisting over many consecutive years (BOM, 2020). While drought has historically been a part of Australian farming, reports from various organisations (Department of Agriculture Forests and Fisheries 2019, DoEE 2016, Productivity Commission 2009) state climate change, and the increased frequency and severity of drought, is the most serious threat to land management in the future and will likely result in the decline in natural capital[1] and productivity. Droughts are likely to be more regular, longer in duration and broader in area, going beyond current farmer's lived experience.

The broader economic and social impact of drought is also profound. While drought directly affects farming with declines in productivity and profitability (Australian Bureau of Agriculture Resource Economics and Sciences, 2018), it also has an impact on businesses, communities and regions (Debelle, 2019). Stress levels in people rise during drought, affecting the health and wellbeing of farmers, their families and communities (Rickards, 2011).

The growing domestic and global consumer demands around product integrity, including environmental sustainability and animal welfare, further adds to the pressures droughts places on farming businesses and the supply chain (Dowling and Crossley, 2004).

The response to drought by farmers has also changed over time. In 1982 Robinson wrote this as a suggested response to drought.

> *"Whilst it is difficult to generalise about what is the 'best' stocking strategy prior to a drought, there is some consensus on the following in-drought strategies.*
>
> *Reduce stock numbers early in a drought, hopefully before prices for stock have begun to decline markedly and continue to reduce numbers as conditions deteriorate.*
>
> *Do not undertake hand feeding programs for the remaining stock. If the drought is prolonged and available agistment has been exhausted, either sell the remaining stock or if sale is not possible due to low prices, high cost of transport or condition of stock, let them take their chance."*

This is no longer an acceptable response.

Regional perspective

There are approximately 22,000 farming business that operate sheep and cattle enterprises on 8.6 million hectares of improved pasture in Victoria, South Australia and Tasmania (ABS 2021). These

[1] The loss of 1mm of topsoil results in 130 kg/ha organic carbon, 20 kg/ha nitrogen (equivalent of 40 kg/ha of Urea and 8 kg/ha phosphorus (equivalent of 100 kg/ha single super).

businesses run 3.4 million beef cattle and 27.7 million sheep and lambs, generating a gross income from meat and wool of $4.04 billion in 2021 (AgSurf 2022).

Drought has a profound impact on these grazing businesses. Computer modelling at various locations across the three states indicates pasture growth during past drought periods is approximately 35% to 55% less than median production (Nicholson *pers comm*) due to the inability of plants to take up enough water to support growth and metabolic processes. The reduction in pasture growth requires businesses to respond by reducing stock numbers (sales)[2] and/or introduce supplementary feeding. Historically this feeding has occurred on pastures, often leading to a decline in persistence, groundcover and an increased risk of wind and water erosion. Another consequence of paddock feeding was the delay in recovery after the drought breaks, with farmers often needing to undertake the costly task of resowing degraded pastures, purchasing replacement livestock (at above long term average prices) and ongoing supplementary feeding.

The construction and use of containment areas to confine and feed stock has emerged as an alternative to paddock feeding or using sacrifice paddocks[3]. While there are varying definitions associated with containment and confinement (refer to definition box), the intent of the practice during drought is similar, that is to confine livestock in a smaller area to enable controlled feeding, manage animal welfare and to protect other land areas.

Stock containment definitions

The definitions and terminology used to describe containment feeding and stock containment areas varies across the peak information bodies used by farmers.

'Confinement feeding is a drought feeding practice that aims to promote animal health and welfare while preserving ground cover and land condition across the majority of the property.' (Confinement feeding | Meat & Livestock Australia (mla.com.au)).

'Confinement feeding (also referred to as lot feeding or feedlotting) is an intensive feeding system in a confined area where all, or the majority of, feed and water is supplied to the contained animals.' (Confined paddock feeding and feedlotting of sheep | Agriculture and Food WA)

'Confinement feeding areas (also referred to as 'droughtlots' or 'Stock containment areas') are used for short term production or maintenance ration feeding.' (Confinement feeding stock (nsw.gov.au))

'A Stock Containment Area (SCA) is a carefully selected, fenced section of the property, which is set up to periodically hold, feed and water livestock. They are primarily used to protect soil and pasture resources during adverse seasons such as after a fire, during droughts or late autumn breaks or for general farm management. It should be considered as part of the property management plan and once established should be maintained and available for use during emergencies and to manage other seasonal challenges.' (https://agriculture.vic.gov.au/__data/assets/pdf_file/0008/537578/Stock-containment-areas.pdf)

[2] The national beef herd fell 10% after the 2018/2019 drought in eastern Australia, a level not seen since the 1990s.

[3] Generally, sacrifice areas are selected based on their poor pasture composition, are intended to be resown or contain species that are highly drought and grazing tolerant e.g. Australian phalaris. Portable infrastructure may be brought it and sacrifice paddocks will often change during the grazing period.

There are no national or regional statistics collected on the use of containment areas on farm. Data collected from farmer workshops in NE and SW Victoria (see Part II Background) indicated approximately 30% of farmer businesses had dedicated stock containment areas (SCA), with 45% using sacrifice paddocks to feed livestock in. The Derwent Catchment Project in Tasmania identified 54% of those surveyed had containment areas (Lazurus, pers comm). In low rainfall areas more prone to seasonal shortages, containment feeding is expected to be higher (Note: these figures should be used with caution because of the likely bias of those attending the workshops).

The use of containment areas is growing, with many farmers who had constructed and started using this practice in adverse times now recognising their strategic use to achieve other animal production objectives. This includes finishing animals to meet market specifications, achieving optimum joining targets and restricting grazing so pastures can 'get away' at the autumn break. The more regular users of containment also made better use of the capital invested in infrastructure, although some additional use encroached on the grey area of when a containment area becomes a feedlot. Feedlots requires council approvement and often are governed by additional legislative requirements (Appendix 1).

Literature and resource information on stock containment

There is significant information and resources for stock containment feeding, accumulated over many decades. A scholarly literature scan by the University of Melbourne (Cheng, 2022) identified 226 papers between 1970 and 2021 on feeding and containment, of which 59 references were deemed relevant to this business case (Appendix 2). The key points from the Cheng review were:

- livestock containment areas were mainly used for emergency feeding and managing seasonal challenges.
- the Australian literature was focused on sheep with limited information on cattle
- there has been limited *scientific* studies that explored the design and feeding strategies for containment area
- there has been limited cost-benefit, social and biophysical analysis from using containment feeding
- many biotic and abiotic factors contribute to the decision making of using containment feeding on farm.

A scan of non-scholarly articles and information (extension resources) by Riverine Plains highlighted a large amount of 'grey' information. References and extension materials deemed useful have been grouped into themes and listed (Appendix 3).

Historic strategies for management of stock during drought

Management of livestock entering a drought, during and recovering from drought is a complex challenge. There are many uncertainties and changing social attitudes, which requires well thought through decisions that suit individual businesses and circumstances. It can be a costly exercise, highly dependent on set up expenses, duration of feeding required, as well as current and future livestock prices (Webb Ware, 2021).

The quote by Robinson the start of this document and the evolution in Government response since highlights an important shift in farmers attitude towards drought preparedness through early and well considered selling of livestock and/or the installation of infrastructure to enable effective and profitable containment feeding. Ultimately drought preparedness will continue to rely on farmers making good decisions, both in having the required facilities established before drought and making timely decisions when entering and during drought.

The value proposition surrounding the construction and operation of containment facilities will also be enhanced if opportunities to utilise the infrastructure investment and skills obtained, can also be utilised well in non-drought periods.

Historic activities in stock containment

The practice of confining sheep in small areas started in the 1980's coinciding with the 1982 to 1983 drought across much of southeast Australia (AWI, 2017). Australian Wool Innovation reported containment feeding emerged in the face of changing community attitudes towards environmental degradation and increased awareness of the role of perennial pastures in sheep production. Further documentation of farmers using sacrifice or containment areas were noted in 1988 in South Australia and 1994 in Victoria (Court, 2002).

In 2007 Agriculture Victoria provided incentives to set up drought containment areas and again in 2016 for drought declared areas of the State. Soil Conservation Authority incentives were also used in the NSW Lachlan catchment in 2007 (Coutts and Sampson 2007).

Often the programs were linked to financial incentives to encourage adoption. Agriculture Victoria's first incentives program in 1994 offered $1000, in 2015 grants of up to $2000 were made available for farmers in the Wimmera, Mallee, North Central and the Goulburn Broken Catchment Management Authority (CMA) regions and were offering up to $5000 in 2019 to Gippsland affected farmers with dollar-for-dollar co-contribution. The Lachlan catchment in NSW offered incentives of $2/Dry stock Equivalent (DSE) up to $10,000 for stock containment area set up.

The number of installations of containment areas achieved from these programs is difficult to judge, however from the limited information available it suggests:

- 64 facilities were installed from 1994/95, Southwest Victoria, Bendigo and Mildura regions of Victoria (Bluml, 1996)
- 209 facilities installed for the first time, with a further 94 upgrades in Lachlan region (Coutts and Sampson, 2007)
- 262 facilities installed in 2016 around Horsham, western and central Victorian districts (Stock and Land, 2016).

These programs were largely reactive, in response to drought situations and represents approximately 4% of a possible 22,000 farming business where containment facilities may be useful.

Recent investment related to stock containment

More recent developments in general drought preparedness support include:

- NSW Department of Industries has embraced a more holistic approach to drought management. Under the banner of PROfarm, the program integrated four decision support tools (DroughtPack, FSA Pack, ImPack, PlanPack and two resource manuals (StockPlan and a drought management booklet) (Whelan et al, 2013). NSW DPI are not currently offering StockPlan as it is under redevelopment (Lazarus, pers comm)
- Western Australian and Victorian governments recommend including containment feeding as part of a whole farm livestock, pasture and erosion management planning (Roberts and Curnow 2021; Agricultural Victoria 2018a).
- The creation of the Federal Government Future Drought Fund (FDF) in 2020, and subsequent Drought and Innovation hubs, where containment feeding to manage farm productivity and natural resources is a priority area in most States. Some current FDF projects related to stock containment within state hubs and across hubs have included:
    - Economic modelling of three scenarios related to containment feeding (Cross hub SA, Victoria and Tasmania).
    - Producer focus groups on stock containment establishment and operations to establish barriers to adoption and identify innovations. This is the basis of Part II of this business case (Southern NSW hub).
    - Development of decision matrices for entry into and out of stock containment based on using triggers through running workshops (Cross hub SA, Victoria and Tasmania).
    - Calibration of satellite assessment of quantity of feed on offer and groundcover for use in entry and exit into containment areas (Cross hub SA, Victoria and Tasmania).
    - Containment feeding and the effect of ewe health over lambing using onfarm learning and demonstrations (SA hub)

MLA and MLA Donor company (MDC) have also recently invested in projects related to stock containment include:

- Optimising ewe reproductive performance in containment areas in containment areas. MLA Final report - Suzanne Robertson (Completed 2020).
- MLA Profitable Grazing Systems (PGS) training course *Dry Time Ready*, designed by Holmes and Sackett (MLA, 2020). No courses have been delivered to date.
- Developing a framework for tactical decision making to address feed deficits. MDC. Yohannes Alemseged (Completed 2021 but report unpublished Dec 2022)
- Increasing production using containment areas. MLA Producer Demonstration Site (PDS) - Barossa Improved Grazing Group, SA (due for completion January 2023)
- Which set up? Implementing confinement feeding. MLA PDS - AgPro Management, WA (due for completion September 2024).

Part II Market research

Background

In 2022 the Northeast node of the Victoria Drought hub (Riverine Plains Inc) used funding from the Future Drought Fund with support from the Victorian Drought Hub to initiate a study on farmer's needs in relation to confinement feeding (challenges and knowledge) and the establishment of stock containment areas. This local initiative was expanded through a collaboration with the Northwest (Birchip Cropping Group) and Southwest (Southern Farming Systems) Victorian nodes. The study area grew further to include Southeast South Australia (Barossa Improved Grower Group, MacKillop Farm Management Group) and Tasmania (Derwent Catchment Project) resourced through an additional innovation grant from the Future Drought Fund *(Drought Resilience Practices in Mixed Farming Systems).*

The focus of the farmer research was to understand the barriers to adoption, with the goal to encourage the installation of containment feeding before the next drought and without large scale incentive payments on infrastructure to individual farm businesses.

Twelve farmer workshops involving 124 farmers, along with an additional 48 individual farmer interviews were conducted by six farming groups. The group facilitators met to share and collate farmer experiences and analyse the data within a framework of thinking called a MAKAT[4]. Details of the MAKAT analysis are provided (Appendix 4). The MAKAT analysis identified barriers to adoption and relevant activities to overcome those barriers. Additional input was provided by the University of Melbourne and Charles Sturt University.

It is anticipated the findings would also be applicable to New South Wales and Western Australia.

Target audiences

Two broad target audiences emerged from the farmer research.

Audience 1: Convinced of the benefits of containment facilities.

These farmers had constructed drought containment facilities (commonly during previous droughts) but saw ongoing opportunities in the farming business to use the facility for a wide variety of non-drought operations (refer appendix 4). Many started as temporary facilities, but these have been 'upgraded' over time, in scale, permanency and sophistication of operation. The regular use of the containment facility not only achieved successful outcomes, but their repeated use helped build skills and confidence in the practice.

> *"Once you have it, the more uses you will find for it."*
>
> *Producer (Victoria)*

This group did not need convincing of the benefits of containment feeding, irrespective of seasonal conditions. They were looking to continuously improve the way they use the facility, were hungry to identify other opportunities and to become more efficient in its use. The key areas of information

[4] MAKAT refers to (Motivations, Attitudes, Knowledge, Ability, Technology/Tools) and is an analysis technique that has been used extensively by the GRDC to identify barriers to adoption.

this group were seeking to fill knowledge gaps included ideas for expanding the utilisation of infrastructure, optimum feeding regimes and options for minimising animal health and welfare issues.

The ‘farming environment’ and ‘farming system’ also contributed to their adoption of containment feeding. Locations that experience long periods without feed (droughts), repeat seasons that finished early, have ‘light soils’ prone to erosion or have cropping forming a significant component of their enterprise were more likely to have established containment feeding systems. The fit of containment was easier with crop and livestock farmers, as they had ready access to grain and machinery and often had exhausted the grazing value of their stubbles before pasture feed was available. Put simply, their need was greater and some of the components required for successful containment feeding were easier to achieve. They had the belief that, on balance, containment feeding was the best option for their business to maintain long term profitability.

Despite being competent with operating a containment facility, they still grappled with understanding the true benefits and costs of containment feeding compared to the other alternatives, especially selling of livestock rather than retaining them. The whole farm system impact remains unanswered, but this advance is seen as an enhancement, not a reason to stop operating a containment facility.

This group of farmers provides excellent demonstrations of localised application of the practice, and if they are respected in the community, could be used to motivate others. However, to keep them engaged, they would require opportunities for peer to peer learning from other like-minded producers on ongoing improvements, especially systems implications of their feeding decisions.

Audience 2: Not convinced of the value in more permanent containment facilities.

This audience has not established dedicated stock containment areas. When required they commonly used sacrifice areas (usually pastures or temporary fencing of smaller section of a grazing area) to feed stock. Selling down stock numbers in combination with sacrifice paddocks were preferred management approaches.

The use of containment was needs based. Even though they knew “things could get ugly” (in drought), they were willing to accept this and rectify any damage after the drought had broken. If they did have some form of containment feeding, these facilities were deconstructed or not used after the drought had finished. Not surprisingly this approach was more common in locations with more reliable and longer seasons.

Previous droughts did provide a motivation for some farmers in this group to transition to containment supporters because their past experience had been highly challenging, however most were comfortable with their current approach.

This farming audience had many reservations about integrating a containment facility into their farming operation permanently. The areas of unease included:

- difficulty finding information about how to “get it right”
- not currently being set up to store and use grain as the major energy source

- questioning the value of the capital investment in infrastructure (making wrong costly decisions that are not easily reversed or not used often enough to justify the expense)
- committing to ongoing feeding if they choose to rely on this practice more regularly
- animal health and welfare problems
- district perceptions and possible operating regulations
- exclusion from certain markets

These barriers (real or perceived) need to be addressed if adoption is to occur with this target audience. This includes examining the research gaps, some of which have been identified (Appendix 4).

It was also evident through the comments from this audience that they had less confidence in making a containment feeding system work on their farm. The barriers (risks) mentioned above often masked the confidence issue. Confidence, while being partly influenced by the temperament of the person, is also developed through *successful* application of a practice. Having the skill to respond to different circumstances is essential. In turn these skills are underpinned by a sound knowledge base. Support with the specific aim to build skills and confidence (not simply impart knowledge) is required.

General observations

The decision to sell rather than retain stock has a significant influence on the subsequent containment requirements. Both target audiences expressed a desire to have better processes and tools to determine if selling rather than feeding would be the correct choice for them at that point in time. This is a dynamic decision, as multiple factors are likely to influence this consideration (prices, duration of feeding, finances, labour etc). Having created trigger points before this decision needs to be made also enhances the effectiveness of the decision making.

The current process around establishing containment facilities needs the sell or retain decision to be embedded as the first step in a containment discussion. This decision, which may involve multiple classes of livestock, needs to be made in a timely and informed way. This should inform what decision support tools would be useful (rather than the other way around which commonly occurs i.e. create a tool no-one uses because it is not relevant or too complex for the decision being made). This will require improved decision support processes from what we currently have available.

It is worth re-iterating that containment feeding is complex, and to integrate this practice as part of a whole farm system is challenging. There is no recipe, as each business will have its own set of unique circumstances to confront. What is important is to present the pros and cons of various options and support an individual in deciding which best suits their needs. Having a process to make a decision 'on balance' is required.

Developing confidence in complex practices is possible if the risk of implementation can be reduced. Two interventions can help. The first is deconstructing a complex practice into component parts that can be implemented, evaluated and built upon (this may require modification along the way). The second is having access to knowledgeable people (other farmers, advisors) and information so uncertainties can be discussed and resolved. The complexity in containment feeding resided in two broad areas:

- The design of the system that matched the business needs
- The operation of the system, which will change depending on circumstances

Opportunities to access peer to peer and individual expert support is required to enable problems to be solved and mitigation strategies to be created. While a few private consultants provide support around containment issues (mainly feeding), there is no recognised group of 'experts' operating around this practice (unlike for example the agronomy community of practice). A knowledgeable, well networked, and trusted group of experts, who could share information, solve problems and support each other is needed. This would provide easier access for farmers to work through their confinement feeding considerations.

Areas of investment and actions

Five areas of investment were identified that would address the barriers to adoption of containment feeding

Enhanced decision making

Objective: To enhance the decision making around critical decisions associated with containment feeding.

1. Create processes to enhance key decisions around
   - Selling animals versus containment feeding
   - Creating a hierarchy of animal classes to sell
   - Choosing to use sacrifice paddocks compared to purpose build containment facilities
   - Determining the sophistication of the containment facility appropriate to the business

2. Review existing decision support tools and processes to determine how well they inform key decisions
   - Modify existing tools and courses as required (including benefit cost analysis)
   - Create new tools as required (including benefit cost analysis)

Advice

Objective: To establish a team of local containment experts who can assist farmers design and implement a containment facility that suits their farming business

1. Invest in an agency to lead the creation and mentoring of an expert team to support farmers in design and operation of containment facilities
2. Create materials and tools to enable expert-farmer discussion and documentation of containment design. In particular:
   - Develop an information package that breaks containment feeding into components, with each component able to achieve a stand-alone outcome if adopted.
3. Create training packages (workshops, courses) to develop farmers skills and confidence in the ongoing operation of containment facilities. In particular:
   - enhance tools to ensure adequate ration formulation and feeding.

Information and information access

Objective: Create a one stop shop for all information on the options, design and operation of containment facilities

1. Identify an organisation to host and maintain an information portal
   - Review existing materials, identifying the best resources and cataloguing these for easy access by farmers and advisors.
   - Encourage / facilitate the contribution by farmers of new resources (video, pictures, written) with emphasis on the pros and cons of containment design and operation.

Research

Objective: To address the current knowledge gaps through research, studies and surveys.

Priority areas of research are:

- Understanding the risks (perceived and real) farmers have about different containment feeding approaches and the mitigation approaches that could be applied.
- Optimal feeding strategies.
- Determine the difference in energy requirements between paddock and pen feeding (it is currently assumed animals in containment need ~20% less energy than those in paddocks)
- Collation of feeding requirements for cattle (most available information is for sheep)
- Optimum management and mob sizes to minimise shy feeders.
- Differences in breed type and feeding requirements (higher requirements for crossbred sheep and cattle)
- Animal health issues
  - how much roughage is needed? (This is important for rumen function and prevention of acidosis but is usually more expensive per unit of energy than grain).
  - subclinical acidosis (animals are not dying but their performance is less than expected, especially if on grain diets)
  - mineral supplementation (it is thought to be worse in grain heavy diets)
  - vitamin supplementation (it is thought the addition of vitamins A, D, E is needed but maybe not in mature livestock)
  - prolapses (it is thought that this could be through lack of physical activity)
  - pneumonia (it is thought this is more prevalent in cooler, wetter, high humidity environments)
- Release timing, especially near the point of lambing and feeding strategies required to manage change in feed.
- Benefits of shade on heat stress particularly on reproductive stock (this is thought to be more prevalent in animals in hotter environments and over summer)
- Impact on pasture survival and recovery by 'spelling' the pastures compared to using sacrifice paddocks (it is thought to be better for pasture survival and recovery if 'spelled'

compared to continual grazing - but may be species dependent. Some species might not survive, like perennial ryegrass.

Communications

Objective: To reframe and extend communications around containment facilities to support their implementation on farm

- Promote containment feeding being a positive management tool that farmers should have, and can be used to achieve other production outcomes, rather than a practice of last resort when in drought.
- Promote the existence and services of the expert team
- Increase the use of existing demonstrations and farmer experiences, through multiple extension techniques (such as visits, conferences, webinars, videos etc)
- Establish new demonstrations to address local knowledge gaps or to introduce the application of new technologies that promote more varied and efficient use of containment facilities.

Part III Return on investment

Levels of adoption

The CSIRO ADOPT tool (https://adopt.csiro.au/) was used to estimate the impact from the recommended investment. Four scenarios were modelled, one with no investment, one with extension investment only, one with research investment only and one with a combination of extension and research.

The analysis shows there will be continuing adoption of containment facilities without external investment in extension and research. This will be through passive observation with other farmers and advisors. The estimated increase in adoption without intervention is to have 7.7% more farms operating containment facilities after 5 years and 26.2% after 10 years.

Investing in extension will nearly double adoption to 14.2% after five years and 34.2% after 10 years.

Investing in research without active extension (i.e. only the extension directly associated with the research requirements) also has a positive effect on overall adoption (assuming the research questions are successfully resolved). This would increase adoption to 16.2% after five years and 53.1% after 10 years.

There are significant synergies able to be achieved when a combination of active extension and research is provided. This lifts overall adoption to 34.2% after five years and 67.8% after 10 years (figure 1).

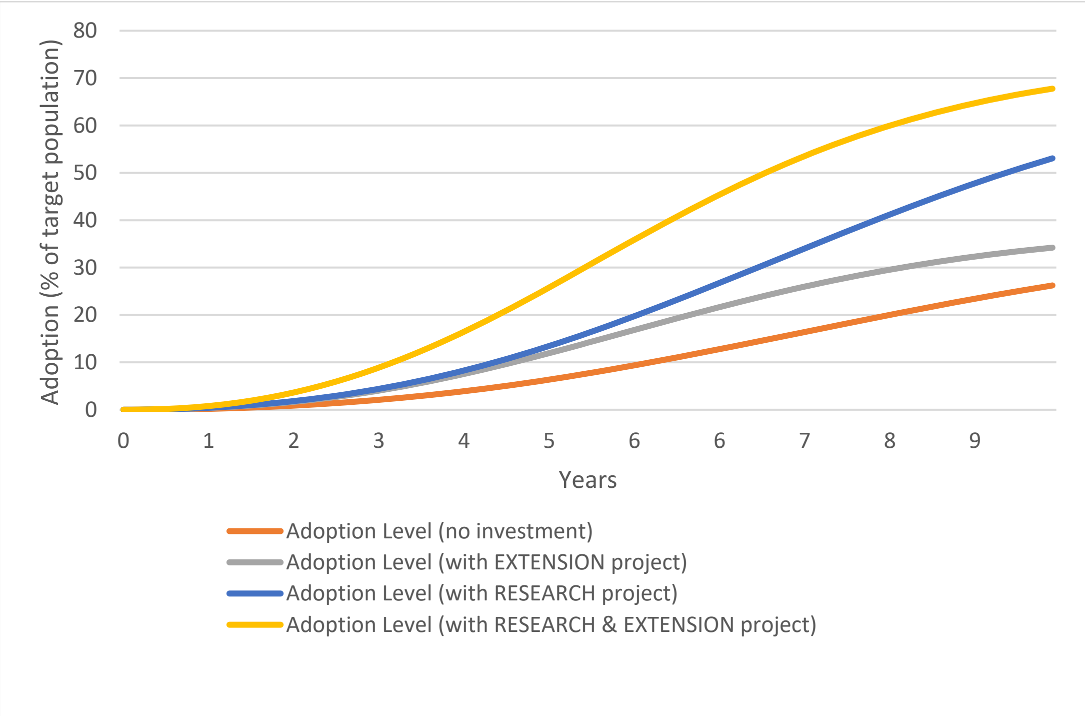

Figure 1: Modelled rates of adoption over time with suggested investment in extension, research or both compared to no investment.

These adoption rates equate to a significant difference in the number of farms with containment facilities after 5 and 10 years compared to no intervention (i.e. do nothing). The total target audience is approximately 17,200 farm businesses[5], who manage 6.3 million hectares of improved grazing land. Estimated number of facilities adopted and by assumption the areas of improved grazing land 'protected' is shown in table 1.

Table 1. Number of farmers adopting containment (rounded to nearest 50 farms) and area of land 'protected' (rounded to nearest 1,000 ha).

Investment		After 5 years	After 10 years
No intervention	Businesses	1,100	3,750
	Area (ha)	483,000	1,652,000
Extension only	Businesses	2,000	4,850
	Area (ha)	891,000	2,154,000
Research only	Businesses	2,300	7,550
	Area (ha)	1,019,000	3,341,000
Both research and extension	Businesses	4,350	9,650
	Area (ha)	1,914,000	4,266,000

Investment in both research and extension would result in nearly a fourfold level of adoption, protecting an addition 2.6 million hectares of grazed land on 4,350 properties after 10 years.

Return on investment

The largest investment in containment feeding is in the initial infrastructure set up costs. This capital investment may be significant for some businesses but minimal for others if they choose low cost temporary facilities. A nominal figure of $20,000 to construct each containment facility was used.

Ongoing operational costs of a containment facility were included in the annual operating costs (gross margin) of the business.

The other significant cost is associated with the research and extension program. While detailed costing on the extension and research programs have not been completed, a nominal figure of $500,000 per year was used over a 10 year period (i.e., $5M research investment).

The benefits include both changes in enterprise returns and the less tangible benefits to soil and pasture protection. A nominal figure of $20/ha/year was used for the combined benefits.

Adoption assumptions were taken from the CSIRO ADOPT modelling. A 3% discount figure was used.

A discounted cash flow over 10 years was created (table 2). This indicated a net present value after 10 years of ($215 million) with a return on investment from farmers, extension and research of 2.1:1. The results also show the significant upfront costs farmers need to make to achieve a return (the collective break even after 5 years).

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[5] It is assumed 80% of all farms are the target audience for this practice (i.e. 20% would totally destock in drought).

If no investment is made, then adoption is significantly slower both in land 'protected' but also in the positive return on the investment by farmers. After 10 years the return on investment is break even (1:1).

Summary of investment needs

Stock containment feeding is a valuable farm practice that achieves multiple benefits during adverse seasons such as droughts, seasonal challenges such as late autumn breaks and even assisting with general farm and livestock management. Benefits include protecting pasture and soil resources, improving animal welfare and achieving labour efficiencies. Stock containment operation should be considered as part of a property management plan, farm risk strategy and drought preparedness.

The main barriers to producer adoption of stock containment areas identified through farmer focus groups can be overcome by strategic investment in the following extension and research activities.

1. Enhance decision making around common critical decisions associated with containment feeding through creation of decision processes and review and modification of existing resources.
2. Establish a team of local containment experts who can assist farmers design and implement a customised containment facility and create materials and resources, training packages to support farmers develop skills and confidence in the ongoing operation of containment facilities.
3. Create a one stop shop of quality information on the options, design and operation of containment facilities which is regularly updated with new content.
4. Address the identified priority areas containing knowledge gaps through research, studies and surveys.
5. Implement a communication strategy that promotes the use of containment feeding as a positive management practice and the availability of the expert team using multiple extension techniques.

If these investment strategies were to be adopted, this would lead to a fourfold increase in adoption of stock containment areas after 10 years. This would result in an additional 9,650 farms having containment facilities suited to their farming business operation, and if used during drought, would achieve protection of 4.23 million hectares of improved grazing land across Victoria, South Australia and Tasmania.

Achieving adoption of stock containment practices directly support the aims of MLA's Red Meat 2030 priorities, specifically 'Our Livestock' - adopting animal health, welfare, biosecurity and production best practices and 'Our Environment' - building on proactive approaches to climate variability. It also supports rural science and research priorities of Australian government involving soil, water and managing natural resources, specifically to manage soil health and improve resilience to climate events and impacts.

Table 2. Cumulative cash flow ($’000) with extension and research funded at $500,000 per year

Assumptions	No
No of farms (target audience)	**14229**
Area of farmed land (ha)	**6295206**
ea per farm (improved pasture)	**442**
erage cost of containment facility	**$ 20,000**
Investment in research and extension ($/y)	**$ 500,000**
Expected benefit per ha protected	**$ 20**
Inflation rate (%)	**3%**

Discounted cash flow	Years									
	1	2	3	4	5	6	7	8	9	10
Facilities adopted per year (no).	140	486	899	1283	1519	1537	1362	1084	793	541
Cummulative facilities adopted (no).	140	626	1525	2807	4326	5863	7225	8310	9102	9643
Area protected each year (ha)	61793	215196	397613	567426	671925	680023	602727	479697	350670	239309
Cumulative area protected (ha)	61793	276989	674602	1242027	1913952	2593976	3196703	3676401	4027071	4266380
Investment cost ($'000)	$ 3,293	$ 10,228	$ 18,474	$ 26,151	$ 30,875	$ 31,241	$ 27,746	$ 22,185	$ 16,352	$ 11,318
Benefits ($'000)	$ 1,236	$ 5,540	$ 13,492	$ 24,841	$ 38,279	$ 51,880	$ 63,934	$ 73,528	$ 80,541	$ 85,328
Annual cash flow ($'000)	-$ 2,058	-$ 4,688	-$ 4,982	-$ 1,310	$ 7,404	$ 20,639	$ 36,188	$ 51,343	$ 64,189	$ 74,010
Discounted annual cash flow ($'000)	-$ 1,998	-$ 4,419	-$ 4,559	-$ 1,164	$ 6,387	$ 17,285	$ 29,424	$ 40,531	$ 49,196	$ 55,070
Cumulative discounted cash flow ('000)	-$ 1,998	-$ 6,417	-$ 10,976	-$ 12,140	-$ 5,753	$ 11,532	$ 40,956	$ 81,486	$ 130,682	$ 185,752

NPV ('000)	**$ 215,261**
ROI	2.1

Appendix 1 – Legislative conditions around stock containment area use

Legislative conditions around Stock Containment Areas (SCAs) vary across state and local council areas.

Some general conditions apply to SCAs:

- Farmer must adhere to planning requirements for fixed feeding infrastructure and should not be located within 100 metres of a dwelling in the same ownership, waterway, residential zone or Urban Growth zone.
- If a SCA is located within a declared water supply catchment, it should be situated 800m for a portable water supply, the take off point, or a bore supplying portable water (including bores) (AgVic, 2017).

In Victoria, farmers can use a Navigation Farm Development tool designed to identify the statutory and planning requirements to streamline farm development projects such as SCAs (NFD - Welcome (agriculture.vic.gov.au)

The NSW government outlines that SCA are to be temporary arrangements for drought and other emergency events and are not to be used as routine farming operations as outlined in the State Environmental Planning policy (Production and Rural Development (SEPP) (NSW DPI 2019). However, it additionally provides exemptions for routine husbandry purposes such as weaning, drenching, breeding and containment prior to sale or for temporary agistment.

The difference between a stock containment area and a feedlot relates to their purpose and use. Stock containment areas are used as a farm management tool to house stock during emergency events such as fire, flood, drought or management of animal disease. They may also be used seasonally to preserve soil, pasture or for maintaining animal condition.

In contrast, feedlots are operated for the sole commercial purpose to rear and fatten cattle, sheep or other animals that run independently from the rest of the farming system. They will involve the construction of permanent earthworks or permanent structures that have required development consent.

A feedlot within NSW has a legislated requirement that a development application be submitted to the local council and the Environmental Protection Agency (EPA) if more than 4000 head are fed or if the feedlot is located on an environmentally sensitive site (Dudley 2016).

Appendix 2 – Summary of Cheng review

A systematic literature search using major international electronic databases of Web of Science, Scopus, Cab Abstract, and Agricola was performed. The following keywords were used: “drought”; “containment feeding”; “confinement feeding”; “sacrifice paddock”; “stock management area”; “stock containment practice”; and “pasture resting”. Based on the results, a further search was also done by Google Scholar to capture non-refereed technical notes.

The initial scan found 226 papers and identified 59 references were relevant for this study. Twenty six referenced studies came from Australia, followed by 16 references in the USA, and the remaining references were from other parts of the world. The selected references were published between 1970 and 2021, with a trend of increasing publications found in this area over the last 10 years. Approximately 80% of the results was attributed to scientific publications and the rest technical reports.

The results showed that most of the studies were related to ruminants, with ~50% from small ruminant. About half of the papers pointed out the effect of containment feeding on livestock welfare and/or diseases and health. In Australia, most studies have been focused on sheep (~88%), while in the USA most references (~94%) focused on large ruminants (i.e. beef or dairy cattle).

Less than 15% of the papers directly mentioned that livestock containment areas are used for emergency feeding (including drought) and managing seasonal challenges (Dowling and Crossley; Robertson, 2008; Higgins et al., 2016). The main advantage of the containment use was the smaller amount of land required to furnish sufficient feed/forage for livestock in a controlled environment.

Specific industry reports, such as MLA (2021) defined containment feeding as a “drought feeding practice” that aims to promote animal health and welfare while preserving ground cover and land condition across the majority of the property. On the other hand, Agriculture Victoria defined containment area as a ‘carefully selected, fenced section of the property, which is set up to periodically hold, feed and water livestock. They are primarily used to protect soil and pasture resources during adverse seasons such as after a fire, during droughts or late autumn breaks or for general farm management’. Therefore, the definition of containment feeding can have different meanings depending on individual use of the term. Future comprehensive literature review should more closely define the term of containment feeding, this helps to prevent causing confusion among producers (e.g., is feedlot considered as containment feeding?).

Less than one third of the papers explored the design (e.g., mob size) and feeding strategies for containment area in drought situations (McFarland et al., 2006; Rasby, 2013; White, 2014; AgVic, 2018; Roberts and Curnow, 2021). While there is limited consensus between literatures for mob size of different classes of livestock, the literatures mostly agreed that planning is critical and should consider area, the number of pens, stock numbers per pen, capital input, labour, and equipment and personnel. This clearly shows the key principles/consideration of using containment feeding applies to different regions and over time.

Only 15% of the papers investigated the cost-benefit, social and biophysical implications of containment feeding in the drought situations (e.g., MacGregor, 2005; Winsten et al., 2010; Ghahramani and Moore 2013; Webb Ware, 2021).

The full report from which this information is taken from is available on request.

Appendix 3 - References and extension resources

Numbers indicate references in the MAKAT analysis. References are repeated under different themes where multiple topics are covered.

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Appendix 4 - Elements of adoption determined by MAKAT analysis

The following information is a synopsis identified at the Farming Systems Group facilitators meeting based on farmers focus groups and interviews. Additional literature support material identified in Appendix 3 has been added where appropriate.

Each component of the MAKAT (Motivation, Attitudes, Knowledge, Ability, Tools & Technologies) is analysed in terms of:

- Where are farmers now? (synthesis of ideas from the workshops and interviews)
- Where do farmers need to be (to achieve adoption before the next drought without incentives)
- What activities would achieve this transition.

Motivation of farmers to adopt stock containment

Where are farmers now?

Most farmers minds turn to containment feeding because they are experiencing a prolonged feed shortage (drought). It is a 'needs based' response, reacting to a looming problem. Once it has passed, historically it tends to fall out of mind.

Short term feed shortages are addressed by one or more of the following strategies

- paddock feeding,
- allowing animals to lose condition or
- selling stock.

Farmers are generally not geared to use grain as the major feed source (they rely on paddock pick, hay and silage) and don't have the equipment to unload, store and manage large quantities of grain. They would prefer to use poor paddocks (sacrifice paddocks) rather than invest in containment infrastructure, knowing the paddock will need to be resown anyway after a drought.

Farmers currently in this group also harbour fears around capital investment in infrastructure (making wrong costly decisions), ongoing feed costs, animal health and welfare problems and district perceptions.

They focus more on overcoming a short term challenge rather than long term opportunities.

However, in the last drought, a few farmers invested more significantly in a containment feeding systems and had success. They had spent money, saw some positive benefits and also saw the value of containment feeding beyond just drought feeding. This evolved into using it as a management tool for:

- Pasture management, recovery and groundcover *(References: 2, 3, 20)*
- Achieving pasture quantity targets for key events e.g., lambing or calving (*References: 44, 45)*
- Retaining genetics rather than selling

- Labour saving and time efficiency in times of feed shortages, if the alternative was having to paddock feed *(References: 1, 24)*
- Bushfire safe haven and for pasture recovery after bushfire/floods *(References: 10, 15)*
- Quarantining of newly arrived animals to reduce introduction of weeds or disease *(References: 1, 51)*
- Worm management (Barbers Pole) (*Reference: 2*)
- Achieving rapid weight gain with young stock e.g., joining ewe lambs at 7 months *(References: 26, 44)*
- Feeling more in control (piece of mind)
- Feeding lambs or calves in poor seasons
- Taking weight off composite sheep breeds (consist of genetics from several breeds which can gain weight more rapidly than pure breed sheep breeds)
- Lambing triplets
- Ram containment and management (*References: 44, 45*)
- Improving conception of young ewes, by increasing contact with rams
- Selective mating for corrective disorders
- Holding paddock
- Increasing livestock numbers without increasing land (safety valve)
- staff management and time management to minimise the need to work on weekends but ensuring livestock are ready for contractors in a timely fashion for things like shearing, dipping etc
- Hay storage areas
- Hospital area
- Housing livestock when they need to be off the crops (spraying crops)
- Backgrounding - where livestock are fed and grown to prepare for a greater range of market opportunities and to add value through weight gain**.**

One farmer said in relation to having a stock containment area, “once you have it, the more uses you will find to use it.”

Once set up, they made use of the investment wherever possible and because the investment was used regularly, it tended to be more permanent, with the shortfalls in its operation rectified over time (and the necessary skills were practiced and as a result were better retained – see ability section).

The ‘environment’ and ‘farming system’ were also two strong motivators to adopt containment feeding. Areas that experience long periods without feed (droughts), had ‘light country’ prone to erosion and/or had significant cropping were more likely to have established containment feeding systems. Stubbles were an important source of feed on these farms, and they had ready access to grain and machinery (the value of which they may underestimate).

Put simply, their need was greater and some of the components required for successful containment feeding were easily achieved. Adoption of SCAs was greater in these situations.

Where do farmers need to be?

Farmers need a clear understanding of the true benefits and costs of containment feeding compared to the other alternatives of selling, using sacrifice paddocks, production impacts with loss of animal condition or long term lowering of stocking rates. This 'four way comparison' would help inform the decision a farmer needs to make. It is not about providing 'the answer', but presenting the pros and cons of different approaches, in different environments and farming systems across time and letting the farmer make an informed choice.

The gap is for those who wish to pursue feeding, the narrative around *containment feeding being a positive management tool* that farmers should have, rather than a practice of last resort when things are bad, is needed. This change in positioning of the message is vital to build the sentiment that 'good' farmers use this as a regular management tool.

To support this repositioning, there needs to be a strong focus on the whole farm benefits of using containment at strategic times. This includes the management benefits identified above, but also achieving things like animal weight targets and fecundity.

Farmers need access to other farmers who are advocates of the different approaches so they can *enquire and make up their own mind on which approach may be best for them*. This would require some decision support during a non-drought period, so farmers know what their preferred course of action is, rather than trying to determine this when approaching or in drought (see decision making in tools and technology). A range of methods could be employed to achieve this – webinars, on-line forums, field days, bus trips, specific demonstrations, videos, e-library of information etc).

What activities would achieve this transition?

What are some of our key solutions, including who needs to lead, timelines, resources, key partners for delivery, their knowledge.

Motivation activity 1 (M1): Conduct comparative modelling to understand the true benefits and costs of containment feeding compared to the other alternatives (NB. Three examples are being prepared by UoM to be completed by March 2023, reporting date June 2023). But others will become available (BIGG – MLA PDS report due December will contain up to 15 economic case studies. *(References: Whelan et al 2013, 50).* Note references 21 and 23 have case studies involving economics of feedlotting). It is notable from the lack of references that this extension material is not available.

Case studies to be addressed by UoM:

- Tasmania – quantifying the costs and benefits of confinement feeding over the autumn for pasture benefits versus normal grazing strategies.
- SA - quantifying the feeding and labour costs of different methods of confinement feeding over time (invest money – how long does payback occur, is it worth it? Discount cash flow analysis (BIGG). Specifically looking at different investments in feeding systems vs more simple feeding systems that require a lot more labour to feed.
- Vic- Is it worth selling livestock or confinement feeding? (Riverine Plains)

Others identified:

- Use of Nitrogen and Gibberellic acid for accelerating growth versus autumn rest using containment feeding (Derwent).

- Identification of adequate stocking rate (sweet spot) to maximise whole farm profitability (rather than having to feed). Require whole farm analysis and is more complex (MacKillop).
- Efficiency of different feeding rations grain based, legume based, Total mixed ration, comparison of buffers (Riverine Plains)
- Cost Benefit Analysis (CBA) on effectiveness of joining and lambing in containment versus in a paddock (Riverine Plains)
- CBA of moving from a sacrifice containment feeding operation to a more permanent fixed containment feeding operation (Southern Farming Systems (SFS).
- Keeping minimum beef livestock numbers for rebuilding versus feeding them (SFS)

Motivation activity 2 (M2): Create positive messaging around containment feeding and extend this.

(Focus on main benefits with appeal to the two different groups,

- Existing - making it more efficient (upgrading).
- Sacrifice- making temporary work efficiently or upgrading to permanent).

Motivation activity 3: Identify and feature farmers using different approaches to manage feeding during drought.

Potential implementation inhibitors

Some farmers may only want to engage when it becomes necessary and so in drought conditions. Or want to wait for incentives that have previously been offered by government agencies during drought.

Attitudes of farmers to stock containment

Where are farmers now?

Farmer attitude was shaped by how frequently feeding was required as part of their normal farming operation. In areas where feeding was a regular occurrence, they were more willing to spend money to establish, maintain and operate an efficient containment feeding system. They had the belief that, on balance, containment feeding was the best option for their business to maintain long term profitability. Understandably their investment in permanent infrastructure and equipment was more common, and the perceived risks were less (manageable) because they had the experience to make it work.

In areas of higher rainfall (or those with lower stocking rates or who chose to sell or have irrigation), they saw less value in having permanent feeding structures (or they avoided even thinking about it). If necessary, they were prepared to undertake short-term feeding in sacrifice paddocks or construct temporary containment pens that would get them through until there was feed again. Investing in structures and equipment that was used occasionally was considered high cost with limited benefit. They accept that when there is drought, things get bad, it's ugly, so we sell or feed in temporary arrangements until things get better (although a few do change their attitude once experiencing a drought).

With many unknowns about containment (feeding, animal health, labour, effects on joining/lambing, right design, costs) they were not prepared to commit to this type of approach.

Interestingly some farmers who were reluctant to consider containment feeding as part of the farm operation, were more comfortable feeding in a paddock (which they have done many times before). They also mention other reasons for avoiding containment feeding (not ethical, cruel, not natural, violates market and quality assurance programs, creates land use problems with local Government etc).

Where do farmers need to be?

Farmers are prepared to make early decisions (possibly incrementally) on either selling stock to reduce grazing pressure or start containment feeding. They know that a decision needs to be made, they make this decision in a timely manner, and they don't have misgivings after the decision is made.

Those who chose to retain livestock believe it is the right thing to do. They can successfully operate confinement feeding, irrespective of the circumstances. They know there will be challenges (risks), but they have the confidence to address and solve the problems that may arise because the information and expertise is available (from experts, other farmers).

What activities would achieve this transition?

Attitude activity 1 (At1): Develop a decision pathway to help farmers choose if selling or small containment feeding is best for them when entering drought (linked to T1, T2). Would need to a sell now versus sell later calculation, including cost benefit calculations.

Attitude activity 2 (At2): Establish a network of containment demonstrations. These demonstrations need to be 'technically right', regionally appropriate (i.e., for frequency and length of feed deficit) and operated by producers who are respected in the local area (influencers).

List of demonstration ideas mentioned through focus groups for addressing gaps in knowledge, accelerating adoption:

- *Design for beef operations*
- *Efficient cost effective set up for sacrifice paddock for containment feeding with temporary and portable equipment, identified pros and cons.*
- *Technology and infrastructure demonstration for reducing labour, making confinement areas easier to manage.*
- *Demonstration showing 4 potential locations on farm and working through pros & cons for each one.*
- *Demonstration of a small step of permanent infrastructure – 2 small holding paddocks*
- *Demonstration on feed testing feed sources and how this helps make feed decisions.*
- *how to use EIDs and the data to help the business*

Attitude activity 3 (At3): Complete a series of 'stories' of the operators (influencers) featured in At2, with a focus on how they worked through their doubts and concerns. These stories to be communicated through a range of pathways (field days, conferences, video, webinar, e-media, etc).

Potential implementation inhibitors

There is a competitive advantage to farmers who have containment areas and source feed early and some potential influencers who may not be willing to share information.

Knowledge of farmers to stock containment

Where are farmers now?

We know enough about containment feeding to achieve a satisfactory result in most circumstances. This level of knowledge has been built through contributions from farmers, advisors and various research projects. The current knowledge covers:

- Facility design (site characteristics, pen spacing, mob size, feeding methods, fencing types, feeding systems) *(References: 1, 2, 3, 4, 5, 13, 22, 25, 28, 29, 30, 35, 36, 40, 42, 48, 52)*
- Some animal health issues (pinkeye) *(References: 13, 16, 17, 19, 20, 22, 23, 24, 28, 29, 30, 33, 37, 41, 47, 52)*
- Nutritional requirements of different stock classes (energy, protein, fibre, minerals etc) *(References: 1, 2, 6, 8, 17, 18, 20, 23, 28, 30, 39, 42, 49, 53)*
- Water requirements (quality, flow rate, trough length, location etc) *(References: 1, 3, 9, 12, 21, 22, 40)*
- Joining and lambing *(References: 44, 45, 46, 47)*
- Need to identify and separate shy feeders *(References: 43, 52)*
- Labour requirements (tasks to do and time required to do them – which may save time depending on the situation) *(References: 23, 30, 50, 52)*
- Economics of short and long term feeding (if the assumptions are realistic and the type of analysis is correct). *(References: 2, 21, 23, 27, 39, 50)*

Much of the knowledge accumulated by this group was through trying something, observing the result, continuing to use, or adjusting based on the outcome. There was limited 'traditional research' to support some actions. This incremental 'farm research' has largely underpinned the knowledge base to date, but unsurprisingly resulted in inconsistent or even conflicting information at times. There are learnings from feedlot industry that could be tailored to confinement feeding.

There are also gaps that need resolving. These include:

- Differences in energy requirements between paddock and pen feeding (it is assumed animals in containment need less energy than those in paddocks) (*Reference*: 55)
- Collation of feeding requirements for cattle (most available information is for sheep)
- Breed type and feeding (there are higher requirements for crossbred sheep and cattle)
- Animal health issues
    - reasons for metabolic disorders even with supplementation (not sure why– some correlation with older stock who 'run out' of resources)
    - subclinical acidosis (animals are not dying but their performance is less than expected, especially if on grain diets)
    - mineral supplementation (it is thought to be worse in grain heavy diets)

- vitamin supplementation (it is thought the addition of vitamins A, D, E is needed but maybe not in mature livestock)
    - prolapses (it is thought that this could be through lack of physical activity)
    - pneumonia (it is thought this is more prevalent in cooler, wetter, high humidity environments)
- Pros and cons of lambing in containment
- Release timing, especially near point of lambing *(References: 14)*
- Benefits of shade on heat stress (thought to be more prevalent in hotter environments and over summer)
- Impact on pasture survival and recovery by spelling compared to using sacrifice paddocks (thought to be better for pasture survival and recovery if spelled compared to continual grazing - but may be species dependent (some species might not survive, like perennial ryegrass)
- Using the correct economic assumptions (analysis is often inappropriate for the conclusions drawn).

The above list highlights the complexity of containment feeding and the multi-factorial challenge to get it right. The issues identified above have risks (defined as likelihood x consequence), but these risks vary depending on the location and type of activity being performed. It is clear the risks associated with various aspects of containment feeding were not well quantified for different environments, yet are crucial considerations when farmers were making their decisions.

Where do farmers need to be?

There needs to be ongoing refinement of the existing information. The current published information resides across many locations and is sometimes dated (not the most up to date). The information also contains some inconsistencies, which confuse readers or presents worst case information (e.g., blindness from pink eye) rather than most likely experience. This needs to be resolved.

The current materials lack a risk perspective. This includes understanding the likelihood of some issues occurring (how often), the consequence if they do occur (the impact) and what mitigation actions could be applied to reduce the risk.

The most urgent knowledge gaps need to be addressed. We believe this is best achieved through a combination of:

- detailed monitoring of farmer operations to collect data to fully understand the frequency and impact and where the gaps are in mitigation approaches
- advisor / farmer networking, to accelerate the sharing and transfer of information knowledge, observations and ideas.
- issue specific research (informed by a literature review and grey literature survey)

This approach is consistent with the way information around containment feeding has evolved in the past.

What activities would achieve this transition?

Knowledge activity 1 (K1): Review, update and collate information in one location (drought hub websites in each state?), including presenting the information through a risk lens (likelihood, consequence, mitigation options) and highlighting inconsistencies in information. Links to other useful tools, e.g. Consider DR.Sat drought resilience self-assessment tool.

Knowledge activity 2 (K2): Undertake survey of farmers who use different containment feeding approaches to determine the risk (likelihood and consequence) and their mitigation approaches around the common elements of containment feeding.

Knowledge activity 3 (K3): Establish an advisor / farmer network group amongst those who regularly advise on containment feeding, resourcing small scale data collection projects on issues where knowledge gaps exist.

Knowledge activity (K4): Conduct specific field research on issues unable to be resolved by on farm observations. Specific issues include:

- how much roughage is needed (*Robertson, 2020*)
- management of prolapses and pneumonia
- subclinical acidosis
- mineral supplementation
- vitamin supplementation on mature livestock
- shade optimisation to prevent heat stress

Potential implementation inhibitors

Farming systems groups are limited in undertaking animal research trials because they do not tend to have veterinarian or nutritionist expertise required or the capacity to animal ethics requirements and require either university or Department of Agriculture involvement.

Where there are true research gaps, this information may take years to become available.

Ability of farmers to adopt stock containment

Where are farmers now?

Containment feeding can be seen to be a complex undertaking. It requires a high level of skill to achieve success (design, water, feeding, animal health, monitoring etc). Understandably it can appear daunting, confusing and overwhelming, which makes it easier for many farmers to continue with current practices rather than make significant changes.

The few sophisticated containment feeding systems already adopted on farms were with 'pioneering' type farmers. Early adopters of containment feeding recognised its value, often without extensive evidence at the time. This allowed them to visualise possible solutions that fitted their farming system. Their foresight and planning means they have access to water (pipelines) or large dams. Their greater appetite for risk, mean these farmers were more willing to spend money and generally persevered to overcome challenges and built a competency base for using containment feeding.

In contrast, late adopter type farmers were more risk averse. They are not able to see the reason to change (i.e., they can see no compelling case where the pros strongly outweigh the cons). If they are adopting some elements of containment feeding, it was the least risky approach, where they modify what they were currently doing by making small changes, testing this and if beneficial, adopting it as a common practice.

They perceived many risks and challenges with the current containment messaging. These include:

- What monitoring of livestock was needed? Can you use condition scoring or regular weighing? *(Reference: 44)*
- Planning regulations, particularly the difference between a feedlot and stock containment area and when council approval was required (*Reference: 41, 44)*
- The extent of capital investment needed to meet stock welfare and feeding requirements in drought (Can the containment area set up be simple or is a higher level of investment needed?)
- Can the setup be temporary or a sacrifice paddock?
- Disease risks but how likely are they?
- The need to secure suitable water when they don't have piped water (e.g., having a large farm dam to secure water or a bore) and perceived difficulty in navigating water access permissions.
- Understand 'new' feed types like canola hay, where there is little information.
- A lack of information on management of stock (lambing, shy feeders, single lambs vs twins.
- A lack of understanding of feed requirements for some of the newer breeds (composites).
- If breeds such as Merino flocks were suitable for containment because of issues with dust contamination of wool (*Reference: 13*).
- The safe use of urea given its toxicity issues for livestock.

Where there was a requirement for regular use containment feeding, farmer capability was more easily built. This occurred in areas where feed shortages were common, leading to the desire to learn and to apply the knowledge and practices on a regular basis. Where feed shortages were not common, and containment feeding was needed less often, important skills were forgotten leading to some farmers questioning their ability to implement confinement feeding in future and this reinforced their fear than investment in, and operation of containment feeding was not worth it (high risk).

Where do farmers need to be?

All farmers who wish to retain livestock and feed ***are confident and competent in implementing a containment feeding program***. The infrastructure and systems are set up to suit their needs and they can operate successfully within this system.

To achieve this, the ***perceived complexity of containment feeding needs to be dissected into manageable components that can be taught and tested incrementally***. This approach starts 'where farmers are at' and builds small, positive experiences.

Access to ***experts around these components*** (including support with the monitoring and reflection) is essential to provide ongoing support. This needs to be easily accessible to farmers who are trying to make changes to their feeding regime (localised).

What activities would achieve this transition?

Ability activity 1 (Ab1): Create an information package that breaks containment feeding into components, with each component able to achieve a stand-alone outcome if adopted. The focus is on enabling users to adopt elements of containment feeding on farm (Possibly an Meat Livestock Australia (MLA) Profitable Grazing System (PGS) containment feeding package?).

Ability activity 2 (Ab 2): Train local 'expert consultants' to provide ongoing support to farmers implementing the components of a containment feeding plan. Establish a good support network for trainers.

Potential implementation inhibitors

Not being able to secure adequate water supply may be a barrier. The role of water catchment authorities to assist in finding solutions is required.

Where are farmers now?

A lot of technology already exists that enables the measurement and monitoring of components of containment feeding. This includes:

- Scales for body weight.
- Scales for feed mixing, trail feeding.
- Walk over weighing/drafting (linked to EIDs).
- Techniques to condition score.
- Water monitoring devices systems *(References: 9, 12, 21, 22, 40)*
- Feed budget tools *(References: 6, 7, 8, 39).*
- Feeding tables with required energy, protein, fibre requirements.
- Calculators to understand the impact of different feeding regimes (e.g., GrazFeed, StockPlan, GrassGro™, Drought Feed Calculator app available Apple store or Google Play *(References: 8, 39)*.
- Laboratory methods (FeedTest) to determine quality of various feedstuffs
- Ration mixing equipment *(Reference:* 49*).*
- Accurate feeding out equipment.
- Self-feeders, some linked to eIDs and automated feeders called The Shepherd *(References: 49).*
- Vaccinations, mineral and vitamin injections *(References: 47).*
- Emerging technologies to monitor FOO and groundcover e.g., Cibo Labs, feed predictions e.g., Farm forecaster and livestock movements e.g., Mobble, Agriwebb.
- Equipment to design and install containment infrastructure.
- Smart tags for disease detection, animal monitoring.

The greatest gap observed by facilitators was in the farmer's use of feed budgeting / feed rationing tools.

Many farmers (and advisors) still struggled to make good decisions as to when to place animals into containment (or possibly sell them). These decisions commonly required considering factors such as feed on offer, groundcover, stock condition, current and future market prices, season forecasts, cash flow requirements, supplementary feed on hand, labour etc. They are complex decisions, further complicated by an individual's appetite for risk (which is personal). There is a 'right' answer, but this answer is unique to each individual (and may change over time). It was observed that the process to make good decisions was lacking when considering the use of containment feeding**.**

Where do farmers need to be?

There is an adequate array of tools and technologies for a farmer to construct a containment feeding area, calculating feed to meet animal requirements and to monitor stock performance. However, given the variety of feeding systems sought by farmers (due to preference, costs, ease of use, reversibility etc) they may not be aware of the full range of options available. Raising awareness on the types of equipment available would be valuable.

The design of a containment system requires combining many different components into a system that works for that farmer. These choices are enhanced by appreciating the pros and cons of each piece of technology. Often the technology only promotes their virtues (benefits and features) and (understandably) not the limitations. Understanding the pros and cons of each component in the system is required to inform a good decision (e.g., Choice or Kondinin Group type comparisons). This information needs to be easily accessible, preferably through one location (e.g., State drought hub websites).

The tools and technologies appear less well developed to assist decision making in relation to containment feeding. It is about making the choice between retaining or selling stock, sacrifice paddocks or smaller pen feeding and then the sophistication of the feeding system. A process to help determine which approach is best for the farmer and their business is required (NB: It is uncertain what value StockPlan® may provide as we were unable to access it easily).

If containment feeding is chosen as an approach, then the next key decision is about when to place animals into confined feeding (the trigger points) and equally when to release them onto pasture again. The focus here is on developing the processes of decision making (critical factors to consider, tipping points for when to think differently, relative importance or each critical factor etc) rather than the technology to inform each critical factor. This needs to be learnt, applied and refined, so individuals can apply it to their own situation. NB: A decision making / trigger points process will be piloted as part of an existing Innovation grant. *(References: 14)*

What activities would achieve this transition?

Tools & technology 1 (T1): Compile a directory of the current tools and technologies available to design, construct and operate a containment feeding operation, including a review of the pros and cons and publicise this widely. Draft up technical designs which incorporates knowledge from animal behaviour specialists with a focus on labour saving and ease of management, for example in terms of gate size and raceways for allowing best flow of stock.

Tools & technology 2 (T2): Develop a decision pathway to help farmers choose if selling, paddock feeding, or small containment feeding is best for them or if it's worth upgrading from a sacrifice area to permanent infrastructure.

Tools & technology 3 (T3): Assess the outcome of the current trigger points pilot project and consider further development if required.

Potential implementation inhibitors

Out of date apps that can't be easily updated. Joint ownership of apps has historically made it difficult to update existing apps.