2020 Graham Centre Livestock Forum
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# 2020 Graham Centre Livestock Forum Program

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<tr>
<td>8.30am–9.00am</td>
<td>Log on to the online platform and test your technology and network in the virtual waiting room</td>
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<tr>
<td>9.00am–9.05am</td>
<td>Welcome (Toni Nugent, Partnerships &amp; Engagement Manager, Graham Centre)</td>
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| 9.05am–10.30am        | Containment and lot feeding  
Containment feeding for maintenance and production  
Producers Glenn Curry and Matthew Martin will share their experience, then you can put your questions to Glenn and Matthew and the other panel members Martin Preuss, Riverina Local Land Services, Wagga Wagga, and Geoff Casburn, NSW DPI, Wagga Wagga |
| 10.30am–11.00am       | Morning tea and a chance to check out news and information from our sponsors                                                                                                                              |
| 11.00am–12.05pm       | Concurrent tea and research snapshots                                                                                                                                                                      |
| **Sheep**             | **Beef**                                                                                                                                                |
| Finishing lambs: optimising preparation and adaptation of lambs to increase feed intake and subsequently growth rate (Thomas Keogh, PhD student, Charles Sturt University) | Extracting more value from cull cows (Michael Campbell, Charles Sturt University)                                                                                                                        |
| Heat stress reduces sheep reproduction rate (Gordon Refshauge, NSW DPI) | GPS collars, pasture biomass estimates and digital agriculture – an introduction to Charles Sturt precision livestock activities (Shawn McGrath & Jon Medway, Charles Sturt University) |
| The importance of genetic benchmarking in the Australian merino industry (Craig Wilson, Craig Wilson Livestock) | The Southern Multi-breed project- Delivering a resource population for multi-breed genomic evaluation in beef cattle (Kath Donoghue, NSW DPI) |
| Research snapshots (Sheep) | Research snapshots (Beef)                                                                                                                                     |
| Optimising ewe reproductive performance in containment areas (Susan Robertson, Charles Sturt University) | Supply chains for male dairy calves (Veronika Vicic, PhD student, Charles Sturt University)                                                                                                                     |
| The Sheep Sustainability Framework – where it is up to and what it means for you (Bruce Allworth, Charles Sturt University) | Verifying the production system of origin for grass and grain fed beef (Bridgette Logan, PhD student, Charles Sturt University)                                                                                     |
| Livestock as key drivers of soil carbon sequestration in the rangelands (Susan Orgill, NSW DPI) | Health and production effects of single vaccination against Mannheimia haemolytica in non-backgrounded feedlot cattle (Liam Mowbray, Honours student, Charles Sturt University) |
| 12.05pm–12.10pm       | Understanding the shared values between vegans and livestock producers in Australia (Erin Stranks, Honours student, Charles Sturt University)                                                                 |
| 12.10pm–1.30pm        | Dual-purpose mixtures                                                                                                                                                                                        |

Many producers are utilising dual purpose mixes and cover crops in their farming businesses but how you make the most from them?  
Producer Brent Alexander will share his experiences, then you can put your questions to Brent and the other panel members Colin McMaster, NSW DPI, Cowra, and Greg Condon, Grassroots Agronomy, Junee
Become a member of Meat & Livestock Australia

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We do this by investing levies and other funding in research and marketing activities that contribute to producer profitability, sustainability and global competitiveness.

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2020 Speaker biographies

Mr Brent Alexander
Brent is a fourth-generation farmer from Lockhart NSW. He is currently running a 3200 hectare mixed farming operation with his wife Simone and father Walter. Their system is based on a 75/25 mix of cropping and a self-replacing merino sheep flock. In recent times the Alexanders have replaced their pulse crops with mixed species cover crops in an effort to reduce risk and increase production. In 2004 Brent travelled as a Nuffield scholar and studied soil nutrients and associated vari-rate technology. Over the years Brent has held positions in many local farming organisations and was a founding director on both the Southern Agventure and FarmLink boards.

Mr Greg Condon
Greg and Kyrri Condon run Grassroots Agronomy, an independent agronomy business in southern NSW. They work with corporate and family farm operations across southern NSW and are passionate about farming systems and innovations that lead to stable farm profits. Landscape management and soil improvement is a particular interest, especially working with growers to develop high residue farming systems and the associated practice change needed for success. Greg is also an extension agronomist with WeedSmart, a national stewardship program aimed at promoting sustainable weed management.

Professor Bruce Allworth
Bruce is currently Professor of Livestock Systems and Director at the Fred Morley Centre at Charles Sturt University's School of Animal and Veterinary Sciences ( Wagga Wagga). Bruce completed his veterinary degree with Honours at Sydney University, and worked at both Massey University and Melbourne University's Mackinnon Project before operating his own sheep and cattle consultancy practice for 25 years. Bruce completed his PhD in footrot, and is a Fellow of the Australian College. Bruce has a keen interest in on-farm disease management and production. Bruce operates his own sheep and cattle property in southern NSW.

Dr Michael Campbell
Michael has a PhD and Bachelor of Science in Agriculture from the University of Sydney and a Master of Business Administration from the University of New England. He worked for over three years as a beef cattle extension officer with the NSW Department of Primary Industries (NSW DPI) and then moved to work for Rabobank in rural finance for three years. Michael has a strong interest in commercial agricultural production and has previously managed a large fully-integrated cattle operation in Papua New Guinea before returning to Australia. He has also worked as a consultant on-farm business benchmarking projects and for industry funded projects. Michael is currently a member of the Australian Intercollegiate Meat Judging Competition committee and the Federal Council of the Australian Association of Animal Sciences (AAAS). His PhD investigated the use of forage crops to increase profitability and decrease risk in commercial pasture based dairy farming systems. Michael currently runs a beef cattle breeding operation with his wife and children near Adelong.

Mr Glenn Curry
Glenn owns and manages a family mixed farming operation in the Junee Reefs/Dirnaseer district. Glenn is married with three adult children. He completed his schooling at Illabo and Junee and after completing his HSC he worked with Dalgety’s as a stock and station agent in Wagga Wagga. He returned home in 1982 to join the family farming operation. Glenn and his brother Brian have successfully grown the family farming operation, with Glenn’s son Tom and Brian’s son Timothy also working on the family farm. The farming operation comprises approximately 2800 hectares, with 1800 hectares sown out to mixed cropping. They also run a 4000 Merino ewe self-replacing enterprise. Glenn has been using sheep confinement lots since 2008 and firmly believes they are a valuable tool for both sheep and land management.

Dr Kath Donoghue
Kath grew up on a mixed farming enterprise, and developed her interest in beef genetics through involvement in her family’s Hereford stud. Kath obtained her Masters (2001) and PhD (2003) at the University of Georgia, USA, and following her postgraduate studies was employed at the Animal Genetics and Breeding Unit, where her research activities included investigations into the feasibility of international genetic evaluation for several different cattle breeds. In 2008 Kath commenced employment with NSW DPI at Trangie Agricultural Research Centre, and has been based at Trangie ever since. Kath’s research has included the genetics of feed utilisation by cattle, in particular the relationship between age at puberty and feed efficiency; genetics of body composition in beef females (Beef CRC Maternal Productivity project) and genetic technologies to reduce methane emissions in beef cattle. Her current research projects include the Southern MultiBreed project, where the key objective is to enable beef producers across Australia to directly compare bulls of different breeds for all BREEDPLAN traits, and assess their genetic merit irrespective of hide colour. The most important output of this project will be the development of the necessary head to head comparisons in order to have multi-breed BREEDPLAN Estimated Breeding Values (EPVs) in Australia for all major temperate breeds.

Mr Geoff Casburn
Geoff has worked for NSW DPI for more than 20 years in Goulburn, Bourke and Wagga Wagga. He has well developed knowledge of livestock and cropping systems and the interactions between enterprises. He has a keen interest in livestock production from pasture and sound experience in drought feeding systems and lamb feedlotting. Geoff has a focus on both wool and meat enterprises and is passionate about agriculture and the rural community. He has been working to develop the Drought and Supplementary Feed Calculator, designed specifically to help develop rations when pasture alone is not enough.
Mr Thomas Keogh
Tom grew up in Sydney and after finishing high school moved to the region to work on the family sheep and cattle property managed by two of his uncles. Tom then commenced a Bachelor of Animal Science at Charles Sturt University and in his final year undertook an honours research project investigating the effects of vitamin D on the calcium status of twin bearing ewes. After graduating, Tom returned to the family property and was assigned the job of working out why lambs were not growing as fast as they should. Tom was unsuccessful in meeting these high expectations, but rather than give up he decided to commence a PhD thesis investigating the constraints on lamb growth in intensive finishing systems.

Ms Bridgette Logan
Bridgette has an undergraduate degree in animal and veterinary bioscience from the University of Sydney, where she completed her honours research in Alpaca meat. She is now a third year PhD student at Charles Sturt University working on her thesis entitled ‘Verification of production systems of origin for beef and lamb.’ Her work focuses on discriminating between grain and grass production systems using Raman Spectroscopy. Bridgette is also a student member of the Graham Centre and works closely with the meat science team in NSW DPI based in Cowra.

Ms Emma Lynch
Emma grew up on her family property in Bathurst, NSW. Emma completed a Bachelor of Animal Science (Honours) in 2017 at Charles Sturt University. After her honours and industry related travel overseas, Emma realised her passion and love for all things beef and decided to pursue a career in research. In 2018, Emma commenced her PhD at Charles Sturt University, where she continued to further investigate her honours research. The title for Emma's PhD thesis is ‘The use of canola meal as a supplement for grassfed beef’, which focuses on animal production, ruminant nutrition and meat science. Emma is currently in her last year of her studies under the supervision of Michael Friend, Gaye Krebs, Michael Campbell and John Piltz. On completion of her studies, Emma wants to continue research and education in ruminant production and nutrition.

Mr Matthew Martin
Matthew is a multi-generational farmer at Mullengandra, NSW. He completed his Advanced Diploma of Agriculture through the University of Melbourne in 2006, before returning home to manage his family property, Old Cobran, north-west of Deniliquin. The property was 8000 hectares of mixed irrigation and dryland farming, the family's Poll Merino stud, and commercial beef cattle. Matthew's real passion is working with sheep, which led to a business decision that saw operations move east to Mullengandra, in the Eastern Riverina of NSW. This decision has proved fruitful, allowing an increase of stock numbers to now run 5000 ewes and commercial cattle on 1820 hectares of undulating land. Matthew enjoys the challenges farming brings, and is constantly looking for ways to improve and make the farm more efficient and productive.

Dr Shawn McGrath
Shawn grew up on a beef and wool property near Tumbarumba, NSW. He completed a Bachelor of Science in Agriculture at the University of Sydney in 2001, before commencing work in corporate agriculture for Elders Ltd, predominantly in the beef supply chain with production and marketing of domestic beef and export Wagyu, and then in rural finance. In 2010 he returned to southern NSW and changed his career focus to research, with a wool industry-sponsored PhD into the utilisation of dual-purpose wheat followed by an MLA-sponsored project comparing Dorper and Merino production in mixed-farming systems at Wagga Wagga. In August 2015 he commenced in his current position as Lecturer in Whole Farm Management in the Fred Morley Unit at Charles Sturt University, with a focus on applied research and undergraduate and postgraduate teaching in livestock production and consultancy.

Mr Colin McMaster
Colin joined NSW DPI in 2005 as a Healthy Soils, Healthy Landscapes Project Officer and has held positions as the Farming Systems Agronomist and the District Agronomist (Forbes). In his current position as a Research and Development Agronomist, Col conducts farming systems research that aims to enhance the profitability of dryland cropping systems within NSW. Research interests include crop water use efficiency, summer fallow management, crop nutrition, canola agronomy and general dryland farming systems research. Current research projects include summer cover cropping, canola establishment and improving pulse nodulation on acid soils.

Mr Jonathan Medway
Jonathan completed an agricultural degree in Wagga Wagga in 1988 before returning home to northern NSW to work on his family's cropping property. After seven years as a Research Officer at Charles Sturt University working on GRDC cropping systems and precision agriculture projects, he established a spatial data services consultancy based in Wagga Wagga utilising a broad range of technical, theoretical and practical skills working with farmers and businesses across Australia and internationally. Since June 2019 Jon has been the Senior Research Fellow – Spatial Agriculture at the Graham Centre. In this role he is developing a program of research activities to investigate and demonstrate the use of spatial and digital technologies in a range of agricultural industries. Part of this newly created role also involves working to expand the agtech capabilities utilised on the Charles Sturt farm for both research and day to day farm management activities.
Mr Liam Mowbray
Liam is a newly graduated veterinarian from Charles Sturt University who completed his honours research in Bovine Respiratory Disease in feedlots. Liam recently started a new job with Taree Veterinary Hospital. He is also the owner-operator of Narlah Angus, an Angus breeding operation on the mid north coast of NSW. His veterinary interests include cattle nutrition, genetics and embryo transfer. Liam also has a degree in medical radiation science, a diploma in business and certificates in agriculture. Liam has travelled the world competing for Australia in archery competitions and plays rugby union for Wagga Agricultural College.

Dr Susan Orgill
Susan is a soil scientist with NSW DPI and is based at the Wagga Wagga Agricultural Institute. Susan is passionate about delivering farm-ready research focusing on strategies to increase soil carbon and nutrient cycling in agricultural soil. Her current projects include grazing and nutrient management to increase soil carbon, using remotely sensed imagery to identify zones to increase soil carbon sequestration in rangeland ecosystems and developing soil condition metrics to value the benefits of improved soil management.

Mr Martin Preuss
Martin joined Riverina Local Lands Services in November 2019 as the Senior Land Services Officer (Livestock) based at the Wagga Wagga office. Martin has extensive animal health experience, having worked in the Australian agribusiness and agrifood sector for the past 30 years. Since obtaining a Bachelor of Applied Science (Agriculture) from Charles Sturt University in 1996 Martin has specialised in the areas of animal health, reproduction and ruminant nutrition across the beef, dairy and sheep production industries. In his role with Riverina Local Lands Services, Martin works with primary producers to identify new opportunities and provide solutions to improve livestock welfare, productivity and profitability.

Dr Gordon Refshauge
Gordon is a research scientist working in the field of small ruminant reproduction. He has worked on studies involving genetics, meat science, meat goat reproduction, nutrition, wool production, disease, vaccine, and body temperature studies, leading to strong interests in the thermal environment impact on sheep production. Gordon is known in places as ‘the autopsy guy’ as he has done a lot of work on neonatal lamb autopsy. Gordon recently led a project that developed a prototype to measure body condition score in sheep. He is currently involved in several research projects including mineral balance in sheep grazing perennial wheat, the survival of triplet ewes and their lambs, increasing the adoption of pregnancy scanning, the vulnerability of sheep production systems to climate variability, and the refinement of body condition score targets for spring and summer mating.

Dr Susan Robertson
Susan completed a Bachelor of Applied Science (Agriculture) at Charles Sturt University and a PhD in sheep and wool production at the University of New South Wales. She spent five years as a livestock officer with the Victorian Department of Primary Industries at Walpeup, before returning to the family farm. Since joining Charles Sturt University in 2006, Susan has worked with teams researching sheep reproduction, particularly practical husbandry to increase both the number of lambs born and lamb survival. Other research includes sheep production systems and simulation modelling. Susan also lectures in sheep production at Charles Sturt University, teaching undergraduate and postgraduate students.

Ms Erin Stranks
Erin is a fourth year Bachelor of Animal Science (Honours) student at Charles Sturt University. Erin grew up in Yass, NSW and moved to Wagga Wagga in 2017, which she now proudly calls home. Erin has an interest in market research and ethical consumerism, how these influence market change, and future market trends within the livestock industry.

Ms Veronika Vicic
Veronika is a PhD student at Charles Sturt University. Her research focuses on the utilisation of male calves within the dairy industry for beef production. Prior to undertaking her PhD, Veronika was involved in the feedlot sector and is passionate about continually improving the efficiency of livestock systems.

Mr Craig Wilson
Craig is Managing Director of Craig Wilson and Associates. His company provides technical advice and Merino genetic consultancy to clients across Australia, including some of Australia’s leading Merino sheep studs and largest commercial breeders. Craig’s company has been heavily involved in across flock benchmarking running wether trials since 2004, measuring both wool and meat traits, clearly defining the strengths and weaknesses of entrant’s flocks genetics. Craig Wilson and Associates also has over 10,000 sheep under its management, having initiated sheep share farming agreements with five properties. The farms provide the land and Craig is responsible for the management, marketing and decision making. In November 2019, he purchased the Kentish Downs Poll Dorset Stud, aiming to supply production driven terminal genetics to clients across Australia.
Animal Health Australia is the trusted and independent national animal health body in Australia, bringing together government and industry to deliver animal health and biosecurity. With our members we scan the horizon for threats and opportunities, advocate for and drive solutions and take a whole-of-sector approach to ensure the long-term success of Australia’s animal health and biosecurity system.

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Sheep confinement lots –
a grassroots perspective

Glenn Curry
Curry Farming Enterprises
T: 0428 247 255 E: glcglenfield@gmail.com

Take home messages

- Confinement lots are a valuable management tool for all grazing operations. They allow flexibility in pasture management depending on seasonal conditions.
- Stock are more content in confinement lots; they are not wasting energy chasing ‘that last blade of grass’ in a large dusty paddock.
- Confinement lots allow better nutritional management of single and multiple bearing ewes.
- Time is maximised using confinement lots, as producers are not driving around the farm checking stock.

Glenn owns and manages a family mixed farm in the Junee Reefs/Dirnaseer area along with his brother Brian, nephew Timothy and son Tom.

Curry Farming comprises 2800 hectares, of which 90 percent of the land is arable. The soil type is a red brown loam over clay to heavy clay, with an average annual rainfall of 500 millimetres.

Enterprises

- Cropping (1800ha), comprising Canola (550ha), Faba Beans (130ha), Wheat (500ha), Barley (260ha), Grazing crop and Vetch mix (300ha)
- Grazing (1000ha), comprising 800ha Lucerne/clover and 200ha native pastures
- Sheep - 4000 merino ewes comprising of a nucleus of a 2000 self-replacing merino ewe flock based on The Yanko bloodlines. The remaining 2000 merino ewes are joined to terminal sires.

Sheep confinement lots are an integral part of the Curry’s sheep management. They first invested in a seven pen confinement lot in 2008, built on a very stony/rocky hilltop that was not arable. Pen sizes are 80 metres x 50m, and the lots have been used every year since they were established, accommodating about 2100 sheep.

After purchasing more property in 2019 and increasing ewe numbers they have built a second confinement lot with pens of varying sizes to accommodate approximately 1400 ewes.

Sheep management

Merinos ewes joined to terminals are joined after a January shearing for 10 weeks maximum, and are scanned at five week intervals to identify singles and twins. The Merino self-replacing ewes are joined after shearing in February for a maximum of five weeks and are also scanned for singles and twins. Scanning for singles and twins allows Glenn to target nutritional needs.

All Merino lambs are shorn in February each year.

All ewes graze cereal and canola stubbles after harvest. As stubbles start to run out, the Curry’s begin supplementing the ewes with barley and silage (generally canola silage due to drought) to prepare them for confinement lots.

Depending on the summer and early autumn, ewes are then inducted into the confinement lots to maintain groundcover and allow perennial pastures to maintain themselves. This generally occurs after shearing.

Glenn generally does not put crossbred or merino lambs into confinement lots as they graze the Lucerne pastures and are supplemented with grain feeders.

Depending on the autumn, Merino wether and ewe lambs will be put into confinement lots after shearing.

Confinement lots provide Glenn with the opportunity to manage age groups differently and divide the ewes up based on condition score. This enables him to better manage the nutritional requirements and sheep condition.

The use of confinement has allowed the business to maintain (and even increase) stocking rates, yet not compromise groundcover during dry times. The Curry’s do not have to sell down during drought and can potentially buy in when it rains.

Confinement lot design

The first confinement lot built consisted of seven pens, 80 x 50m; a total of 4000 square metres allowing for mobs of 800 maximum with sufficient space. Stocking density for sheep is at least five square metres per head. Stocking density is determined by the length of rubber belted trough in the middle of the pen. Glenn works on 5 sheep/m of trough, allowing all sheep to feed at the same time evenly on both sides of the trough.

In the 80 x 50m pens a 60m trough is used allowing 300 head/pen.

Figure 1. Glenn uses rubber belting for troughs in his confinement lot.
The second confinement lot is close to sheep yards, and like the first confinement lot, stocking rate is determined by the trough length.

**Induction into confinement lots**

Prior to ewes entering confinement lots they are generally conditioned to barley and silage. All ewes entering the confinement lots are worm tested and drenched to minimise health issues.

**Feeding**

Depending on feed tests, the ration consists of 800 grams barley/hd/day, fed three times a week. Sheep are supplemented with 570 grams silage/day and fed barley straw as a buffer. Lime and salt is added to the grain ration.

All grain is fed into a rubber belt feed trough using a Bromar Feed Cart with scales via an auger. Glenn has found this minimises grain loss and all sheep are able to access feed at the same time. Silage and barley straw is fed in a full bale on the ground.

Costs (per tonne fresh):
- Barley $360/t
- Silage $150/t
- Straw $100/t

Equates to:
- Barley @ $0.86 per head per week
- Silage @ $0.60 per head per week
- Straw @ $0.10 per head per week

This equates to a total cost of $1.56/hd/week.

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**Figure 2.** Grain is fed into the rubber matting feed trough, allowing for five sheep per metre of trough, meaning all sheep can feed at the same time evenly on both sides of the trough.

**Joining in confinement lots**

Joining rates in confinement lots are 1.5%. As mentioned above, Merinos joined to terminals are joined over a 10 week period, while Merinos joined to Merinos are joined for a maximum of five weeks.

Scanning Results for 2020 were:
Merinos joined to merinos:
- Joined 1280 ewes in confinement (2½ - 4½ years)
- Scanned singles: 330 ewes (27%)
- Scanned multiples: 884 ewes (69%)
- Dry: 57 ewes (4%)

In 2020 maiden ewes were joined on a faba bean stubble.

Terminals over merinos:
- Joined 1332 ewes (10 week joining)
- Scanned singles: 552 ewes (41%)
- Scanned multiples: 704 ewes (53%)
- Dry: 73 ewes (7%)

**Health issues**

Over the years the Curry’s have had minimal losses, averaging no more than 0.5% maximum losses. Wet inclement weather can increase health issues, with sheep simply ‘failing to do’ in extended inclement weather periods.

Shy feeders are drafted off when the rams are taken out or at scanning, and are put into a pasture paddock to recover. They may re-enter again at a later.

**Release from confinement lots**

For general hygiene, sheep are let out into neighbouring paddocks during continual wet weather.

Ewes are taken out of containment gradually to manage both animal health and wool quality. Glenn puts ewes into smaller holding paddocks outside the containment pens for a few hours each day, gradually increasing the length of time out of containment over a couple of weeks before they move fulltime onto pasture paddocks.

Glenn has not lambed in confinement lots and does not intend to at this stage. Putting sheep into confinement lots allows the Curry’s to maintain their pastures, also allowing the pastures to respond better to the autumn break.
Containment feeding at 'Old Cobran'

Matthew Martin
Old Cobran Pastoral
E: mmmrmartin705@gmail.com
Facebook: https://www.facebook.com/oldcobran

Take home messages
- Minimum 30cm trough space per animal, all sheep need to be able to feed at once.
- Clean, cool water is essential.
- Does not need to be anything too flash, just functional.
- Keep containment lot close to yards and silos.
- Ensure sheep have access to salt, lime and Causmag while on grain.

Old Cobran was originally located at Deniliquin, before operations were moved to Holbrook, NSW in 2015. The business changed from an extensive to an intensive grazing system running 4,500 commercial ewes and 500 Poll Merino ewes on 1800ha. Matthew also runs 150 beef cattle on the property.

The construction of containment pens has improved capacity and efficiency, and helped to alleviate stress as a result of the ongoing drought. Matthew believes the advantages of containment feeding are:
- Preserving groundcover
- Faster pasture response, post rainfall
- Reduced feeding time and feed wastage
- Reduced energy expenditure from walking to graze
- Can also be used as holding paddocks prior to shearing, scanning, and other sheep management operations.

Establishing a containment lot

Site selection must be carefully considered. When building his containment lot, Matthew selected the most unproductive land and ensured the pens were close to the hayshed, silos, sheep yards and shearing shed. He also made sure the containment lot could be accessed from existing laneways.

Pen size is important, with a minimum of five square metres per head needed. Pens are rectangular in shape, allowing good length for feed troughs, with the average pen dimension being 100 x 50m, holding around 450 sheep. Matthew does not put more than 450 sheep in the pens, as more than this does not allow all sheep to access the feed trough.

Feed and water

Feeding is carried out externally with no entry to the pens required. Matthew uses a modified Bromar feed bin with an extendable auger, and feed bin scales for accuracy of feed rations being fed out.

Figure 1. Containment feeding pens on Matthew’s Holbrook property.

Figure 2. Aerial view of containment lot.

Figure 3. A Bromar feed bin is used for feeding sheep in the containment lot.
A minimum of 30 centimetres of single-sided trough space per animal is provided, and 20cm of trough space per animal for double-sided access. When Matthew established his containment lot in 2018, he originally used single-sided troughs, but has since transitioned to double-sided troughs. These are more economical due to increased pen capacity. Feed troughs are constructed out of 300mm PVC pipe, cut in half and tek screwed to timber blocks. The PVC pipes were cut with a chainsaw. The feeding system costs around $3.10/sheep.

Figure 4. Feed troughs are made from PVC pipe.

Water is sourced through a solar powered bore and stored in 2 x 20,000 litre tanks with automatic refilling. Water troughs are constructed using 150mm PVC pipes in six metre lengths, with a screw cap on the lowest end for easy cleaning. The opposite end has a 300mm sleeve with a large float valve. There are 10 x 80mm access points per trough.

Figure 5. Water troughs are 6m in length and are made from PVC pipe.

Water is gravity fed using two inch poly pipe and flow rates are high allowing quick refill after cleaning. This watering system is the equivalent to concrete pricing, but with less wastage, and cleaner and cooler water. The two tanks have serviced approximately 5000 sheep.

Feeding for production

Ten pens (1500m² pens/300 lambs/pen) are utilised for intense feeding. Matthew puts three lick feeders per pen. All lambs are introduced initially using troughs, allowing for the slow and safe introduction of grain.

Figure 6. Self-feeders are used for production feeding.
Sheep

Finishing lambs - optimising preparation and adaptation of lambs to increase feed intake and subsequently growth rate

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Take home messages

• Creep feeding lambs is not effective when nutrient supply to the ewes and lambs is high.
• Supplementing lambs post-weaning with grain while grazing lucerne did not increase lamb growth rates.
• Provision of a feedlot ration prior to induction to a feedlot is effective at increasing intake in the feedlot and subsequent growth rates.
• Ensure sufficient post-weaning intake of a novel feed source prior to feedlot induction for lambs to be appropriately familiarised.
• Despite increased nutrient intake during the post-weaning period and in the feedlot, lamb growth rates still appear to be constrained and are below potential.

Post-weaning lamb growth rates are consistently less than potential. Practical measures to increase nutrient availability are necessary to minimise the constraints on lamb growth (Oddy and Walmsley, 2013). Specialist lamb finishing operations, such as lamb feedlots, have the ability to provide the unlimited intake of the necessary nutrients for unrestricted lamb growth, but it is unlikely that lambs in these systems are reaching their potential for growth. In rare cases where reported post-weaning growth rates exceeded 400 grams per day, it could be shown that this was more likely due to errors in measurement than actual lamb performance (Oddy and Walmsley, 2013).

The purpose of this study was to determine if exposure to creep feeding pre-weaning, and access to a feedlot diet post-weaning, would allow lambs to better transition to the feedlot environment and improve lamb growth rates.

A replicated experiment was conducted in southern NSW with single-born lambs (n=216) that were exposed to one of four pre-weaning treatments for six weeks prior to weaning. The treatments included creep access to grain (barley and lupin mix), lucerne hay, both grain and hay, and a control that received no supplementation (Figure 1). At weaning, lambs were randomly assigned to one of three post-weaning treatments; grazing irrigated lucerne with access to grain, grazing irrigated lucerne only, or weaned directly into a feedlot. After a 30 day post-weaning period, all lambs entered the feedlot for the 39 day finishing period.

The feedlot diet of 70% whole barley, 25% whole lupins and 5% commercial mineral pellet and rumen buffer, contained 12.9 megajoules of metabolisable energy and had a crude protein percentage of 17.2%. Lambs were provided with lucerne hay during the 16 day induction as the grain diet was gradually introduced.

Lambs were provided with unrestricted access to barley straw from the conclusion of the induction period.

Table 1. Growth rates and supplement intake of lambs during the pre-weaning, post-weaning and finishing periods.

<table>
<thead>
<tr>
<th>Pre-weaning treatment</th>
<th>Hay</th>
<th>Grain</th>
<th>Hay + Grain</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-weaning period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average daily gain (g/day)</td>
<td>381</td>
<td>356</td>
<td>379</td>
<td>375</td>
</tr>
<tr>
<td>Grain intake (g/day)</td>
<td>-</td>
<td>105</td>
<td>-</td>
<td>81</td>
</tr>
<tr>
<td>Hay intake (g/day)</td>
<td>131</td>
<td>-</td>
<td>107</td>
<td>-</td>
</tr>
<tr>
<td><strong>Post-weaning period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average daily gain (g/day)</td>
<td>96a</td>
<td>149b</td>
<td>124bc</td>
<td>135bc</td>
</tr>
<tr>
<td><strong>Post-weaning treatment</strong></td>
<td>Feedlot</td>
<td>Lucerne</td>
<td>Lucerne + Grain</td>
<td></td>
</tr>
<tr>
<td>Average daily gain (g/day)</td>
<td>97a</td>
<td>149b</td>
<td>133b</td>
<td></td>
</tr>
<tr>
<td>Grain intake (kg/day)</td>
<td>1.27</td>
<td>-</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td><strong>Finishing period (Feedlot)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average daily gain (g/day)</td>
<td>147a</td>
<td>79a</td>
<td>127a</td>
<td></td>
</tr>
<tr>
<td>Grain intake (kg/day)</td>
<td>1.55b</td>
<td>1.27a</td>
<td>1.50b</td>
<td></td>
</tr>
</tbody>
</table>

1. Effect of pre-weaning treatment on growth rate during the post-weaning period.
2. Effect of post-weaning treatment on growth rate and grain intake during the feedlot period.

Results

Lamb growth rates pre-weaning did not differ between creep fed treatments, with daily liveweight gain (ADG) pre-weaning averaging 373 g/day (Table 1). There were no differences between treatments in grain intake (93 g/day) or lucerne hay intake (119 g/day) throughout the 42 day pre-weaning period. There were no differences in ewe liveweight at weaning and no differences in pasture availability at the start or conclusion of this period. These results suggest no benefit in liveweight gain pre-weaning from creep feeding lambs, most likely because of the high quality and quantity of feed available to ewes and lambs (Ates et al., 2017, Moss et al., 2009).

During the post-weaning period, growth rates were lower for lambs weaned directly into the feedlot than lambs grazing lucerne or lucerne supplemented with grain. Supplementing lucerne with grain did not increase growth rates during this period.

Over the entire post-weaning period, growth rate of the grain pre-weaning treatment was greater than the hay treatment, but the grain and hay treatment and the control were not significantly different from other treatments (Table 1).

1. a, b denotes significant differences (p < 0.05)
Rumen development is initiated following the intake of solid feed with an increase in rumen capacity stimulated by presence of the physical bulk of feed (Tamate et al., 1962). The maturation of the ruminal epithelium involves the development of papillae to increase the absorptive surface area. A viable fermentation must be established in the rumen for this to occur suggesting there is a requirement for volatile fatty acids that are the end products of ruminal fermentation (Sander et al., 1959). A high energy grain diet results in the greater production of volatile fatty acids that stimulate the rumen to increase the absorptive capacity of the rumen epithelium.

The supplementation of lambs pre-weaning with a combination of hay and grain would be expected to increase the rumen capacity, thus increasing the intake of nutrients, and the ability of the rumen to absorb these nutrients. There is no direct evidence of this from this study. It is possible the intake level of creep feed during the pre-weaning period was insufficient and greater intake of hay and grain could produce different results. There were also no differences in grain intake on the lucerne pasture or in the feedlot as a consequence of pre-weaning treatments.

During the finishing period, lamb growth rates were greater for lambs that were weaned into the feedlot and lambs with access to grain on the lucerne compared to lambs that only grazed lucerne post-weaning. There were no differences in grain intake in the finishing period as a result of pre-weaning treatments. Grain intake was greatest for lambs that were weaned directly into the feedlot (Table 1). This level of intake was significantly greater than lambs that grazed lucerne only post-weaning. The intake of lambs with access to grain while grazing lucerne was not significantly different to both the feedlot and lucerne post-weaning treatments.

Prior exposure to grain pre-weaning has previously been shown to improve acceptance by lambs in a feedlot diet (Savage et al., 2008), but in the current study prior exposure only increased intake for lambs that were supplemented with grain during the post-weaning phase. This could suggest there is a certain level of intake required to familiarise lambs to increase subsequent intake or that providing grain when there is a more attractive energy source (milk) is not an effective way to familiarise lambs to the novel feed source. There were no differences in growth rates as a consequence of feedlot entry weight that averaged 39.1kg at the commencement of the finishing period. There were no differences between treatments in average liveweight at the conclusion of the trial.

**Conclusion**

The results of this experiment indicate that feeding supplementary grain to animals with access to high quality and quantity of feed is unlikely to be beneficial irrespective of whether lambs have been weaned or not. Exposing lambs to a feedlot diet prior to feedlot entry and ensuring sufficient intake of that diet does appear to subsequently increase feed intake and lamb growth in the feedlot. The results suggest that despite sufficient feed intake to enable rapid growth, growth rates appear to be constrained and are below what would be expected.

**Acknowledgements**

This paper is based on a trial funded by the Meat and Livestock Australia Donor Company and the Graham Centre in 2019-2020. We thank the collaborating producer and technical staff who were integral to the running of this experiment.
The effects of heat stress on sheep reproduction

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Take home messages

• Sheep reproduction rates decline when ambient temperature rises above 32°C.
• Every phase of reproduction is susceptible, rams and ewes.
• Potential nutritional solutions exist but have not been examined.
• The importance of shade seems obvious, but its benefit has not been properly examined.
• Little is known about the genetic correlations between heat tolerance and sheep production traits.

Reproduction is particularly sensitive to heat stress because of the way the mammalian body reacts (Hansen, 2009). Pregnancy rates decline when ambient temperatures exceed 32 degrees celsius. Undertaken 50 years ago, that study found significant reductions in the number of ewes lambing and the number of lambs born, but without a reduction in ovulation rate (Lindsay et al., 1975). This evidence points to poor ova fertilisation and elevated embryo mortality. Twenty years later, Kleemann and Walker (2005) also observed a similar negative relationship between fertility and ambient temperatures above 32°C.

Reports from the 1940s suggest Australian sheep producers were aware that summer-mated flocks had lower reproduction rates (Lee and Phillips, 1948). Recent economic estimates suggest heat stress is reducing the value of the Australian sheep industry by $97 to $168 million per annum (van Wettere et al., 2020). More experimental work is required before solutions can be offered to the industry that mitigate the metabolic consequences of heat stress on the key reproduction hormones and the key reproductive tissues and cells, including sperm, ova and embryos. This is a significant issue given the context of our rapidly changing Australian climate.

What is heat stress?

Heat stress is the demand made by the environment for heat dissipation (Slanikove, 2000). Mammals regulate their own body temperature, which rises as a consequence of exercise, digestion and metabolic activity. Temperature in the mammal is regulated behaviourally and physiologically; the systems aim to match heat production with heat loss. Respiration rates and sweating increase as the mammal undergoes heat stress. In sheep, 60 percent of heat dissipation occurs via panting and 40% via sweating (Aggarwal and Upadhyay, 2011).

Heat stress lowers feed intake, leading to altered hormone levels

Prolonged, chronic, heat stress reduces feed intake while also possibly increasing maintenance requirement (Baumgard and Rhoads, 2013). Eating less inevitably lowers metabolic heat production, but after some time the animals acclimatise, that is, get used to the heat and get back to eating, but reductions up to 22% have been observed (Alhidary et al., 2012). Prolonged low feed intake leads to a negative energy balance in the animal, triggering reductions in the governing reproduction hormones (Figure 1), dampening germ cell preparedness, sexual activity and reproductive success, but impaired reproduction is not just due to lower feed intake.

Figure 1. Three pathways illustrating the impact of heat stress on key reproduction hormones leading to lower fertility, adapted from Aggarwal and Upadhay (2011).

Heat stress causes metabolic stress and lowers fertilisation success

The metabolic consequence of heat stress is increased production of reactive oxygen species (ROS). When the production of ROS exceeds the cell’s antioxidant capacity, damage is incurred. Spermatids, spermatocytes, follicles, oocytes, corpora lutea and early embryos will be directly impacted by ROS (Hansen, 2009). In the early embryo, susceptibility to heat induced ROS decreases with embryonic growth as older embryos have improved antioxidant capacity (Dutt, 1964).

Heat stress impairs placental development, birthweight and lactation

Chronic heat stress reduces placental development and key reproductive hormones (Bell et al., 1989), but evidence shows that more than one day (eight hours) of extreme heat is required to impair placental blood flow (Andrianakis and Walker, 1994). This means enduring heat waves are likely to lower birthweight. The impacts of short-term heat are limited to their depressing effects on milk yield, as observed in dairy sheep (Finocchiaro et al., 2005).

Why is heat stress a problem now?

Attention is turning to heat stress because of the risk posed by global warming. Examination of freely available weather data for Wagga Wagga (72150 WAGGA WAGGA AMO) is presented in Figures 2 and 3. These figures show clear rises in temperature, particularly since the mid-2000s. A continuation of temperature rises will require the sheep industry to develop solutions that support tactical lowering of body temperature or improved tolerance. The solutions to examine include nutrition, shade and genetics.
Figure 2. Number of days recorded above 40°C since 1940 for Wagga Wagga.

Nutritional solutions exist already, sort of

The primary outcomes for nutritional supplementation are to either lower body temperature or maintain feed intake. To date, such research has only focussed on the growing sheep. Supplements that act to lower body temperature, while also providing antioxidant support against ROS are most interesting (Chauhan et al., 2016). A number of supplements have been examined in sheep and may offer solutions to lower body temperature or maintain higher intake under heat stress conditions (Dunshea et al., 2017), but none of these studies examined reproducing sheep.

The argument for increased shade

Providing shade has clear benefits for pregnant and lambing ewes, with evidence for improved lamb birthweight (Hopkins et al., 1980) and lamb survival (Stephenson et al., 1984). Shade during autumn has also resulted in improved lamb weaning weight (Cloete et al., 2000). Shade may also help maintain body condition score, unless well-conditioned sheep seek more shade. These areas of research are not properly explored in farm environments (van Wettere et al., 2020). What effect shade has on fertility appears to be completely unexplored, so too are the possible interactions between shade and the time of shearing.

The potential for genetic solutions

The largest gap in our genetic knowledge is the relationship between the production traits and thermal tolerance in sheep. Very few studies are available to inform the industry.

Technical difficulties in collecting the relevant information are the barrier. It would be cost prohibitive to expose the progeny of large genetic breeding programs to climate-controlled chambers, while it would be risky to insert temperature loggers into such sheep and expose them to the natural variability of weather, and hope for sufficient heat and cold stress conditions. Heritability estimates for body temperature are moderate to high (Rose and Pepper, 2001). Ewes with known higher body temperatures will have lower birthweight lambs (McCrab et al., 1993) and the genetic relationships with milk quality are unfavourable (Finocchiaro et al., 2005). A further complication for geneticists is that tolerance to heat results in susceptibility to cold. This is a conundrum for sheep reproduction, with cold exposure a looming risk to lamb mortality, although global warming may lower that risk in many environments and many years, but not all and not always.

Conclusions

Too little is known about the impact of heat stress on sheep reproduction. Too many gaps exist in our knowledge, and in the face of a rapidly changing climate, these gaps must be narrowed or closed. Strategic investment into heat stress is urgently required, but this requires sheep producers to demand such investment. Herein lies the challenge; modern research investment requires producer support. The pathway to adoption of newly discovered science takes about 30 years to complete. So, high quality scientific experimentation that leads to successful, predictable improvements in reproduction under heat stress conditions is urgently required. Solutions must be in the form of a technology or modification that aligns with the interests of sheep producers that are keen to engage in rapid adoption.

References


Genetic benchmarking in the Merino industry

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Take home messages

- Nutrition and management will affect Merino genetic performance.
- Benchmarking is vital to identify genetic merit and profit capacity.
- Merino benchmarking clearly identifies genetic traits that can be improved.
- High performing Merino genetics can have a significant effect on net profitability.
- Use of high performance Merino genetics matched with good management decisions provides for strong farming businesses.

Lucerne is a valuable pasture species in farming systems, particularly in the mixed-farming zone. Lucerne fixes nitrogen for the following cropping phase and provides a high quality feed for livestock

Craig Wilson and Associates is an independent genetic consultancy business, advising some of Australia’s largest and most influential sheep and wool growing businesses in New South Wales, Victoria and Western Australia. Approximately 70, 000 ewe hoggets are classed annually and over 600 rams are purchased annually. Since 2004, the business has played a key role in benchmarking Merino genetics, coordinating wether trials and Merino challenges. Trials have been run at Collingullie, Alectown, Taralga, Warren, Temora, Narrandera Harefield and Lockhart, NSW. Over 15, 000 merino wethers have been analysed and data is independently audited by NSW Department of Primary Industries and Sally Martin Consulting.

There are a number of ways to benchmark Merino genetics including:

- Traditional wether trials – Merino Bloodline Analysis.
- Sire Evaluation – across site comparison of rams
- Sheep Genetics Database – MERINOSELECT and LAMBPLAN – Australian Sheep Breeding Values (ASBVs)
- Peter Westblade Memorial Merino Challenge – Wool and Meat Components

Figure 1. Peter Westblade Memorial Merino Challenge wethers - Wool Challenge. Australia’s largest evaluation of commercial merino genetics.

Same sheep – different environment

Components

- Use of high performance Merino genetics matched with good management decisions provides for strong farming businesses.
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Figure 1. Peter Westblade Memorial Merino Challenge wethers - Wool Challenge. Australia’s largest evaluation of commercial merino genetics.
To highlight the effects of nutrition and management on raw production figures, two teams of 30 wethers were selected from the one drop of wethers and run in two different environments (Table 1). This data clearly highlights that production information can be greatly affected by stocking rate, nutrition and management.

**Table 1. Comparison between the same sheep at different locations on traits of profitability.**

<table>
<thead>
<tr>
<th>Trait</th>
<th>Taralga – NSW 5 DSE Ha</th>
<th>Warren – NSW 5 DSE Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greasy Fleece Weight</td>
<td>4.6</td>
<td>6.0</td>
</tr>
<tr>
<td>Yield</td>
<td>71%</td>
<td>65%</td>
</tr>
<tr>
<td>Clean Kg</td>
<td>3.26</td>
<td>3.90</td>
</tr>
<tr>
<td>Fibre Diameter</td>
<td>16.8</td>
<td>18.2</td>
</tr>
<tr>
<td>Body Weight</td>
<td>41.7 kg</td>
<td>56.8 kg</td>
</tr>
</tbody>
</table>

**Peter Westblade Memorial Merino Challenge**

The Merino Challenge measures both wool and meat values over the duration of each trial. It provides a platform to benchmark and evaluate the relative performance and variation of a range of genetic traits in Merino sheep under a constant managed environment. The aim of the challenge is to show the benefits in making well informed decisions based on Merino genetics and quality unbiased information. It also provides a forum for progressive Merino breeders to share and compare.

**Figure 2. Peter Westblade Memorial Merino Challenge - Wool Challenge (left) and Meat Challenge (right).**

The Wool Challenge is run on pasture under strictly commercial conditions for two years and all traits are measured. The Meat Challenge measures all traits under feedlot conditions, and lambs are processed and full carcase traits calculated. Reports can be accessed at www.craigwilsonandassociates.com.au

**Figure 3. Peter Westblade Memorial Merino Challenge; all teams 2004 to 2020 – Wool and Meat Value $ Deviations from Trial Average.**

**Figure 3 highlights the range that exists between teams of wethers for wool and meat traits. The dot points represent the deviations in the second year of the trial. In the top right quadrant, the teams that are plotted have measured high meat and high wool values. In the bottom right quadrant, the teams that are plotted have measured both low wool and low meat values. In the top left quadrant, the teams that are plotted have measured low wool and high meat values. In the bottom left quadrant, the teams that are plotted have measured both high wool and low meat values.**

**Table 2. Peter Westblade Memorial Merino Challenge 2010-2020, team comparison raw data.**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Age at Shearing</td>
<td>1.5 Yr</td>
<td>2.5 yr</td>
<td>1.5 Yr</td>
<td>2.5 yr</td>
<td>1.5 Yr</td>
<td>2.5 yr</td>
<td>1.5 Yr</td>
<td>2.5 yr</td>
<td>1.5 Yr</td>
<td>2.5 yr</td>
<td>1.5 Yr</td>
</tr>
<tr>
<td>Months of Wool</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>12</td>
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<tr>
<td>Average Fiber Diameter</td>
<td>18.4</td>
<td>18.7</td>
<td>16.7</td>
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<td>16.3</td>
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<td>19.6</td>
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<td>20.5</td>
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<td>18.9</td>
<td>18.8</td>
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<td>19.3</td>
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<tr>
<td>Average Clean Wool Weight</td>
<td>3.4</td>
<td>3.4</td>
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<td>0.5</td>
<td>0.3</td>
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</tr>
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</table>
Figure 4 shows that regardless of season, location and market Team A (blue line) consistently performs at a higher level than Team B (orange line). This highlights how decisions based on selecting reputable genetics are a great risk management tool. The range shown between Team A and Team B can equate to a significant difference on the return on investment year in and year out.

Table 3 below shows the difference in the combined fleece and meat value for an enterprise, for 5000 animals with a ratio of 1:1 (i.e. 1 fleece sale to 1 sheep sale), and for a ratio of 5:1 (i.e. 5 fleece sales to 1 sheep sale). At a ratio of 1:1, the difference in income is 11%, but when the ratio is increased to 5:1, the difference in income increases to 24%, which equates to $371,594.59 for a five year period.

Table 3. Peter Westblade Memorial Merino Challenge 2010-2020, team comparison gross income per head.
Depending on the time of joining and duration of feeding, ewes may be in containment during joining and/or pregnancy. These are critical periods for influencing pregnancy rates, and preparing ewes for successful lambing. The industry perception is that reproductive rates after containment are generally ‘good’, but attention to management is needed to avoid known pitfalls. Pregnancy rates of less than 50 percent to over 95% have been reported after containment feeding, but the cause of poor results often is not known. Possible factors known to occur include disease, poor ram performance, poor ewe condition score, feed issues, and unintended access to toxic substances.

Twinning rates also vary widely as they do in grazing ewes, but it is not clear what management in containment areas produces optimal reproductive performance. The aim of this study is to update the guidelines for producers based on scientific evidence, and evaluate where further information is needed.

Developing updated guidelines

The scientific literature was reviewed to determine any impact of practices on reproduction. Current practices, and priorities for further research, extension messages and adoption activities were developed from a forum with producers and consultants experienced in containment management. Acidosis (grain poisoning) and pregnancy toxaemia are probably the most common health risks, which can lead to large losses, but the risk can be managed.

Key issues for future research and adoption

The optimum feeding strategies, mob size, and impact of shade were priority topics where further research is needed. Shy feeders are a common problem, but what practices increase the level of shy feeders also is not clear.

The priority topics that producers can adopt now to improve ewe reproduction and health are; ram and joining management, introduction to feed (rams and ewes), monitoring of ewes to ensure feed is adequate, management of shy feeders, and managing removal from containment.

Key guidelines for containment management of ewes

Detailed guidelines will be published on the MLA website at the end of the project. In brief, the key points to consider are:

- Optimal mob size, space allowance and design is unknown. Ensure adequate shade, water and access to feed, and safety. Provide a minimum 1.4 square meters per ewe for heavy sheep, and 1.8m²/ewe for those with lambs, to meet welfare requirements.
- Minimise potential health issues by vaccinating for pulpy kidney and other clostridial diseases. Monitor faecal egg counts and drench if needed, and add 1.5% limestone to grain or cereals. Seek veterinary advice if needed.
- Sheep should be slowly introduced to grain to prevent acidosis. A minimum 10% roughage is needed.
- Monitor ewes regularly to make sure feed is adequate, and remove shy feeders to maintain health.
- Feeding at less than daily intervals, and feeding straw rather than hay as roughage, reduces the level of shy feeders.
- The risk of low lamb marking rates can be reduced by maintaining ewes and rams in an adequate condition score (minimum 2). Better results may be obtained when sheep have a higher condition score.
- Manage rams for two months prior to joining to increase fertility. Increase nutrition to increase sperm production, target condition score 3 at joining, allow adequate exercise and prevent health issues.

- Use a ram percentages of 1% for adult ewes and 2% for maidens, but if joining’s are short or other risk factors such as lower condition or heat stress are present, more rams may improve results.

Further research is needed to identify the best feeding practices for breeding ewes in containment. Updated guidelines will be made available when possible.

Producer survey

A national survey is also being conducted to examine the variation in ewe reproduction after containment or supplementary feeding. The survey results will help identify what practices tend to result in better lamb marking rates, and what to avoid, so the guidelines can be updated for the benefit of all producers. The results will also identify any further research needs. To obtain accurate data, it is important the project team receives as many responses as possible, including good, average and poor lambing results. The survey is anonymous, and it would be greatly appreciate if you are able to complete the survey. The survey and further information can be found at: https://www.research.net/r/Containment_feeding

Acknowledgements

The project team gratefully acknowledge the support of Meat & Livestock Australia.
Sheep Sustainability Framework

Professor Bruce Allworth 1,2
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2Graham Centre for Agricultural Innovation, an alliance between Charles Sturt University and the NSW Department of Primary Industries, Wagga Wagga, NSW
T: 0427 369 233 E: ballworth@csu.edu.au

Take home messages
- The Sheep Sustainability Framework (SSF) is led by Sheep Producers Australia and Wool Producers Australia, with Australian Wool Innovation and Meat and Livestock Australia providing funding together with strategic and secretariat support.
- The Steering Group comprises nine people from across the Australian sheep industry supply chain.

Agriculture is increasingly needing to respond to consumer perceptions and a changing physical and social environment. Having reliable and credible information on how an industry is performing builds trust with customers and assists industry to identify areas for improvement.

Sustainability frameworks exist or are being developed to provide information on high priority areas within an industry. The Dairy Sustainability Framework (https://www.sustainabledairyoz.com.au/) and the Beef sustainability Framework (https://www.sustainableaustralianbeef.com.au/) already exist.

In July 2017, the Red Meat Advisory Council (RMAC) made a public commitment to a sheep framework on behalf of industry. Since then, through industry leadership from Sheep Producers Australia and Wool Producers Australia, the Sheep Sustainability Framework (SSF) has been initiated to demonstrate sustainable practices, identify areas of improvement, and better communicate these with customers and assists industry to identify areas for improvement.

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In July 2017, the Red Meat Advisory Council (RMAC) made a public commitment to a sheep framework on behalf of industry. Since then, through industry leadership from Sheep Producers Australia and Wool Producers Australia, the Sheep Sustainability Framework (SSF) has been initiated to demonstrate sustainable practices, identify areas of improvement, and better communicate these with customers and consumers. Demonstrating sustainable production of sheep meat and wool is critical to secure access to local and global markets. Our customers must be confident the food and fibre they purchase has been produced responsibly. The SSF will enable industry to share its story about sustainable food and fibre. Further, the SSF supports the priorities of the RMAC Meat Industry Strategic Plan 2030.

The SSF structure will provide evidence of industry status in sustainably produced Australian sheep meat and wool through:
- Identification of priority areas for reporting
- Identification of the appropriate indicators
- Gathering and reporting of the indicator data

The SSF will:
- Identify opportunities, challenges and impacts for sheep production
- Inform industry investment for improvement in priority areas
- Help protect and grow access to investment and finance by providing evidence of performance and improvement
- Foster constructive relationships with stakeholders to work collaboratively
- Promote the sheep industry to the community and customers

The SSF will not:
- Require any specific input from individual producers
- Impose any additional reporting costs or reporting requirements on producers
- Attempt to move the sheep industry in a particular direction

The steering group comprises nine members from across the value chain and regions across Australia:
- Prof Bruce Allworth (Chair) - Director, Fred Morley Centre, Charles Sturt University, New South Wales
- Will Barton - CEO, Gundagai Meat Processors, NSW
- Dr Will Bignell - Producer, Thorpe Farm, Tasmania
- Andrew Blanch - Managing Director, New England Wool, NSW
- Michael Field - Producer, Jugiong, NSW
- Johnny Gardner - Producer, Cavendish, Victoria
- Deanna Lush - Managing Director, Ag Communicators, South Australia
- Emily Stretch - Producer, Kojonup, Western Australia
- Mark Wotton - Producer, Manager and Principal of Jigsaw Farms, Victoria

The steering group is coordinating the consultation with industry and external stakeholders in three phases:

Consultation I – meetings with key industry stakeholders, including SFOs to obtain initial feedback on a discussion paper containing the draft SSF elements. This was completed in early April 2020, and resulted in the first draft of the framework.

Consultation II – web based interactive workshops with industry and external stakeholders gave feedback on the first draft. This was completed in early June, and a second draft is currently being prepared.

Consultation III – all interested entities will comment on the second draft via an online feedback survey. A wider call will go out via media to make this a more public consultation and feedback will be invited on each element of the SSF. Stakeholders will be invited to make individual submissions.

The feedback from each consultation informs the following draft of the SSF until the final framework is achieved. The steering group will then finalise the SSF and seek approval from the SSF Board, with the final report due for release in September 2020. Figure 1 shows the timeline for industry consultation.
Figure 1. Timeline for industry consultation.

<table>
<thead>
<tr>
<th>Activity/ Month</th>
<th>Who?</th>
<th>Mar/ Apr</th>
<th>H2 Apr</th>
<th>H1 May</th>
<th>H2 May</th>
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<tr>
<td>Consultation I</td>
<td>SFOs, PICs, RDCs</td>
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<td>Consultation II</td>
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<td>Consultation III</td>
<td>SFOs, Stakeholders</td>
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</table>

The framework and producers

The SSF takes an industry-wide perspective and does not have any direct implications for producers. However, it may highlight areas where on-farm practices can be improved. At an individual business level, the SSF does not require any direct input as businesses already provide a wide range of information to government and other agencies.

The SSF will be used by industry to guide and track aggregate performance on-farm to ensure Australia continues to be recognised as a global leader in sustainable sheep production. It is planned to include the whole production chain over time.

The framework will support individual businesses by providing the proof behind Australia’s reputation as one of the global leaders in sustainable sheep production. This will assist in maintaining market access for our products. The framework will not:

- Establish or endorse measurement systems at an individual business level
- Provide an accreditation or certification system
- Endorse prescriptive management practices
- Create paperwork for individual businesses; existing data is used where available.

How to be involved

For the SSF to achieve its objectives, we need all stakeholders to engage in its development. We welcome your organisation’s input during the next two consultation phases, so please make sure you attend and are involved.
Livestock as key drivers of soil carbon sequestration in the rangelands

Susan Orgill1,2 and Dean Revell3
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2 Graham Centre for Agricultural Innovation, an alliance between Charles Sturt University and NSW Department of Primary Industries, Wagga Wagga, NSW
3 Select Carbon Pty Ltd, U3 38 Rowland Street, Subiaco WA 6008
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Take home messages

• There are land management practices to increase soil carbon sequestration in the rangelands including:
  - Controlling total grazing pressure to enable rest and promote cover
  - Rangelands Self Herding (Revell and Maynard, 2017) or infrastructure-based practices (fencing or water points) that can be used depending on the circumstances to either retain animals in certain locations or redistribute animals to better utilise underused areas
  - Achieving landscape rehydration through water ponding, water spreading, check-banks and pitting
  - Managing vegetation composition through grazing and water management, and through strategic plantings, seed spreading and multi-species plantings.
• Practice change must be synergistic with production goals and producer values.
• Identifying and targeting practice change in soil carbon ‘responsive zones’ is the key. This can be achieved using a range of remotely sensed and on-ground soil, vegetation and landscape measures (Wang et al., 2018).
• Livestock, managed well, are essential ‘tools’ to repair degraded landscapes. Their hoof impact can create small-scale ‘pits’ that can collect water, seeds and nutrients, while their manure can redistribute seeds and nutrients and stimulate soil microbial activity. Livestock grazing patterns can influence vegetation composition.
• Identifying degraded soils (e.g. scalded or eroded areas) and changing practices or land use can both increase the productive potential of these landscapes, and increase soil carbon sequestration.
• Small changes in soil carbon sequestration at landscape scales has big impacts. Soil carbon sequestration rates of up to 1.5 tonnes of soil carbon per hectare per year can be achieved in ‘responsive zones’ in rangeland environments (Orgill et al., 2016 and 2017 and Waters et al., 2016).

A large portion of the rangelands of Australia consist primarily of privately managed grazing enterprises on rainfall-dependent native grass and shrublands. The region contributes over $2 billion annually to the economy. But high total grazing pressure (TGP), a lack of rotation or movement of animals to adaptively respond to variable circumstances, and ongoing droughts have collectively led to widespread soil degradation, loss of perennial grasses and increasingly poor landscape function. As a consequence, the rangelands are often cited as ‘leaky systems’ due to the loss of soil carbon via wind erosion (Chappell et al., 2019) and impaired or absent plant regeneration.

Improving landscape literacy, and managing the intensity and duration of livestock grazing and the flow of water across the landscape, offer the opportunity to improve soil condition, groundcover and soil carbon stocks, whilst also boosting livestock productivity in the rangelands.

Research and development is blending science, education and a range of best management grazing practices to increase agricultural productivity and diversify farm income through access to ecosystem service markets, including soil carbon. This will enable producers to be prepared and resilient in a future of increased climate variability and changing consumer demands, and an opportunity to access new markets.

The photos below provide examples of land management practices that are being implemented to increase soil carbon sequestration in the rangelands.

Figure 1. Example of total grazing pressure fencing to control livestock grazing and promote pasture rest and regeneration.

Figure 2. Engineering solutions are being used to influence water, nutrient and seed movement across the landscape and promote groundcover revegetation.
Figure 3. Example map of soil organic carbon stock (t SOC/ha 0 to 30 cm) for Western NSW property based on Gray (2018).

Figure 4. An example of using Rangeland Self Herding to redistribute cattle (L-R before-after). GPS tracked cattle, with brighter colours (green and yellow) indicating higher use, (Revell, 2019).

References


Annual Land & Stock Return

Your Annual Land and Stock Return information helps us protect NSW against pests, diseases and environmental threats.

Each year, NSW landholders who are liable to pay Local Land Services rates or have a Property Identification Code (PIC) are required to complete this ‘farm census’ of land use and livestock numbers. This information is vital in helping us respond quickly and accurately in emergencies and biosecurity events.

Even though your 2020 rates notice was covered under the NSW Government’s drought relief package, it’s still important you still lodge your return to help us, help you in your greatest time of need.

It is a requirement for all landholdings that carry livestock six months or older to record these numbers as at 30 June each year. All livestock must be recorded on your return regardless of whether they belong to the occupier, are agisted on your land, they are kept as pets or are on the property under another arrangement. Please note that pigs of any age must be counted, as well as flocks of 100 or more poultry.

There have been some delays in the postal delivery of the Annual Land and Stock Returns this year, but paperwork will land in mailboxes across the state shortly with details on how you can lodge quickly and easily online.

You can stay connected with the status of this year’s Annual Land and Stock Returns through our website www.lls.nsw.gov.au or through our social media channels.
**Beef**

The effects of feeding a high energy ration on the live animal performance and meat quality of cull beef cows.

Jake Bourlet², Christine Harris², Jessie Phillips¹, David Falepau², Gaye Krebs¹,³, Michael Campbell¹,³

¹School of Animal and Veterinary Science, Charles Sturt University, Wagga Wagga, NSW
²School of Agriculture and Wine Science, Charles Sturt University, Wagga Wagga, NSW
³Graham Centre for Agricultural Innovation, an alliance between Charles Sturt University and the NSW Department of Primary Industries, Wagga Wagga, NSW

**Take home messages**

- A higher meat quality outcome is possible for older cows after a period on feed.
- There is potential to develop a high quality product from cull female animals over five years of age.
- Economics of feeding cull cows will vary depending on input costs and carcase prices.

In recent years the Australian beef industry has undergone a reduction in herd numbers, while also experiencing an increase in global demand for our product. With a reduction in herd numbers and predicted lower slaughter rates, industry must extract as much value from every carcase processed, including older females. There has been a shift in the beef industry to producing more branded, premium quality products, which can extract further value from animals that have high eating quality attributes.

With this in mind, it is important that producers understand how to better manage cows that have been culled from a breeding herd to result in better meat quality outcomes. The cow market is unique in the way it is priced, with an increase in price per kilogram as carcase weight increases; this is the opposite of young cattle. Re-conditioning cows through feeding of an energy dense ratio prior to slaughter has been shown to significantly increase liveweight and thus improve not only carcase composition, but also meat quality characteristics (Boleman et al., 1996, Cranwell et al., 1996, Sawyer et al., 2004). But many of the studies have been conducted using growth promotants to increase the lean component of the cow carcases to target the grinding beef market.

A new cipher has recently been created in Australia called the Eating Quality Grade (EQG) (AusMeat Limited, 2017). The EQG allows for a shift away from using traditional carcase descriptors such as dentition and meat colour, to purely focus on eating quality. There is now a potential avenue for primals from aged cull cows to be sold under the EQG cipher (MLA, 2018) and extract more value from the carcase.

**What we did**

This project was approved by the Charles Sturt University’s Animal Care and Ethics Committee (Protocol number A19038).

A mob of 77 Angus/Angus cross cull cows of similar age (6-7 years old) in poor body condition (BCS of 1.5-2) were sourced from a commercial beef property at Coolac, New South Wales. These cows were culled due to age, not diagnosed pregnant and the on-going drought conditions.

The cows were randomly allocated to one of four experimental groups, 0, 28, 42 and 56 days on feed (DOF). The control group (0 d on feed, n = 20) were immediately transported for slaughter at the Teys Australia™ abattoirs at Wagga Wagga, NSW. The remaining three groups of cattle (n=57) (28, 42 and 56 d on feed) were randomly allocated to the Charles Sturt cattle feeding pens (four pens per treatment group).

All experimental groups (28, 42 and 56 d on feed) were provided with the same ration. The feedlot ration was formulated to contain approximately 15 percent crude protein (CP), 40% neutral detergent fibre (NDF) and a minimum of 10.5 megajoules of metabolisable energy (ME)/kg DM (Table 1).

**Table 1. Ration Formulation and Nutritive analysis of ingredients used in the feedlot ration.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Wheaten straw</th>
<th>Barley hay</th>
<th>Pellet 1</th>
<th>Pellet 2</th>
<th>Canola meal</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ration formulation (%DM)</td>
<td>12.3</td>
<td>11.9</td>
<td>70.8</td>
<td>5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Dry matter (%)</td>
<td>89.4</td>
<td>86.4</td>
<td>91.9</td>
<td>92.3</td>
<td>90.6</td>
<td>90.9</td>
</tr>
<tr>
<td>Metabolisable energy (MJ/kg DM)</td>
<td>5.2</td>
<td>11.5</td>
<td>11.5</td>
<td>10.9</td>
<td>11.7</td>
<td>10.5</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>3.9</td>
<td>10.1</td>
<td>16.1</td>
<td>17</td>
<td>41.8</td>
<td>15</td>
</tr>
<tr>
<td>Neutral detergent fibre (%)</td>
<td>78</td>
<td>42</td>
<td>34</td>
<td>39</td>
<td>26</td>
<td>40</td>
</tr>
</tbody>
</table>
The amount of feed offered to cattle was recorded daily and cattle were weighed weekly and feed refusals collected at the same time.

At slaughter all cattle were tracked through the slaughter floor and boning room, and meat samples collected for consumer sensory evaluation and laboratory analysis. A full Meat Standards Australia carcase evaluation was conducted on each animal.

**Results**

As was expected liveweight, carcase weight and quality increased with an increased time on feed (Tables 2 and 3). The number of carcases that met the required standards to be given an MSA index increased to 84% after 56 days on feed compared with only 11% after 28 days on feed.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Days on feed</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot standard carcase weight (kg)</td>
<td>207.95 ± 19.65a</td>
<td>264.00 ± 17.68b</td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>43.7 (±2.5)a</td>
<td>44.8 (±2.4)ab</td>
</tr>
<tr>
<td>Eye muscle area (cm²)</td>
<td>56 (±12)a</td>
<td>67 (±11.9)ab</td>
</tr>
<tr>
<td>Fat colour</td>
<td>5.75 ± 1.45a</td>
<td>4.68 ± 1.77ab</td>
</tr>
<tr>
<td>Meat colour</td>
<td>5.30 ± 0.57a</td>
<td>4.74 ± 0.93a</td>
</tr>
<tr>
<td>P8 fat depth (mm)</td>
<td>1.65 ± 1.35a</td>
<td>8.58 ± 3.27b</td>
</tr>
</tbody>
</table>

Values within rows with varying superscripts differ significantly (p < 0.05).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Days on feed</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSA graded (% of total carcases)</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>MSA Index - 47.69 ± 0.64</td>
<td>52.31 ± 3.33</td>
<td>52.05 ± 3.67</td>
</tr>
<tr>
<td>MSA marbling score - 171.50 ± 51.22a</td>
<td>318.42 ± 63.18b</td>
<td>355.26 ± 42.61bc</td>
</tr>
<tr>
<td>AUS-Meat marbling score - 0.00a</td>
<td>0.84 ± 0.69b</td>
<td>1.21 ± 0.54bc</td>
</tr>
<tr>
<td>Ossification - 590(±0)a</td>
<td>408(±149.9)b</td>
<td>411(±120.2)b</td>
</tr>
<tr>
<td>Ultimate pH - 6.02(±0.3)a</td>
<td>5.74(±0.1)b</td>
<td>5.65(±0.1)b</td>
</tr>
<tr>
<td>Rib fat (mm) - 0.5(±0.3)a</td>
<td>2.5(±0.1)b</td>
<td>4.1(±0.1)c</td>
</tr>
<tr>
<td>Intramuscular Fat (%) - 4.3 (± 1.65)</td>
<td>9.8 (± 2.85)</td>
<td>12.4 (± 2.16)</td>
</tr>
</tbody>
</table>

Values within rows with varying superscripts differ significantly (p < 0.05).
The efficiency of gain decreased as the cows remained on feed from day 42 to day 56 (Table 4), with the feed conversion ratio increasing from 4.84 (± 0.17) to 6.55 (± 0.59). A significant difference in carcase weight was observed between 42 DOF and 56 DOF (282kg vs 303kg), but no significant difference was noted in liveweight (624.4kg vs 631.7kg).

Table 4. The effects of time on feed on average (± SD) daily feed intake, average daily liveweight (LW) gain and feed conversion ratio of cull cows fed a high energy ration.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>0 (n=20)</th>
<th>28 (n=19)</th>
<th>42 (n=19)</th>
<th>56 (n=19)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily feed intake (kg DM/hd/d)</td>
<td>-</td>
<td>16.20 ± 1.57a</td>
<td>17.21 ± 2.94ab</td>
<td>18.20 ± 2.34b</td>
<td>0.028</td>
</tr>
<tr>
<td>Initial liveweight (kg)</td>
<td>474.1 ± 41.18</td>
<td>476.8 ± 37.39</td>
<td>473.0 ± 34.91</td>
<td>474.1 ± 45.49</td>
<td>0.992</td>
</tr>
<tr>
<td>Final liveweight (kg)</td>
<td>474.1 ± 41.18a</td>
<td>583.3 ± 30.75b</td>
<td>624.4 ± 42.76c</td>
<td>631.7 ± 53.8c</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Average daily LW gain (kg/hd/d)</td>
<td>-</td>
<td>3.92 ± 3.10a</td>
<td>3.70 ± 2.79a</td>
<td>2.81 ± 2.75b</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Feed conversion ratio</td>
<td>-</td>
<td>4.24 ± 0.16a</td>
<td>4.84 ± 0.17a</td>
<td>6.55 ± 0.59b</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Values within rows with varying superscripts differ significantly (p < 0.05).

Fat depth increased with DOF at both the P8 and Rib sites, with rib fat increasing above the minimum 3 millimetres required for MSA grading at 42 DOF. Intramuscular fat increased with time on feed, and it will be interesting to evaluate the results of the consumer sensory evaluation against this measurement once completed. Fat and meat colour both improved from zero DOF to 42 DOF (Figures 2 and 3).

In terms of economics, it appears that much of the potential margin is accrued in the first 28 DOF (Table 5). If the market is only paying a base price for the product then marginal returns decrease after 28 DOF. If the market is able to pay a premium for quality, say 50cents/kg cwt for MSA graded carcasses, then feeding for 42 and 56 days might be profitable. Table 5 also shows how the carcasses in this trial could be valued on a commercial grid that differentiates on basic quality measures for cow beef (i.e. carcase weight, fat depth, fat and meat colour). If taken to the next step and an MSA premium over the top of a differential carcass grid is applied, it can be seen there is potential to increase margin over feed costs trough to 56 DOF. It is important to note that margin over feed costs does not include labour, interest costs, or other variable costs that need to be considered when making a decision about feeding cows.
Table 5. Economic analysis of time on feed and marginal returns.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Days on feed</th>
<th>0 (n=20)</th>
<th>28 (n=19)</th>
<th>42 (n=19)</th>
<th>56 (n=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Cost ($/head)</td>
<td>$350 / tonne</td>
<td>-</td>
<td>158.76</td>
<td>252.98</td>
<td>356.72</td>
</tr>
<tr>
<td></td>
<td>$400 / tonne</td>
<td>181.44</td>
<td>289.13</td>
<td>407.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$450 / tonne</td>
<td>204.12</td>
<td>325.27</td>
<td>458.64</td>
<td></td>
</tr>
<tr>
<td>Margin over Feed Cost ($/head) @ feed price of $400/tonne</td>
<td>-</td>
<td>42.76</td>
<td>7.07</td>
<td>-27.48</td>
<td></td>
</tr>
<tr>
<td>Base Price - $4/kg carcase weight</td>
<td>-</td>
<td>57.28</td>
<td>95.90</td>
<td>99.78</td>
<td></td>
</tr>
<tr>
<td>Actual Grid1</td>
<td>-</td>
<td>156.66</td>
<td>146.05</td>
<td>125.21</td>
<td></td>
</tr>
<tr>
<td>Actual Grid + 50cent MSA premium</td>
<td>-</td>
<td>171.18</td>
<td>240.21</td>
<td>252.47</td>
<td></td>
</tr>
</tbody>
</table>

1 Actual Grid price is taken from a publicly available price grid that differentiates cow carcases on quality but does not include a premium for MSA.

What does this all mean?

There is potential to increase the quality grade of carcases from aged cows by putting them on feed for a period of time before slaughter. The profitability will be determined by feed price and the ability of the market to pay a premium for the higher quality beef. Feed efficiency in this trial decreased from 42 DOF to 56 DOF and this needs to be considered when making feeding decisions.

Future work should consider the use of supplements at pasture for culled cows to reduce the cost of forage in the diet.

References


Acknowledgements

This project was funded by Meat and Livestock Australia through the Meat Standards Australia program. The project team also thank the collaborators for the use of their animals and Riverina Oils and Oilseeds Australia for supplying the canola meal and pellets.
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GPS collars, pasture biomass estimates and digital agriculture – an introduction to Charles Sturt University precision livestock activities

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Take home messages

• Digital agriculture presents an opportunity to substantially refine the collection, management and analysis of information both on- and off-farm, to greatly improve Australia’s livestock industries.

• Charles Sturt has commenced a significant program of digital agriculture activities to investigate and demonstrate their potential.

The National Farmers Federation report ‘2030 Roadmap - Australian Agriculture’s Plan for a $100 Billion Industry’ outlines the ambition to significantly grow the value of Australia’s agricultural industries over the next decade. Central to this plan is the expected contribution that a diverse range of recent and emerging digital technologies can achieve through the improved ability to collect, manage, integrate and analyse on-farm and off-farm information to improve management decision making processes and outcomes.

Contributing to the investigation and demonstration of digital agriculture technologies Charles Sturt has refined its activities in this area with the commencement of an integrated system of data collection, management and analysis across all aspects of the Charles Sturt farm operation, (e.g. crops, pastures, livestock, environment, resources, finance) to facilitate improved management. Starting with the development of a comprehensive Geographic Information System (GIS) to map the farm resources, the program will then move to the establishment of a data collection network as part of specific research projects investigating crop and pasture agronomy, precision livestock management and a diversity of other horticulture, viticulture, environmental and resource utilisation applications. Building on the functionality of an advanced digital farm record keeping system and data network the project has implications for Charles Sturt research, teaching and community/industry engagement.

Specifically within the livestock production systems, projects have commenced to investigate the use of livestock tracking technology through the fitting of 20 Moonitor GPS collars to some of the Charles Sturt Angus cows (Figure 1). These units are able to monitor the activity of each animal recording whether the animal is grazing, walking or resting every four seconds and its location every five with an internal GPS. Data is automatically uploaded via a satellite link each evening. A further 400 units are hoped to be fitted later this year, greatly expanding the ability to research how detailed knowledge of individual animal activities can improve their management.

In parallel with the animal based projects, field work using remote sensing and other technologies to assess pasture biomass has commenced. With a number of commercial pasture assessment services now being available in this region, understanding the strengths and weaknesses of these technologies and how they influence pasture agronomy and grazing management will be critical to ensure its appropriate adoption.

Highlighting the multi-disciplinary approach that is required to successfully integrate the range of technologies, data and agricultural knowledge we have also commenced an IT project to develop a customised database to manage the GPS Collar data, processing and automating the large volumes of raw data for use by researchers and automated export to farm management decision support tools.

Key issues for future research and adoption

Central to the program of activities commencing at Charles Sturt is the need to integrate the diverse range of data being collected for use in decision support systems. While there are currently many examples of farms and research facilities collecting data from extensive sensor networks, much of the collected information remains isolated from the other data being collected.

The mixed farming activities at Charles Sturt present an opportunity to investigate and demonstrate the integration of information collected by a comprehensive range of technologies across both the livestock and cropping value chains.

Figure 1. Moonitor GPS collars have been fitted to Charles Sturt Angus cows to monitor the animals activity.
Strategies to utilise non-replacement male dairy calves for beef production

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Take home messages
• Non-replacement male dairy calf production can be profitable by implementing viable management strategies on-farm.
• Developing an integrated beef supply chain and accessing profitable markets for non-replacement calves has the potential to increase returns for producers in Australia.
• Dairy bred beef may meet growing consumer demand for greater animal welfare produced products.

There is a paucity of knowledge concerning practices and management strategies, when considering current growth pathways and available markets for non-replacement calves in the Australian dairy industry. The term ‘bobby calf’ is widely accepted in Australia for a male calf that is unaccompanied by its dam under six weeks old and also is most commonly slaughtered at less than 10 days of age from a dairy herd (Moran, 2002). Unlike beef calves that are reared by their dams, dairy farmers must attempt to artificially rear calves in an economically viable manner. Producers can be faced with many challenges as bobby calves are sensitive to the conditions they are exposed to, due to their size and age (Moran, 2002). Other deterrents to rearing bobby calves can reside in the lack of saleable markets and unestablished rearing facilities to enable pathways of growth for bobby calves to enter the Australian beef market (Stafford et al., 2001).

Australia is in the minority of developed countries around the world that still perceive the practice of slaughtering male dairy calves as more profitable than rearing them for meat production (Cave et al., 2005, Ashfield et al., 2014). There is an absence of recently published figures that suggest the total amount of dairy bred calves produced yearly, but it is estimated that 400,000 non-replacement calves are processed each year in Australian abattoirs (Dairy Australia Ltd, 2017). The need to identify rearing strategies and potential supply chain markets is of importance to manage and assist good welfare of non-replacement dairy calves. The aim of this study is to identify industry practices as bobby calves are sensitive to the conditions they are exposed to, due to their size and age.

Current Australian dairy owners and managers of 18 years of age and older, were recruited to comprehensively explore past, present and emerging practices associated with rearing non-replacement male calves in dairy systems. This recorded a timeline of practice change and assessed concurrent attitudes producers express toward the treatment and welfare of non-replacement calves. It was of utmost importance to interview owners and managers of dairy enterprises as they had the ability to implement changes within each production system. Identification of supply chains for male calves have been accounted for through each participant’s personal experience regarding the saleability of past male calves and expected future markets. To address the scope of the research question, a saturation sampling technique was used in this study (Tweed and Charmaz, 2006). The audio recordings from each interview were transcribed verbatim by the author. Analysis for this study is yet to be completed, but thematic analysis described by Braun and Clarke (2006) will be used to analyse interview data and assist in formulating themes. Strategies to utilise and rear bobby calves will be identified as well as current supply chains that are utilised in Australia. This study intends to provide feedback to dairy producers with identified strategies to assist management practices surrounding male calf production. This study is projected to be completed by December 2020.

How will the results assist producers?
Through the success stories of some producers the research aims to establish a platform that will give producers a better understanding of how to integrate successful production practices on dairy farms in order to rear male calves for beef production. It will provide viable strategies to assist management and develop profitable business structures surrounding male calf production.

Acknowledgements
Special thanks to the participating producers for providing their knowledge and personal experiences. This project is supported by the Australian Government Research Training Program.

References
Verifying the production system of origin for grass and grainfed beef

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Take home messages
• Long-term grainfed cattle can be successfully identified from other production systems.
• Raman spectroscopy has been identified as a potential tool for objective carcase measurement.

Verification of Australian beef production systems is based on audits and conditional on producers meeting processor-set specifications, which vary for individual grain and grassfed brands. Maintaining accountability within the beef supply chain is a major cost in the form of auditing, and an even greater potential cost if there is a failure in the audit process. There is a need for an objective method to verify production systems, which can be used to guarantee premium beef products.

Raman Spectroscopy (RS) has been identified as a potential tool for objective carcase measurement as it provides a chemical fingerprint of a sample. RS is a measurement of the vibration of molecules once high intensity light is directed at the sample, and provides a spectra that contains information about the chemical bonds making up the sample. This technology is suited for verifying production systems as it is rapid, nondestructive and available as a portable handheld device. Consequently, the aim of this study was to assess the viability of RS to accurately discriminate between production systems.

A total of 520 beef carcasses were sampled from four differing production systems (n = 130 from each), including cattle fed a grain-based diet in a feedlot for at least 100 days before processing and short-term grainfed cattle for a minimum of 70 days in a feedlot. Further samples were collected from grassfed cattle grazed on southern pastures from weaning to processing and cattle grazed on southern grass pastures and supplemented with pulse pellets. All production systems were verified through the supply chain as per current standards as well as direct confirmation with producers. At 24 hours post slaughter Raman spectra were collected using a Mira handheld device (Metrohm) in three positions on the subcutaneous fat at the point end brisket using a total measurement time of 15 seconds. Spectral analysis was conducted using principal component analysis (PCA) with the spectra averaged by carcase and preprocessed to remove signals not related to fat composition.

Results
Modelling demonstrates RS ability to split the feeding groups based solely on the collected spectra. As illustrated in Figure 1, long grainfed samples are separated from grass and grass supplemented samples. The short-term grain spectra are mixed between the long grain samples and grass and therefore cannot be clearly identified. Separation between the grassfed and grassfed supplemented is not clear within the first two principal components. Principal components are a collection of points used to model the data by identifying differences in the spectra. Using this technique, clearly shows the differences in some situations between the different production systems.

Figure 1. Scatter plot of spectral variation of Raman spectra collected from the subcutaneous fat from long grain, short grain, grass and grass supplemented beef cattle carcasses highlighting carcase classification based on feed type.

This research is intended to be used as a method of authenticating the claims for production of Australian beef products destined for international markets. The technology has been developed into a tool that will be used on carcasses when a satisfactory model and library can be established for Australian beef cattle. The technology is designed to be used in combination with current grading techniques. Developing this model based on a more comprehensive database, including various grain and grass feeding ratios, will help improve the development of the method as an accurate tool for identification of production systems.

Conclusion
Long-term grainfed cattle can be successfully identified from other production systems. Further investigation on the samples not being separated in the PCA will be beneficial to establish the cause of the lack of observed difference on this occasion. Supplementary research could lead to RS being adopted as a method for verifying beef from diverse production systems.

Acknowledgements
The authors thank NSW DPI and Meat and Livestock Australia for funding this research. Scholarship funding was provided by the Australian Meat Processing Corporation and the Graham Centre for Agricultural Innovation.
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Health and production effects of single vaccination against *Mannheimia haemolytica* in non-backgrounded feedlot cattle

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Take home messages

- Bovine Respiratory Disease (BRD) is a non-specific respiratory disease that costs the Australian beef feedlot industry an estimated AU$40 million per annum.
- Vaccination against some BRD pathogens prior to feedlot induction (on-farm or in a backgrounding period) has shown reduced incidence of BRD in feedlots. A single vaccination of cattle at feedlot induction with *Mannheimia haemolytica* vaccines may be an alternative method for attempting to reduce BRD where pre-feedlot vaccination is not practiced.
- In this trial, a single vaccination against *Mannheimia haemolytica* with Bovilis MH at feedlot entry increased ADG in non-backgrounded feedlot cattle.

Bovine Respiratory Disease (BRD) is a non-specific respiratory disease that costs the Australian beef feedlot industry an estimated AU$40 million per annum. BRD is caused by various bacterial and viral pathogens when a host’s immune system is compromised from stress or localised infection of the upper respiratory tract. Pathogens such as *Mannheimia haemolytica* that are commensal to the upper respiratory tract can then proliferate and are inhaled, leading to pneumonia.

Vaccination against some BRD pathogens prior to feedlot induction (on-farm or in a backgrounding period) has been associated with reduced incidence of BRD during their subsequent time in the feedlot. Single vaccination of cattle at feedlot induction with *Mannheimia haemolytica* vaccines is an alternative method for attempting to reduce BRD where pre-feedlot vaccination is not practiced. However, there is currently little published control trial work to document if this practice leads to improved health and production outcomes.

**BRD trial**

A randomised double-blind control trial was conducted using 1571 cattle of mixed sex, breed, origin, age and feedlot entry weight at a commercial feedlot in South-East Queensland. The cattle were randomly allocated to one of three treatment groups at induction:

- Group 1 (control)
- Group 2 (single vaccination with Bovilis MH*)
- Group 3 (single vaccination with Bovishield*).

All cattle additionally received an intranasal modified live Bovine Herpes Virus-1 (BHV-1) vaccine (Rhinoguard*) and a pour on fly control treatment (Arrest*). Cattle were fed a total mixed ration for 60 to 70 days.

The average daily gain (ADG) for cattle was calculated at the end of the feeding period and effect of single *Mannheimia haemolytica* vaccination was assessed using a mixed linear model with ADG as the outcome. Vaccination status, BDR status, sex and induction weight were used as fixed effects. Animal type (number of permanent incisors, tropical breed content and distance travelled to feedlot) was used as random effects to account for clustering of groups. A quantile-quantile plot was utilised to ensure the mixed model residuals were normally distributed.

**Does a single vaccination improve health and production in non-backgrounded cattle?**

Cattle treated with a single dose of Bovilis MH* vaccine had a higher ADG compared to the control group. Cattle treated with a single dose of Bovishield* had a higher ADG compared to control group, however it was not significant (Table 1). The overall incidence of clinical BRD during the trial was 1.65 percent (group 1 = 1.58%, group 2 = 1.41%, group 3 = 2.00%).

<table>
<thead>
<tr>
<th>Tx</th>
<th>Estimates</th>
<th>Confidence Interval</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovilis MH*</td>
<td>60g</td>
<td>10g-100g</td>
<td>0.009</td>
</tr>
<tr>
<td>Bovishield*</td>
<td>20g</td>
<td>-20g-70g</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Increased ADG in the absence of a high incidence of clinical BRD cases may have been due to a reduced number of subclinical BRD cases in vaccinated cattle. The low incidence of clinical BRD may have been due to routine administration of a modified live BHV-1 vaccine at feedlot induction. Modified live intranasal vaccine provides rapid immunity to BHV-1, a pathogen found to play a significant role in the proliferation of *Mannheimia haemolytica*.

In this trial, a single vaccination against *Mannheimia haemolytica* with Bovilis MH at feedlot entry increased ADG in non-backgrounded feedlot cattle.

**References**


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Take home messages

• Canola meal can be used as an approved PCAS supplement for grassfed beef cattle grazing low quality roughages.
• Supplementing canola meal can increase liveweight gain and dry matter intake on low quality roughages.
• The ideal inclusion rate to supplement canola meal to weaner calves is 1.0% - 1.5% of liveweight.

Managing variability in pasture quality and quantity is a challenge for beef producers supplying to certified grassfed beef programs. In southern Australia, pasture quality during the summer-autumn period is often below the maintenance requirements for livestock. Traditionally, many producers supplement livestock with grains or a grain-based pellets to enhance energy and protein supplies for ruminants grazing on low quality pastures (Lee et al., 1985, Leng, 1990).

But supplementing with grain or grain products is not approved for use if beef producers are supplying beef to grassfed programs, such as the Pasturefed Cattle Assurance System (PCAS). Protein supplements that are approved for use in the certified grassfed beef programs can be used to increase cattle growth rates of livestock on low quality pastures. Canola meal is one protein supplement that has become more available, cost competitive and is an approved PCAS supplement (PCAS, 2016). However, feeding standard guidelines have indicated the rate of supplementing canola meal can vary from 0.3 to 3 kilograms dry matter per head per day (Blackwood and Clayton, 2007, Mailer, 2004) for growing cattle.

Therefore, liveweight (LW) change and dry matter intake (DMI) for weaner calves supplemented with varying levels of canola meal when offered low quality canola hay ad libitum was investigated in this study.

Eighty four weaned Angus calves (5-6 months old; 161 ± 1.6 kg) were randomly assigned to 12 feeding pens (seven weaner calves per pen) for 70 days (d), including a 14 d adaption period. The weaner calves were offered one of four dietary treatments, being canola meal offered at 0.5%, 1.0%, 1.5% or 2.0% of LW (based on average pen LW) equivalent to 0.93, 1.88, 2.77 and 3.66 kg/h/d respectively. Calves received the canola meal (11.9 MJ/kg, 42.6% CP) supplement daily and canola hay (7.9 ME MJ/kg DM, 8.0% CP) ad libitum (Table 1).
Table 1. Average quality of the dietary treatments (varying levels of canola meal and *ad libitum* canola hay) offered (kg/h/d) to weaner calves.

<table>
<thead>
<tr>
<th>Quality of the dietary treatments offered</th>
<th>Dietary treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5% CM</td>
</tr>
<tr>
<td>CP (%)</td>
<td>14.6</td>
</tr>
<tr>
<td>ME (MJ/kg DM)</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Findings of the experiment showed supplementation of 1.0%, 1.5% and 2% inclusion levels of canola meal had a greater average daily liveweight gain (ADG > 0.04 kg/h/d, Figure 1) and total DMI consumed (DMI > 4.6 kg/h/d, Figure 2) compared to the 0.5% canola meal. Average daily liveweight gain and total DMI consumed for calves fed at 1.5% canola meal were higher (ADG 0.95 kg/h/d, DMI 5.97 kg/h/d) compared with all other dietary treatments (Figure 1). Supplementing canola meal up to 1.5% (LW) in the diet resulted in increased ADG and DMI, but when supplemented at the 2.0% inclusion level ADG (0.65 kg/h/d) and DMI consumed (5.43 kg/h/d) decreased.

**What do the results mean for producers?**

This study provides evidence of the optimum inclusion levels of canola meal for weaner calves fed low quality roughage. Overall, supplementing canola meal at an inclusion level between 1.0% and 1.5% appears to the most efficient inclusion rates, with an ADG of 0.86 and 0.95 kg/h/d and feed conversion ratio (FCR) of 6.40 and 6.28, respectively. However, further economic analysis is required before making management decisions.

**Conclusion**

Canola meal can be used as a supplement to:

- Increase growth rates on low quality pasture
- Allow producers to supply to grassfed beef programs
- Provide a viable option for producers to grow weaner calves during times of low quality pastures/roughages.

**References**


Take home messages

- There appears to be a shift in the preference to meat consumption by Australian consumers.
- Qualitative research is underway investigating the values and opinions livestock producers and vegans share, or oppose, about current animal welfare practices in Australia, and the possibility of collaboration to discuss the future of the Australian livestock industry.

The antagonism between vegans and livestock producers in Australia reached a peak in 2019, with vegans and animal rights activists participating in radical protests and trespassing on private property for the rights of animals (Murphy, 2019). Due to these events, 2019 was dubbed ‘The Year of the Vegan’ by The Economist Magazine (Parker, 2019). As Veganism continues to gain social licence and influence globally it is important to understand the differences and similarities in beliefs held by vegans and livestock producers as they can provide insight into consumer preference and prediction of future markets (Jacoby and Morrin, 2015).

Vegan culture challenges the views surrounding consumption of meat and the use of animal products (Meyer, 2019). Despite the Australian livestock industry being a major contributor to the economy, there appears to be a shift in the preference to meat consumption of Australian consumers. A Food Frontier report on meat consumption, showed that one in 10 Australians are reducing their meat intake. The report found that 57 percent of vegans are millennials, aged between 23 and 38 and that the baby boomers, aged between 56 and 76 are leading the reduction in meat consumption with 43% of meat reducers fitting in this age bracket (Brunton, 2019). It is for this crucial reason, the Australian livestock industry must not remain ignorant towards vegan culture as their entire livelihood rests on consumer preference and buying power (Buddle et al, 2018).

This qualitative research investigates the values and opinions livestock producers and vegans share, or oppose, about current animal welfare practices in Australia and the possibility of collaboration to discuss the future of the Australian livestock industry. Data will be collected via a survey which explores vegan and livestock producer attitudes, ethics and morals surrounding animal welfare.

References


Mixed species magic

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**Take home messages**

- Mixed species increase dry matter production, reduce inputs and risks.
- Mixed species increase diet variety and improve animal performance and animal health.

Annesley Pastoral Company is based in southern NSW near the town of Lockhart, roughly 70 kilometres south west of Wagga. The property covers 3250 hectares, comprised of mixed cropping (2500ha) and merino sheep (750ha) enterprises.

Brent’s progression into mixed species cropping and grazing has been an evolution that began from trying to combat annual ryegrass, but has since grown into an integral part of his farming operation, providing much more than just weed control.

The percentage of crop grown each year has expanded over the years, and Brent was very close to removing sheep from the system. This led to a heavy reliance on pulse crops for nitrogen supply and also meant he was increasingly reliant on in-crop selective herbicides for weed control.

The introduction of vetch as a green manure crop allowed nitrogen levels to be replenished quickly and non-selective herbicides could be used for weed control. The vetch improved cropping results, but was underutilised, so Brent again introduced sheep to make money from it during the year.

Although the vetch has prolific growth in the spring, early in the season (autumn/early winter) it is slow growing with limited grazing, so Brent added grazing wheat to the mix and his love affair with mixed species cropping began in 2015.

**Mixed species**

After a couple of years of using the vetch/wheat mix, Brent followed the advice of his agronomist Greg Condon, and added tillage radish and purple top turnip to the mix, seeing quite dramatic results. He had an immediate increase in dry matter production and sheep health.

In 2019, a very low rainfall year (189 millimetres growing season rainfall), mixed species grazing crops peaked at 12 tonnes per hectare of dry matter production.

Brent’s grazing area now consists of about 400ha of permanent pasture, made up of Lucerne/phalaris mixes and 350ha of mixed species cover crops.

The basic mix comprises of:

- Wheat @ 30kg/ha ($12/ha)
- Vetch @ 30kg/ha ($30/ha)
- Tillage radish @ 2kg/ha ($13/ha)
- Purple top turnip @ 0.5kg/ha ($3.5/ha)

This equates to a total cost of $58.50/ha

---

In 2020 Brent has also experimented with adding more species to the mix and has purchased a 12-way mix from Down Under Covers. He has mixed it 50:50 with his basic cover mix to increase diversity and hopefully increase production.

**Dual purpose crops**

To increase grazing area, he also utilises dual purpose grazing crops. In the past this has been grazing cereals and canola grown as a monoculture. After the success he has had with the mixed species cover crops, Brent now includes a companion with all grazing crops. The mixes for 2020 include:

- Kittyhawk wheat with tillage radish
- Kittyhawk wheat with vetch
- Kittyhawk wheat with vetch and 970 canola
- Mannus oats with vetch

The mixes provide much improved animal performance, due to the variation in diet and also reduces the reliance on artificial fertilisers, in particular the use of applied nitrogen (due to the N supply from the vetch).

Brent plans to terminate the companions in the late winter/early spring, once he has utilised them for grazing. The crops will then be taken through to harvest.

In 2020 he decided to remove grazing canola from the program as he was struggling to achieve viable grain yields and the slow maturity meant it was difficult to fit into the regular cropping program.
Fertiliser and herbicides

Another huge benefit Brent has seen from the mixing of species, is that he has been able to reduce the reliance on synthetic inputs, thus lowering his risk profile. The interaction between the different plants appears to provide much of the nutrition the crop needs.

All the mixed species covers are now planted with no fertiliser, fungicides or insecticides and Brent is still achieving good production results.

He is still using phosphorous fertiliser with the dual-purpose grazing crops, but has reduced inputs down to 20 kilograms per hectare of MAP (2.2kg/ha P).

In 2020 he has moved to mixing urea into water, to apply nitrogen as a foliar, with a view to reducing inputs even further.

Brent still uses some pre-emergent herbicides in the dual-purpose crops, but has removed them from the mixed species covers. He finds that by sowing early the covers seem to quickly cover the ground and out compete any weeds, with any survivors mopped with a fallow herbicide in the spring.

Summer covers

There has been quite a lot of research conducted into the use of mixed species cover crops grown over the summer, and while results in the northern hemisphere seem positive, the use of valuable soil moisture in the Australian climate, means that results here have been varied at best. With this in mind Brent is keen to do some research himself, and in 2020 will experiment with a couple of summer covers. To overcome the soil moisture deficit, he will limit this to stubbles that are marked for a winter cover in 2021.

Utilisation

Utilisation of the extra feed has its challenges. Brent experiences a squeeze in feed availability in the early autumn, before the cover crops have come on board, and again in the spring, when the majority of the covers are fallowed for the next years cropping program. This means there can be excess feed available in the winter and early spring when the covers are really thriving.

To help utilise the feed better a Kiwitech electric fencing system has been purchased that allows for easy management of the sheep, controlling grazing patterns and the amount of cover retained on paddocks.

Figure 4. An Kiwitech electric fencing systems allows easy management of sheep.

In 2020, the Alexander's retained their merino wether lambs in an effort to lift stocking rates. While wool returns have taken a fall recently, they hope the wethers will give them more flexibility with grazing pressure. They can be pushed much harder during the autumn/winter period when pregnant ewes have a high demand for nutrition and if the break is late or non-existent, they can be sold quickly to relieve grazing pressure.

Conclusion 5. Sheep grazing Brent's mixed species paddocks.

If seasons allow there are other options for utilising the extra growth. Paddocks can be locked up and cereal/vetch mixtures can be baled. Mixed species crops can also be taken through to harvest and seed retained for sowing the following year.

The other very important addition to the Alexander's business has been a disc seeder. The seeder enables them to retain a lot more cover and make use of small rainfall events that occur in the late summer/early autumn period. This means they can sow covers and grazing crops much earlier and try and minimise the impact of the early feed gap.

Other avenues Brent has explored to utilise the extra winter feed have included agistment and trading of livestock, but to date he has not ventured down these paths.

Future

Future plans will focus around increasing soil cover, with an emphasis on maintaining cover year-round. To help enable this, Brent has ordered a stripper front for the 2020 harvest. This will further enhance groundcover and help in the early establishment of dual-purpose crops and covers.

To enable better utilisation of feed, he will continue to refine the electric fencing system, with a focus on improving water supply to the sheep, which he finds is currently one of the biggest limiting factors.

Conclusions

Dual purpose crops have been a major step forward in mixed farming over recent years. They have become an important tool to help cover the autumn/winter feed gap on mixed farms.

The addition of multi species into this system has taken it to another level, providing increased dry matter production, reducing the reliance on synthetic inputs and importantly improving livestock health and subsequent performance. Brent will not grow another grazing crop as a monoculture again, as the benefits of mixed species crops are too great.

Utilising the extra growth certainly has its challenges, but with improved grazing techniques and other non-grazing options available, producers who are prepared to think outside the square can take full advantage of the magic of mixed species.
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