Final report

Managing Welfare and Production at Weaning

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1 Abstract

This report summarises the results from the *Managing Welfare and Production at Weaning* project in the Northern Territory, Queensland and Western Australia. This trial demonstrated best practice animal husbandry and investigated the welfare and production benefits of providing pain relief at the time of castration and dehorning.

The study involved two phases, a pilot study in 2019 and an on-property study in 2020-2022. The pilot study involved 447 weaners across two sites in the Northern Territory. The on-property study involved 4,370 *Bos indicus* and *Bos indicus* cross weaners in 16 herds across eight properties from 2020-2022. Across four treatment groups, two commercially available pain relief products were tested. The treatments were: Trisolfen®; Meloxicam injectable; Trisolfen® + Meloxicam; and Control (no pain relief). The effect of the treatments on animal production were assessed by monitoring weight change in the time following the procedures and any instances of mortality, while welfare benefits were assessed by monitoring behaviours through video recordings, GPS collars and accelerometer ear tags. Wound healing and infection of both castration and dehorning wound sites were also assessed as part of monitoring the animals' welfare.

The project highlighted the importance of best practice husbandry during castration and dehorning procedures, including the use of aseptic technique, appropriate handling, monitoring and management for infection. However, in this study the provision of pain relief did not impact the change in liveweight in the time following the procedures. The analyses of GPS data did not show consistent differences between treatments in distance travelled or time spent stationary. Accelerometer tag data has undergone initial analysis, but currently shows no differences in overall movement between weaners administered pain relief when compared to control animals. Observed behaviours in the hours following the procedures showed little impact from the administration of pain relief. Wound healing was observed not to be influenced by the provision of pain relief products.

1 Executive summary

Background

Some husbandry procedures, while regarded as necessary (for safety, welfare or production reasons), are recognised to cause significant discomfort to animals during their undertaking. Pain relief products have recently been approved and become commercially available for use during some husbandry procedures. These products have the potential to improve livestock welfare during and following husbandry procedures. The purpose of this project was to trial the use of pain relief products in a commercial environment and to demonstrate to producers the use of pain relief products and their impact on livestock during the husbandry procedures of castration and dehorning. The results of this study will be used to spread awareness of the currently available pain relief products, and to update current recommendations on best practice for husbandry procedures.

Objectives

- Demonstrate best practice husbandry procedures through commercial demonstration sites.
- Demonstrate the use and practical application of pain relief products during surgical husbandry procedures.
- Document the production and welfare outcomes following the administration of different pain relief products, assessed by monitoring liveweight, behaviour and wound healing following the procedures.
- Develop and update a producer handout for 'best practice during husbandry procedures', including the use of pain relief.

Methodology

- Animals at each site were first weighed prior to the undertaking of husbandry procedures.
- Animals were then randomly allocated on presentation at the calf cradle to one of four treatment groups;
    - Trisolfen®
    - Meloxicam injectable
    - Meloxicam injectable + Trisolfen®
    - Control
- Behaviour of animals was monitored in the yards in the hours following the procedures using GoPro cameras to record the animals. Behaviour in the paddock was monitored through use of GPS collars and accelerometer ear tags.
- Liveweight and wound healing were assessed in the veterinary crush approximately 21 days following the procedures.

Results/key findings

This study demonstrated the production impacts of husbandry procedures in cattle herds. In 8 of the 16 study herds, a decrease (on average) in liveweight following the procedures was observed. Poll heifers were present in 8 of the 16 study herds and had significantly greater liveweight gains than animals that had undergone castration and/or dehorning in five of these herds.

However, the study found no consistent significant difference in liveweight change between animals that did or did not receive pain relief. There was no consistent significant difference in behaviour in the hours following husbandry procedures, GPS and accelerometer data, or wound healing.

Liveweight was found to be negatively impacted by the occurrence of an infection in either the castration or dehorning wound sites, demonstrating the importance of minimising the occurrence of infection by using best practice procedures. Infection of the dehorning site was observed to be influenced by the occurrence of an open sinus, with open sinus wounds averaging an infection rate of 21% vs 4% for non-open sinus wounds.

The results of this trial have been presented at BeefUp forums and field days across northern Australia, and an updated 'best management for husbandry procedures' brochure has been developed.

Benefits to industry

As a result of this project,

- Cattle producers across northern Australia were able to use and see the use of pain relief products firsthand.
- Epidemiological data on the impact of castration and dehorning in northern Australia was collected.
- An updated 'best practices for husbandry procedures' flier was developed, providing clear guidance for beef producers to support animal wellbeing outcomes.

Future research and recommendations

The findings of this study would suggest that further research is needed to find a longer lasting, more effective pain relief product and/or a product that overcomes the practical administrative challenges (e.g. storage, dosage, administration) of the extensive pastoral environment in northern Australia.

It also demonstrates the merit of investing in R&D to reduce the need for these procedures altogether, such as polled genetics or non-invasive chemical castration.

2 PDS key data summary table

Project Aim:

To demonstrate the use and practical application of pain relief products during surgical husbandry procedures, and to document the production and welfare outcomes following the administration of different pain relief products.

	Comments		Unit
Number of core participants engaged in project	9 properties across 3 years	~50	people
Number of observer participants engaged in project			
Core group no. ha	Total of all properties	~700,000	ha
Core group no. cattle	Total of all properties	~50,000	hd cattle
% change in knowledge, skill & confidence – core	*Producers who were able to try pain relief products for first time*	57%	
% practice change adoption – core	*Will continue using pain relief products in future*	85%	

Key impact data

Increase to cost of production* ($/200kg animal) *cost of product as of September 2023	**Trisolfen (200kg animal)** Male/polled $1.71 Male/horned $3.23 Female/horned $1.52 **Meloxicam (200kg animal)** Male/polled $10.00 Male/horned $10.00 Female/horned $10.00 **Meloxicam + Trisolfen (200kg animal)** Male/polled $11.71 Male/horned $13.23 Female/horned $11.52

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1. Background

Across beef production systems globally there has been increased interest in improving animal welfare, including during husbandry procedures such as castration and dehorning. The increased scrutiny on painful surgical procedures is seeing more investigation into current practices, with a public push to eliminate, or at the very least improve, many of the practices currently used. A survey conducted by Phillips et al. (2009) asked Australian-based beef producers, veterinarians, animal welfare scientists and animal welfare advocates, to rank the importance of different welfare issues in livestock production, with dehorning emerging as the number one concern for advocates.

In line with the industry-level strategy *Red Meat 2030,* Meat & Livestock Australia is prioritising continued investment to improve animal welfare into the future (Meat & Livestock Australia, 2016). While it is generally perceived that pain relief products are likely to have positive production impacts, there is limited evidence quantifying these impacts in extensively managed herds in northern Australia. Further, there is opportunity to increase the rates of adoption of pain relief in northern beef businesses. This project was designed to address these issues by determining any objective benefits from pain relief and demonstrating its use to industry.

The northern Australian beef industry encompasses Queensland, the Northern Territory and northern areas of Western Australia including the Kimberley and Pilbara regions (Martin, 2016; Thompson and Martin, 2012) and presents a unique challenge when it comes to changing current husbandry practices. Covering a total land area of approximately 4 million km^2 (ABARES, 2019) the total beef herd varies from year to year between 10-14 million cattle (Department of Agriculture, 2019). Average property and herd size also varies greatly from region to region (Meat and Livestock Australia, 2014), with the average property size across northern Australia being 24,415ha (Thompson and Martin, 2012). Average beef herd sizes can vary from 716 AE (Adult Equivalent) in the Queensland Eastern Downs to 12,682 AE in the Northern Territory's Barkly Tablelands, with herds in some areas exceeding 40,000 (Meat and Livestock Australia, 2014; Department of Agriculture, Fisheries and Forestry, 2012; Thompson and Martin, 2012). The herd is primarily *Bos indicus* and *Bos indicus* cross cattle, with estimates of these breeds of cattle making up 64-80% (Bortolussi et al. 2005; Department of Primary Industry and Fisheries, 2010) and 95-100% in the Northern Downs and Northern Forest areas (Fordyce et al. 2022) of the total herd.

The extensive nature of the northern beef herd means mating is often uncontrolled and mustering is often only done once or twice a year based on the wet/dry season cycle (McGowan et al. 2014; Department of Primary Industry and Fisheries, 2010; Fordyce et al. 2022). This results in a great variation in the ages and sizes of calves that require marking, with ranges reported to vary between 3.5 to 10 months of age (Bortolussi et al. 2005; DRDPIFR 2009). This also means there is little opportunity for post-operative care or observation after the cattle are returned to the paddock. While calf losses and incidents of infection are poorly documented across the northern beef industry, one study conducted across various sites in northern Australia found that during vaccination, branding and dehorning (no castration) of calves approximately 2-5 months old, 2.1% died in the dehorned group, compared to 0.2% in the un-dehorned group (natural polled) (Bunter et al. 2014).

In this study, the practices of castration and dehorning were examined, and the impact of administration of commercially available pain relief products on animal production, behaviour and wound healing tested. The procedures of castration and dehorning are often regarded as necessary husbandry procedures. Castration is undertaken to improve carcase quality and prevent unwanted breeding, while also improving safety for handlers (Hendrickson and Baird, 2013; Booker et al. 2008;

Bretschneider, 2005). Dehorning is performed to minimise the risk of injuries to livestock (both in the field and during transport) and the people handling them (Sinclair, 2012; Stafford and Mellor, 2011; Stock et al. 2013; Knierim et al. 2015; Kupczyński et al. 2014). Both of these procedures have been documented to cause pain and/or discomfort to the animal, and pose a risk of wound infection (Hendrickson and Baird, 2013; American Veterinary Medical Association, 2014; Robertson et al. 1994, Cooper et al. 1995; Petrie et al. 1996; Stafford and Mellor, 2011; Ballou et al. 2013).

In recent years, pain relief products have been approved for producer use during castration and dehorning, but little has been reported on the outcome of using these products in the extensive northern environment. There is also a considerable knowledge gap on the impact of these procedures on animal production and the occurrence of complications such as wound infection. The main target audience for this study was commercial cattle producers of northern Australia. In addition to testing the administration of pain relief products in the field, epidemiological data on the impact of both castration and dehorning (whether conducted individually or together) on livestock production, behaviour, wound healing and infection rates was collected. This will allow producers to make more informed choices about their weaning and husbandry practices.

2. Objectives

The objective of this project was to evaluate the effectiveness of providing pain relief during the standard husbandry practices of castration and dehorning in providing welfare and production benefits. It was also to educate participating producers on best practice pain mitigation and aseptic techniques during routine husbandry procedures.

This includes:

1. Initial pilot study completed on NT DITT research station
   - Achieved and on-property project plan developed as a result

2. Following findings from initial pilot study, 4 properties in the NT, 3 in WA and 1 in QLD will demonstrate the use and practical application of pain relief during surgical procedures to increase animal welfare outcomes:
   a. Faster return to gaining weight
   b. Reduced depression in weight gain
   c. Reduced mortalities
   d. Improved calf/weaner welfare outcomes

   - Achieved the property participation target. However the anticipated production and welfare benefits were not able to be observed/documented.

3. Implement best practice training for dehorning and castration to increase the capabilities of 40 pastoralists (station hands to owner/managers).
   - Achieved, all participating properties were shown the correct use of the pain relief products and best practice techniques.

4. Conduct 2 field days to showcase the demonstration site, disseminate results and encourage adoption of animal welfare best management practices
   - Results presented at Victoria River Research Farm field day, Katherine Research Farm field day and Douglas Daly Research Farm field day as well as at BeefUp forums.

5. Develop Tips and Tools spreadsheets for producers on best practice castration/dehorning and weaner management
   - *Achieved, a four page handout was developed for producers, which also refers them to the full MLA guide.*

6. Contribute to redevelopment of MLA's 'A guide to best practice husbandry in beef cattle'
   - *Achieved, redevelopment ongoing*

7. Analyse the aggregated data from all associated project PDS sites across Western Australia, Northern Territory and Queensland
   - *Achieved, results detailed in this report*

8. Conduct a cost benefit analysis of treatments and subsequent welfare outcomes
- As no measurable production or welfare benefit was observed, a cost benefit was unable to be performed.

3. Demonstration site design

3.1 Methodology

This project comprised two components; a pilot study, followed by on property trials. A separate methodology will be described for each phase of the project.

2.1.1 Pilot study methodology

Animals and environment

This study was conducted on DITT research stations at Katherine Research Station (KRS, herd 1) (-14.47375, 132.30553) and Douglas Daly Research Farm (DDRF, herd 2) (-13.83388, 131.18603), during the typical branding time in June 2020. A total of 447 *Bos indicus* and *Bos indicus* cross weaners of mixed sex were part of the study, consisting of 400 animals to be dehorned and/or castrated and 47 naturally polled heifers. Measurements (described in the section 'dehorning and castrating procedure' and 'yard measurements') were taken at the time of dehorning and/or castration and over a following period of 5 months (observations on days 5, 9, 28, 57, 79, 156 approx.). Weaners were also branded and vaccinated at this time, as is typical practice for the region, and had been weaned a month prior. All weaners had existing management tags with a unique animal management number. Cattle were grazed as one group on each site, in paddocks comprised of a mix of native and improved pastures. Water was available at all times via a trough.

Treatments and allocation

There were 236 weaners at KRS and 211 weaners at DDRF. In each of these locations the calves were allocated to one of five treatment groups. Treatment groups were: control; Meloxicam; Meloxicam + Trisolfen®; Trisolfen®; and poll. Allocation to each treatment group was done by blocked randomization in order of presentation at the branding cradle (block size n=20), with the exception of the poll treatment group (all animals in this treatment group were naturally polled heifers). That is, the animals presented randomly with the treatment group allocation changing every 20 animals. This was done due to the large number of animals at each site.

Polled males were castrated only, while horned females were dehorned only. Horned males were both castrated and dehorned. All weaners already had an NLIS tag and management eartag with a unique identification number. Prior to dehorning/castrating, weaners were all weighed (animals had access to water but not feed overnight before being weighed). The large standard deviation in average initial liveweight observed is reflective of the large variation in animal age/weight that is typical of the region, Table 3.1.1

Table 3.1.1- Treatment allocation and average initial liveweight of weaners by treatment and study site. Liveweight measured in kg. Means in the same column that do not share a common superscript letter are statistically significant at the 0.05 level.

Treatment group	KRS (n= 236)	DDRF (n= 211)
Control	192.1 ± 32.3 (n=51)	144.2 ± 43.0 (n=49)[a]
Meloxicam	195.4 ± 25.0 (n=52)	162.1 ± 39.3 (n=48)[b]
Meloxicam + Trisolfen®	189.8 ± 26.6 (n=52)	154.7 ± 44.6 (n=48)
Trisolfen®	197.8 ± 26.1 (n=52)	168.2 ±42.4 (n=48)[b]
Polled	194.9 ± 27.9 (n=29)	134.3 ±33.2 (n=18)[a]

Dehorning and castrating procedure and yard measurements

Weaners were restrained in a calf cradle for the procedures. As each animal presented to the calf cradle its management number was recorded and it was allocated to a treatment group. The horn/poll status (including horn size) and sex was recorded for each animal. Horn size was graded visually as small, medium or large (small = < 2.5cm in diameter at horn base; medium = 2.5-4cm at horn base and large = > 4cm at base or protruding further than 2.5cm from the head). If the animals were allocated to the Meloxicam or Meloxicam+Trisolfen® groups, the Meloxicam was administered at this time.

Both dehorning and castrating were performed by experienced operators. Dehorning was conducted using a dehorning knife or dehorning scoops, depending on the size of the horn. Weaners with small horns/horn buds were dehorned with the dehorning knife, while larger attached horns were removed with dehorning scoops. All dehorning equipment was rinsed in a disinfectant solution between animals. At the time of dehorning it was recorded if the sinus was exposed or remained intact.

Male weaners were surgically castrated. The scalpel was placed in a disinfectant solution between animals. If an animal was allocated to the Meloxicam+Trisolfen® or Trisolfen® treatment group, Trisolfen® was applied to the wound as per the label directions immediately following castration. Polled heifers were branded and vaccinated only.

Note: The current recommendation for meloxicam administration is 10 minutes prior to surgery. This was not always possible in this study, due to the large number of animals being processed, changing treatment group frequently throughout processing events , and variation in yard setups between sites. Animals receiving meloxicam were either treated in the calf race immediately prior to entering the calf cradle/cattle crush, or in the calf cradle/cattle crush. The meloxicam was always administered before any procedures were undertaken. Studies in cattle following subcutaneous administration of meloxicam have demonstrated that it is detectable in plasma within 5 minutes of administration, continuing to increase until peak plasma concentrations are reached at 3.7-7.6 hours following administration (Jokela et al. 2024; Melendeez et al. 2019).

Weight and wound healing

In the days and months following dehorning and/or castrating, the animals were periodically weighed at each site and wounds inspected. Frequency of weighs and inspections are detailed in Table 3.1.2. Wound sites were inspected for any signs of infection and for stage of wound healing. This was graded on a predetermined scale, Table 3.1.3. Observation stopped at day 83 at KRS as animals had to be moved to a new site.

Table 3.1.2. Inspection days following procedures by study site. (The day of castration and/or dehorning was day 0)

KRS	DDRF
-	Day 5
Day 8	Day 9
Day 28	Day 28
Day 56	Day 57
Day 83	Day 79
-	Day 156

Table 3.1.3. Wound healing scale

Wound healing score	Description of wound score	
	Dehorning wounds (1 – 7 scale)	Castration wounds (1 – 5 scale)
1	Wound fully healed (full wound epithelization and contraction has occurred)	Wound fully healed (full wound epithelization and contraction has occurred)
2	Wound partially healed (scab is present over wound site- some wound contraction and epithelization has occurred)	Wound partially healed (scab is present over wound site- some wound contraction and epithelization has occurred)
3	Wound partially healed (scab is present over wound site- NO wound contraction or epithelization has occurred)	Wound partially healed (scab is present over wound site- NO wound contraction or epithelization has occurred)
4	Partial scab formation (wound is partially covered by the formation of a scab, areas of wound are still 'open' (no scab)- sinus is NOT open)	Wound is open (wound is open along part or all of incision site)
5	Scab/partial scab formation with open sinus (a scab has formed, or has partially formed- but the sinus remains open)	Infection evident (purulent wound exudate clearly evident)
6	Open sinus wound (no evidence of scab formation over wound- sinus remains open)	
7	Infection evident (purulent wound exudate clearly evident)	

2.1.2 On property trial methodology

Animals and environment

This study was conducted across Queensland (Qld), Northern Territory (NT) and Western Australia (WA) from 2020-2022 (Table 3.1.2).

Table 3.1.2 identification of study sites by state and year

State	Herd number	Site name	Year
Northern Territory	1	DDRF	2020
	2	DDRF	2021
	3	DDRF	2022
	4	NT Site 1	2021
	5	NT Site 2a	2021
	6	NT Site 2b	2021
	7	NT Site 2c	2022
	8	NT Site 3a	2021
	9	NT Site 3b	2022
Queensland	10	Spyglass	2021
Western Australia	11	WA Site 1a	2021
	12	WA Site 2a	2021
	13	WA Site 3a	2021
	14	WA Site 1b	2022
	15	WA Site 2b	2022
	16	WA Site 3b	2022

A total of 3,966 (200 Qld, 1,566 NT and 1,566 WA) *Bos indicus* and *Bos indicus* cross weaners of mixed sex and age were monitored as part of the study. An additional 370 poll heifers were run within the NT and WA herds at DDRF 2020, DDRF 2021, DDRF 2022, NT Site 2a, NT Site 2b, NT Site 2c, NT Site 3a and WA Site 3b, and were included as a positive control comparison group. At NT Site 2a and 2b, 34 non-castrated and non-dehorned males were also run with the trial animals and included as a positive control (n=34).

At all sites, measurements (described below) were taken at the time of dehorning and/or castration and again approximately 21 days later. At some sites an additional weight was recorded several months after the procedures to examine long term effects (exact time varied between sites). Weaners were also branded and, on some sites, vaccinated and ear tagged at this time, as is typical practice for the region (Table 3.1.3). Weaners that did not have an existing management tag with a unique animal management number were given one of these tags. In the NT and WA study herds in 2021 and 2022, 20 weaners per site (5 from each treatment group) were also fitted with a GPS collar set to record location every one minute and an accelerometer ear tag which recorded constantly at 100Hz to measure movement along the X, Y and Z axis. Animals that received GPS collars and accelerometer tags were selected randomly. A 'control' GPS collar was set up in a paddock away from any metal structures and under light canopy cover (simulating real paddock conditions), to document GPS error. The control collar was set to record GPS location every 10 minutes and was set up for 219 days.

Treatment groups were grazed together on each property. All animals had adequate access to feed and water at all times.

Table 3.1.3 Husbandry procedures performed at each study site

Herd number	Site name	Year	Branded	Eartag	Earmark	Vaccinated	GPS collars	Accelerometer ear tags
1	DDRF	2020	Y			Y		
2	DDRF	2021	Y			Y	Y	Y
3	DDRF	2022	Y			Y	Y	Y
4	NT Site 1	2021	Y				Y	
5	NT Site 2a	2021	Y	Y	Y	Y	Y	Y
6	NT Site 2b	2021	Y	Y	Y	Y		
7	NT Site 2c	2022	Y	Y	Y	Y		Y
8	NT Site 3a	2021	Y	Y		Y	Y	Y
9	NT Site 3b	2022	Y	Y		Y	Y	Y
10	Spyglass	2021	Y	Y	Y			Y
11	WA Site 1a	2021	Y	Y	Y	Y		
12	WA Site 2a	2021	Y	Y	Y	Y		
13	WA Site 3a	2021		Y	Y	Y		
14	WA Site 1b	2022	Y	Y	Y	Y	Y	Y
15	WA Site 2b	2022	Y	Y	Y	Y		Y
16	WA Site 3b	2022		Y	Y	Y	Y	Y

Treatment and allocations

In each of the 16 study herds, weaners were allocated to one of four treatment groups. Treatment groups were: Control (no pain relief); Meloxicam; Meloxicam + Trisolfen®; and Trisolfen®. If there were any polled heifers running with the trial mob, these were identified as they came through the calf cradle and allocated to the polled group. The NT Site 1 only had control and Meloxicam treatment groups due to castrating using rubber rings and dehorning by hot iron cautery. Allocation to each treatment group was by blocked randomization on order of presentation at the branding cradle (block size n=10). Weaners had been previously identified with an NLIS tag on NT Site 3a and 3b, a rumen bolus on NT Site 2a and 2b, and with an NLIS tag and management tag on DDRF 2020/2021/2022, NT Site 1 and Spyglass. Tagging occurred at the same time as castration/dehorning at WA Site 1a and 1b, WA Site 2a and 2b and WA Site 3a and 3b. Animals were identified with an additional management tag on NT Site 3a and 3b at the time of branding. The day before or day of dehorning/castrating, weaners were all weighed (uncurfewed liveweight) and the weight recorded (Table 3.1.4). Some significant difference ($P<0.05$) between treatment group average starting weight was seen at site NT Site 3a and WA site 3a, this was due to random chance in the block allocation that was not overcome by the large group size.

Table 3.1.4. Treatment allocation and average initial liveweight of weaners by treatment and study site. Live weight (kg). Means in the same row that do not share a common superscript letter are statistically significant at P<0.05.

			Treatment group			
Study site	Meloxicam	Trisolfen®	Meloxicam+Trisolfen®	Control	Polled	Herd SD
DDRF 2020	161.8 (n=76)	163.5 (n=77)	166.1 (n=74)	165.2 (n=72)	165.1 (n=48)	±34.2
DDRF 2021	165.7 (n=47)	166.6 (n=51)	161.4 (n=47)	164.7 (n=47)	160.4 (n=41)	±35.8
DDRF 2022	169.5^{A} (n=131)	168.5^{A} (n=132)	166.5^{A} (n=123)	167.5^{A} (n=129)	147.4^{B} (n=75)	±35.6
NT Site 1 2021	144.3 (n=100)	-	-	142.3 (n=100)	-	±22.5
NT Site 3a 2021	171.3^{B} (n=65)	170.9 (n=71)	173.2^{B} (n=68)	161.3^{A} (n=65)	174.8^{B} (n=44)	±31.4
NT Site 3b 2022	198.7(n=55)	192.6 (n=53)	200.8 (n=54)	191.4 (n=52)	-	±29.7
NT Site 2a 2021	182.3 (n=25)	161.9 (n=36)	178.2 (n=30)	163.0 (n=25)	176.9 (n=37)	±43.2
NT Site 2b 2021	166.2 (n=50)	165.4 (n=60)	167.5 (n=52)	166.3 (n=53)	169.9 (n=47)	±31.7
NT Site 2c 2022	192.5^{A} (n=44)	178.7^{A} (n=45)	182.0^{A} (n=45)	177.0^{A} (n=47)	152.8^{B} (n=59)	±48.6
Spyglass 2021	217.0 (n=51)	220.1 (n=53)	219.2 (n=51)	218.4 (n=54)	-	±36.9
WA Site 1a 2021	159.3 (n=75)	163.5 (n=75)	165.4 (n=75)	159.0 (n=75)	-	±26.6
WA Site 2 a2021	233.2 (n=50)	231.4 (n=50)	230.7 (n=50)	219.3 (n=50)	-	±40.5
WA Site 3a 2021	212.3 (n=74)	223.9^{B} (n=73)	207.6^{A} (n=75)	216.2 (n=74)	-	±40.3
WA Site 1b 2022	187.4 (n=75)	189.3 (n=75)	182.8 (n=75)	185.2 (n=75)	-	±29.0
WA Site 2b 2022	218.0 (n=77)	216.2 (n=73)	215.7 (n=72)	217.1 (n=75)	-	±42.8
WA Site 3b 2022	196.5 (n=43)	193.8 (n=44)	207.0 (n=44)	193.9 (n=42)	199.7 (n=46)	±35.8

Dehorning and castrating procedure and yard measurements

Weaners were restrained in a calf cradle for the procedures at all sites except NT Site 2a, 2b and 2cb where they were restrained in a cattle crush. As each animal presented to the calf cradle/crush its management number was recorded, it was allocated to a treatment group, its horn/poll status (including horn size; detailed in results section) and its sex was recorded. If the animals were allocated to the Meloxicam or Meloxicam+Trisolfen® groups, the Meloxicam was administered at this time. If the animal was to be given a GPS collar (brand of GPS 'i-gotU GT 600') and accelerometer eartag (accelerometer used AX3 Axivity, Fig. 3.1.5) it was fitted at this time.

Figure 3.1.5 Accelerometer ear tag

Amputation dehorning was conducted on all sites except NT Site 1, which used cautery dehorning. Weaners with small horns were dehorned with the dehorning knife, while larger attached horns were removed with dehorning scoops. All dehorning equipment was rinsed in a disinfectant solution between animals. At the time of dehorning it was recorded if the sinus was exposed or remained intact. If the animal was in the Trisolfen® or Meloxicam+Trisolfen® groups the Trisolfen® was applied to the wound immediately following dehorning.

Male weaners were surgically castrated by an experienced technician at DDRF, Spyglass, WA Site 1, WA Site 2 and WA Site 3 while band castration was used at NT Site 1, and the short scrotum technique with bands at NT Site 3. NT Site 2 did not castrate. As such no Trisolfen was used on castration sites at NT Site 1, NT Site 2, and NT Site 3. For surgical castration, the scalpel was placed in a disinfectant solution between animals. If an animal was allocated to the Meloxicam+Trisolfen® or Trisolfen® treatment group Trisolfen® was applied to the wound during castration as per the label directions of 4ml per wound. If the animals were castrated by a band, it was ensured bands were stored correctly and kept free of dust. Both dehorning and castrating were performed by experienced operators. Polled heifers were branded only.

Weaners were observed following the procedure in the yards to monitor for any adverse outcomes. Footage of behaviours, recorded using GoPro cameras (model 'Hero7 Silver') set up around the yard, was later analysed. Camera recording time varied from 86 – 175 minutes before batteries ran out. Behaviours expressed during this time were recorded using an ethogram (Table 3.1.6).

Table 3.1.6. Ethogram of observed behaviours

Behaviour	Description
Standing/lying	Animal standing or lying
Head Shaking	Aggravated shaking of the head
Head Scratching	Scratching of the dehorning wound site, this may be by the animals foot, or by the animal rubbing the site on an object (such as a post, or other animal)
Ear Flicking	Aggravated flicking of the ears
Tail Flicking	Aggravated flicking of the tail
Foot Stamping	Stamping of any of the feet
Pacing	Quick burst of speed by the animal
Vocalisation	Any instance of vocalisation
Self-Grooming	Any instance of the animal licking itself
Rumination/feeding	Any occurrence of feeding or rumination
Reversing	Several fast paced steps backwards

Accelerometer tags

Accelerometer tags were configured to a sample rate of 100Hz (100 readings/second) and were calibrated to the local time zone: NT (GMT +9.30) and WA (GMT+8.0). Data was downloaded from the tags using the program ‘AX3/AX6 OMGUI Configuration and Analysis Tool’, then exported in .csv format. Data was analysed by Anita Chang, Central Queensland University. For each tag 25 measures were generated for each day of recording (Table 3.1.7) (Chang et al. 2022).

Table 3.1.7 Details of each measure calculated from accelerometer tag data. T = time, n= total number of counts in each epoch

Measurement	Formula
Average X	$mean_X = \frac{1}{n}\sum_{t=1}^{n} x\ (t)$
Average Y	$mean_Y = \frac{1}{n}\sum_{t=1}^{n} y\ (t)$
Average Z	$mean_X = \frac{1}{n}\sum_{t=1}^{n} z\ (t)$
Average all	$mean_{all} = \frac{1}{n}\sum_{t=1}^{n}(x(t) + y(t) + z(t))$
Average movement intensity	$mean_{MI} = \frac{1}{n}\sum_{t=1}^{n}(\sqrt{x(t)^2 + y(t)^2 + z(t)^2})$
Average movement variation	$mean_{MV} = \frac{1}{n}\sum_{t=1}^{n}(\lvert x_t - x_{t-1}\rvert + \lvert y_t - y_{t-1}\rvert + \lvert z_t - z_{t-1}\rvert)$
Minimum X	min_x
Minimum Y	min_Y
Minimum Z	min_Z
Minimum all	min_{all}
Minimum movement intensity	min_{MI}
Minimum movement variation	min_{MV}
Maximum X	max_X
Maximum Y	max_y
Maximum Z	max_Z
Maximum all	max_{all}
Maximum movement intensity	max_{MI}
Maximum movement variation	max_{MV}
Standard deviation X	$SD_X = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(x(t) - \overline{x})^2}$
Standard deviation Y	$SD_Y = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(y(t) - \overline{y})^2}$
Standard deviation Z	$SD_Z = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(z(t) - \overline{z})^2}$
Standard deviation all	$SD_{all} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(((x + y + z)(t)) - \overline{x + y + z})^2}$
Standard deviation movement intensity	$SD_{MI} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(MI\ (t) - \overline{MI})^2}$
Standard deviation movement variation	$SD_{MV} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(MV\ (t) - \overline{MV})^2}$
Range X	$Range_X = max_X – min_x$
Range Y	$Range_Y = max_Y – min_Y$
Range Z	$Range_Z = max_Z – min_Z$
Range all	$Range_{all} = max_{all} – min_{all}$
Range movement intensity	$Range_{MI} = max_{MI} – min_{MI}$
Range movement variation	$Range_{MV} = max_{MV} – min_{MV}$

Weight and wound healing

Weaners were reweighed (uncurfewed liveweight) and had wound sites inspected approximately 21 days following the procedure (Table 3.1.8). Note at site NT 2a reinspection was delayed due to COVID-19 lockdowns in the Northern Territory restricting staff from travelling to the property. GPS collars and accelerometer ear tags were removed at this time. Wound sites were inspected for any signs of infection and for stage of wound healing. This was graded on a predetermined scale, detailed in Table 3.1.9.

Table 3.1.8. Reinspection day following procedures by study site (the day of castration/dehorning was day 0)

Study Site	Reinspection day 1	Reinspection day 2
DDRF 2020	21	168
DDRF 2021	22	232
DDRF 2022	23	190
NT Site 1	27	-
NT Site 3a	31	-
NT Site 3b	25	-
NT Site 2a	46	123
NT Site 2b	23	-
NT Site 2c	38	-
Spyglass	23	-
WA Site 1a	21	-
WA Site 2a	35	-
WA Site 3a	21	-
WA Site 1b	21	-
WA Site 2b	21	-
WA Site 3b	21	-

Table 3.1.9. Wound healing score descriptions.

Wound Healing Score	Description of wound score Dehorning wounds (1 – 7 scale)	 Castration wounds (Surgical) (1 – 5 scale)	 Castration wounds (Bands) (1 – 5 scale)
1	Wound fully healed (full wound epithelization and contraction has occurred)	Wound fully healed (full wound epithelization and contraction has occurred)	Wound fully healed
2	Wound partially healed (scab is present over wound site- some wound contraction and epithelization has occurred)	Wound partially healed (scab is present over wound site- some wound contraction and epithelization has occurred)	Scrotum detached, scab present over wound
3	Wound partially healed (Scab is present over wound site- no wound contraction or epithelization has occurred)	Wound partially healed (Scab is present over wound site- NO wound contraction or epithelization has occurred)	Scrotum detached, open wound/ partly opened
4	Partial scab formation (wound is partially covered by the formation of a scab, areas of wound are still 'open' (no scab)- sinus is not open)	Wound is open (wound is open along part or all of incision site)	Scrotum attached (either fully or partially)
5	Scab/partial scab formation with open sinus (a scab has formed, or has partially formed- but the sinus remains open)	Infection evident (purulent wound exudate clearly evident)	Infection evident (scrotum attached or not) (purulent wound exudate clearly evident)
6	Open sinus wound (no evidence of scab formation over wound- sinus remains open)	-	-
7	Infection evident (purulent wound exudate clearly evident)	-	-

3.2 Economic analysis

The cost:benefit was calculated based on the expense of the products vs any improved liveweight gain over control animals. Product expense was calculated on a per animal basis and varied depending on the treatment group and also the procedural group (dehorned only, castrated only, castrated and dehorned).

3.3 Extension and communication

The extension and communication activities identified for this project were;

- Training of stockpersons on participating producer properties in the use of pain relief products and aseptic technique
- Presentations at field days/BeefUps of project findings
- Tips and Tools sheet- Key messaging on "how to" of best practice for husbandry procedures and weaning
- Contribute to MLA's "A guide to best practice husbandry in beef cattle"
- Rural media articles eg FutureBeef

3.4 Monitoring and evaluation

In addition to the livestock measures collected (liveweight, behaviour and wound healing), producer experience before and following the study was conducted. This took the form of a casual interview in which producers answered;

- if they had used pain relief products before
- how they felt about using the products
- if they noticed any difference in the animals
- if they would continue using the products
- if not continuing use of the products, why not.

4. Results

4.1 Demonstration site results

4.1.1 Pilot study results

Liveweight

The average liveweight of weaners entering the study was 193.9 ± 27.6kg at KRS, and 155.2 ± 41.5kg at DDRF. Due to the differences in average liveweight between and within treatment groups, change in weight (measured individually for each animal) from day 0 was assessed rather than average liveweight.

All dehorned/castrated treatment groups (Control, Meloxicam, Meloxicam+Trisolfen® and Trisolfen®) lost a small amount of weight compared to their initial weight, when measured on day 8/9, whereas the polled heifers group gained a small amount of weight ($P<0.05$), Figure 4.1.1 (KRS) and Figure 4.1.2 (DDRF). There was no significant difference ($P>0.05$) between the four dehorned/castrated treatment groups on the day 8/9 weigh at either KRS or DDRF. The polled heifers performed better ($P<0.05$) than all castrated/dehorned treatment groups on days 5, 9 and 28 at DDRF. At KRS the observed weight loss continued from days 28 to day 83 for all treatment groups including polled heifers, whereas the DDRF site all treatment groups achieved a weight gain from day 28 onwards. Final weights were taken at KRS on day 83, as weaners had to be moved to a different property due to decreasing feed availability due to a below average wet season.

Figure 4.1.1- Average change in weight from day 0 over time for each treatment group at KRS with SD shown.

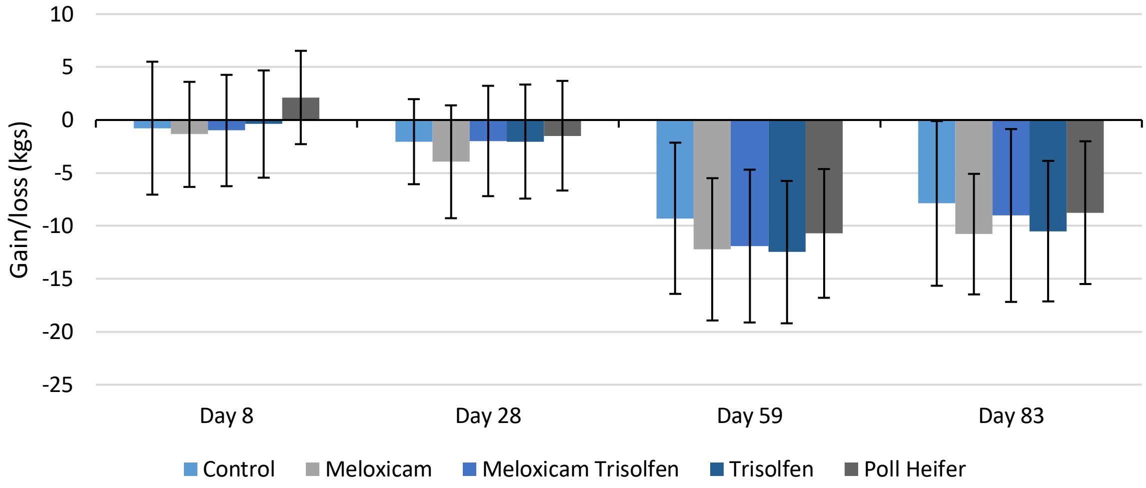
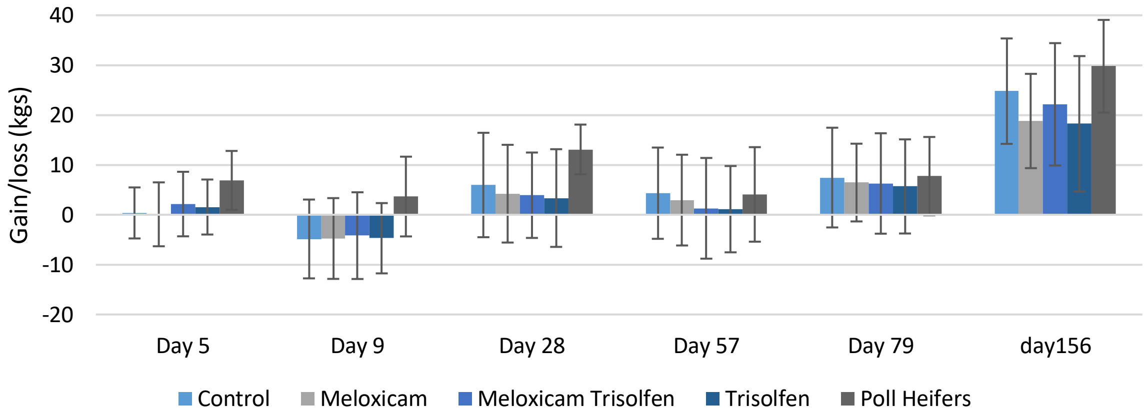


Figure 4.1.2- Average change in weight from day 0 over time for each treatment group at DDRF with SD shown.



Sex effect

Males had a greater starting weight at DDRF in the Control, Meloxicam+Trisolfen® and Trisolfen® groups (P-values equal 0.00007, 0.00101 and 0.0273 respectively). Difference was not able to be calculated for the Meloxicam group as there was only one female. There were no significant differences between sexes on the change in weight (Table 4.1.3).

At KRS there was also a difference in initial weight with males being heavier in the Meloxicam, Meloxicam+Trisolfen® and Trisolfen® groups (P-values equal 0.0466672, 0.0496036 and 0.0122673 respectively). At KRS differences between sexes were observed in the change in weight on days 28 and 57 (Table 4.1.4). Differences on day 28 were in the Meloxicam+Trisolfen® (P=0.041) and Trisolfen® (P=0.027) treatment groups, with females losing more weight than the males. On day 56 in the control group the females lost more weight (P= 0.048), in the Trisolfen® group the males lost more weight (P=0.0089).

Table 4.1.3. Comparison of sex effect within treatment groups at DDRF

Treatment	Sex	Initial weight (kg)	Change in liveweight (from previous weigh) (kg)					
		Day 0	Day 5	Day 9	Day 28	Day 57	Day 79	Day 156
Control	Female	92.4[a]	1.6	-1.8	8.8	-4.5	4.2	19.9
	Male	154.3[a]	0.1	-6.0	10.3	0.2	2.9	16.9
Meloxicam*	Female	83.3	4.7	-0.9	1.6	3.1	13.4	-2.8
	Male	163.8	0.0	-4.9	9.1	-0.8	3.3	13.3
Meloxicam + Trisolfen®	Female	92.7[b]	-0.7	-8.1	11.7	0.9	0.8	16.9
	Male	158.9[b]	5.1	-6.2	8.2	-2.3	5.3	13.1
Trisolfen®	Female	93.5[c]	7.3	-3.9	9.0	-0.9	3.2	18.7
	Male	173.2[c]	1.2	-6.4	7.9	-2.2	4.4	12.2

*Excluded from statistical analysis due to having only 1 female.
Values in the same column with the same superscript differ significantly (P<0.05).

Table 4.1.4. Comparison of sex effect within treatment groups at KRS

Treatment	Sex	Initial weight (kg)	Change in live weight (from previous weigh) (kg)			
		Day 0	Day 8	Day 28	Day 56	Day 83
Control	Female	184.2	-0.2	-2.0	-9.2[f]	2.3
	Male	198.1	-1.2	-0.7	-5.6[f]	1.3
Meloxicam	Female	188.2[a]	-2.1	-2.8	-8.2	0.8
	Male	202.0[a]	-0.7	-2.4	-8.3	2.0
Meloxicam + Trisolfen®	Female	183.4[b]	-0.1	-2.3[d]	-9.4	1.8
	Male	197.9[b]	-2.2	0.6[d]	-10.6	3.8
Trisolfen®	Female	187.8[c]	-0.3	-3.3[e]	-7.8[g]	1.4
	Male	205.8[c]	-0.5	-0.3[e]	-12.5[g]	2.4

Values in the same column with the same superscript differ significantly (P<0.05).

Husbandry procedure effect

A comparison between animals based on husbandry procedures was done; castrated only, dehorned only or castrated + dehorned. At KRS the castrated-only (poll) group had better weight gains than dehorned groups in some treatment groups on day 8 (Meloxicam+Trisolfen® and Trisolfen®), day 28 (Meloxicam+Trisolfen® and Trisolfen®), day 56 (Meloxicam+Trisolfen® and control) and day 83 (Meloxicam+Trisolfen® and control) (Table 4.1.5). Treatment groups were combined into an 'all animals' group for analysis to more accurately determine a procedure effect. The procedure effect of castrated-only (poll) animals having greater weight gains than dehorned-only or dehorned + castrated can be clearly seen on days 8, 28, 56 and 83 (P<0.05). At DDRF dehorned + castrated animals tended to have lower weight gains compared to castrated-only and dehorned-only animals, which was significant at some measurement dates (Table 4.1.6).

Compared to the polled group, castrated and/or dehorned animals tended to have lower weight gains. At KRS on day 8 the polled group performed better (P<0.05) than the dehorned only and dehorned + castrated groups, but not significantly different to the castrated only group. At DDRF, the polled group performed better on day 9 than the castrated only and dehorned + castrated groups (P<0.05).

Table 4.1.5. Husbandry procedure effect on change in weight (kg) (from initial weight) observed at KRS. Values in the same column, within the same treatment group, that have a different superscript are significantly different (P<0.05).

Treatment group	Husbandry procedure	Number of animals	Day 8	Day 28	Day 56	Day 83
Control	Castrated only	3	1.9	-0.6	3.1^{a}	2.0^{a}
	Dehorned only	22	-0.2	-2.2	-11.4^{b}	-9.2^{b}
	Dehorned and Castrated	26	-1.6	-2.1	-8.9^{b}	-7.9^{b}
Meloxicam	Castrated only	4	2.2	-2.1	-12.6	-5.8
	Dehorned only	25	-1.5	-4.5	-12.4	-11.7
	Dehorned and Castrated	23	-1.8	-3.7	-11.9	-10.6
Meloxicam+ Trisolfen®	Castrated only	3	5.9^{a}	4.7^{a}	-3.2^{a}	4.1^{a}
	Dehorned only	29	-0.1^{b}	-2.3^{b}	-11.7	-9.5^{b}
	Dehorned and Castrated	20	-3.4^{b}	-2.5^{b}	-13.5^{b}	-10.3^{b}
Trisolfen®	Castrated only	4	5.6^{a}	2.5^{a}	-10.6	-7.2
	Dehorned only	23	-0.3^{b}	-3.6^{b}	-11.4	-10.0
	Dehorned and Castrated	25	-1.4^{b}	-1.3^{ab}	-13.7	-11.5
All Animals	Castrated only	14	3.9^{a}	1.0^{a}	-6.7^{a}	-2.4^{a}
	Dehorned only	99	-0.5^{b}	-3.1^{b}	-11.8^{b}	-10.1^{b}
	Dehorned and Castrated	94	-2.0^{b}	-2.3^{b}	-12.0^{b}	-10.0^{b}
	Polled	29	2.1^{a}	-1.5	-10.7	-8.8^{b}

Table 4.1.6 Husbandry procedure effect on change in weight (kg) (from initial weight) observed at DDRF. Values in the same column, within the same treatment group, that have a different superscript are significantly different (P<0.05). *Note Meloxicam dehorned only group was excluded from analyses due to having only 1 animal.

Treatment group	Husbandry procedure	Number of animals	Day 5	Day 9	Day 28	Day 57	Day 79	Day 156
Control	Castrated only	8	1.0	-4.2	6.3	6.9	9.7	27.9
	Dehorned only	8	1.6	-0.2[a]	9.1	4.6	8.8	28.7
	Dehorned and Castrated	33	-0.1	-6.2[b]	5.2	3.6	6.6	23.2
Meloxicam	Castrated only	13	0.3	-1.5	2.6	4.7	6.9	20.5
	Dehorned only*	1	4.7	3.8	5.4	8.5	21.9	19.1
	Dehorned and Castrated	34	-0.1	-6.4	4.9	2.0	5.8	18.1
Meloxicam+ Trisolfen®	Castrated only	17	4.5	2.0[a]	9.6[a]	5.1[a]	9.8	24.0
	Dehorned only	3	-0.7	-8.7[b]	3.0	3.8	4.7	20.5
	Dehorned and Castrated	28	5.5	-7.3[b]	1.0[b]	-1.3[b]	4.1	21.0
Trisolfen®	Castrated only	12	4.0[a]	-2.0	7.9[a]	1.6	6.4	17.6[a]
	Dehorned only	3	7.3[a]	3.3[a]	12.4[a]	11.5[a]	14.7	33.4[b]
	Dehorned and Castrated	33	0.2[b]	-6.4[b]	1.0[b]	0.0[b]	4.6	17.1
All Animals	Castrated only	50	2.7[a]	-0.9[a]	6.5[a]	4.4[a]	8.3	22.3[a]
	Dehorned only	15	2.5[a]	-0.9[ac]	8.2	6.2	10.1	27.7
	Dehorned and Castrated	128	1.2	-6.5[b]	3.0[b]	1.2[b]	5.4	19.8
	Polled	18	6.9[b]	3.7[c]	13.1[c]	4.5	7.7	29.8[b]

Infection

Infection was classed as a visually observable purulent wound exudate. Most infections were observed on the Day 8 (KRS) and Day 9 (DDRF) inspections. These animals were monitored, but infections resolved naturally (usually with a few days) without requiring veterinary intervention.

Impact of infection on liveweight can be seen in Figure 4.1.7 (KRS) and Figure 4.1.8 (DDRF) (these tables separate animals that developed an infection at time of either castration or dehorning and continue that separation even after the infection resolved). On day 8 at KRS animals that had developed an observable infection had lower weight gains (P<0.05) than animals that did not develop infections in the Meloxicam + Trisolfen® and Trisolfen® groups. At DDRF animals that had developed an observable infection had lower weight gains (P<0.05) on day 9 in the control group only. These impacts were only significant whilst the infections were active and did not appear to have significant effect after they were resolved. All animals (excluding polled group) were combined by study site and wound infection status (Table 4.1.9). Animals with an observable infection had lower weight gains at DDRF on day 5 and 9, and at KRS on day 8 and 28. These results suggest that the impact of infection on weight change was not significant long term (no difference after 28-day inspection).

Figure 4.1.7- The effect of infection on change in weight (from initial live weight) within treatment groups at designated days following dehorning and/or castration at KRS.

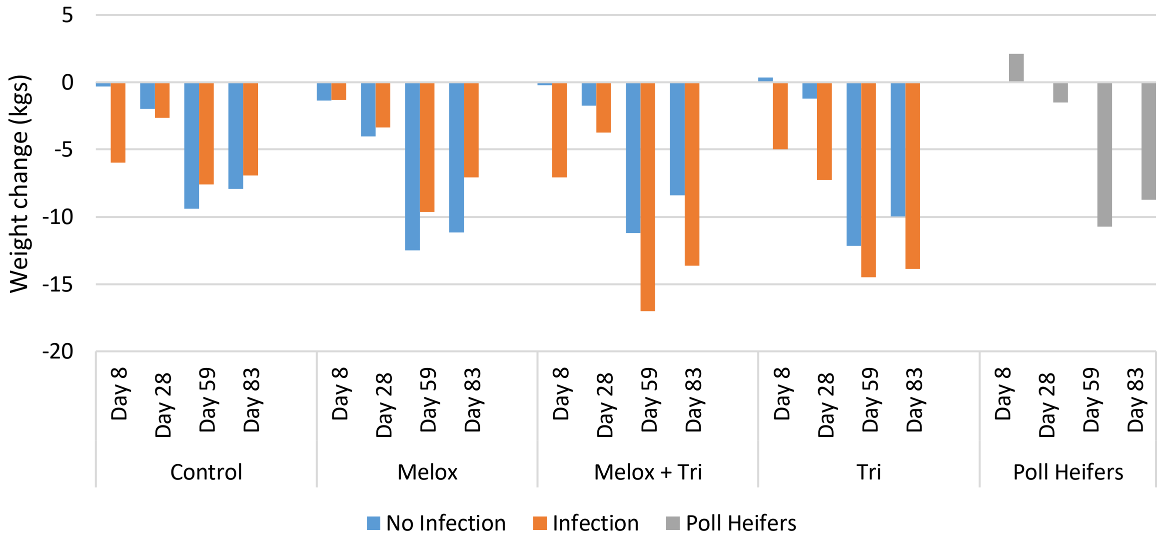


Figure 4.1.8- The effect of infection on change in weight (from initial live weight) within treatment groups at designated days following dehorning and/or castration at DDRF.

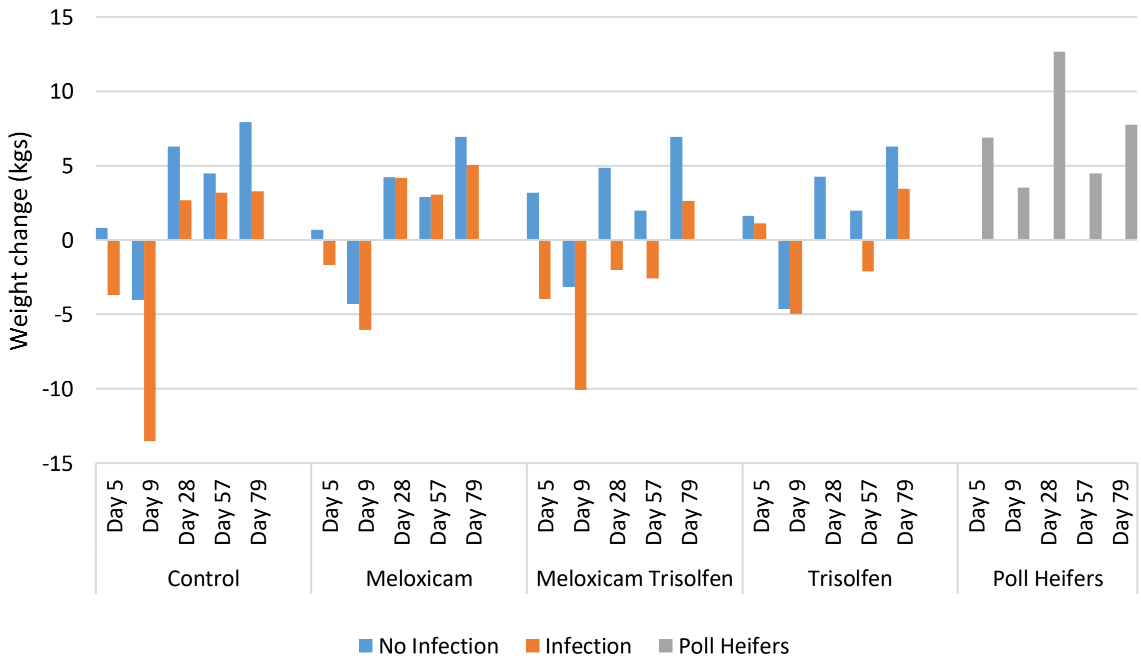


Table 4.1.9. Change in weight from initial weight by study site based on infection status. Weight is for all animals from all treatment groups (excluding Poll Heifers), broken down into infection vs no infection. Values in the same column with the same superscript differ significantly (P<0.05).

Study site		Change in weight (from initial weight)					
DDRF	No infection	1.6[a]	-4.0[a]	5.0	2.9	7.1	21.7
	Infection	-1.6[a]	-7.5[a]	1.4	0.4	3.8	17.6
		(Day 5)	(Day 9)	(Day 28)	(Day 56)	(Day 79)	(Day 156)
KRS	No infection	-	-0.4[b]	-2.2[b]	-11.3	-9.4	-
	Infection	-	-4.9[b]	-4.6[b]	-13.1	-11.2	-
			(Day 8)	(Day 28)	(Day 59)	(Day 83)	

There was no significant difference (P>0.05) in infection rate between treatment groups at either KRS or DDRF (Table 4.1.10). When broken down into dehorning and castration wound infection, there was no difference (P>0.05) between treatment groups for dehorning wounds at KRS or DDRF. However at DDRF castration wound infections were higher (P<0.05) in the Meloxicam group than the other three treatment groups. It is unclear what caused this elevated infection level in this treatment group. Overall DDRF had 7% higher total observed infections than KRS. The cause of this difference is unclear but may be due to unmeasured factors in the environment (feed on offer, flies etc).

Table 4.1.10. Infection rate observed by treatment group and infection site at KRS and DDRF. Values in same column with a different superscript letter differ significantly (P<0.05).

	KRS			DDRF		
Treatment Group	Infection Evident (dehorning or Castration)	Dehorning Wound Infection	Castration Wound Infection	Infection Evident (dehorning or Castration)	Dehorning Wound Infection	Castration Wound Infection
Control	7.8%	4.3%	10.3%	10.2%	12.2%	2.4%[a]
Meloxicam	9.6%	6.3%	7.4%	25.0%	14.3%	19.1%[b]
Meloxicam+ Trisolfen®	11.5%	6.1%	13.0%	14.6%	22.6%	0.0%[a]
Trisolfen®	13.5%	12.5%	3.4%	20.8%	19.4%	6.7%[a]
All animals	10.6%	7.3%	8.3%	17.6%	16.8%	9.1%

Sinus exposure, as recorded at the time of procedure, was compared to the incidence of infection in dehorning wounds on day 8/9. Exposed sinus' correlated to increased chance of developing an infection (P<0.05) (Table 4.1.11). The observed infection incidence in exposed sinus vs non exposed sinus at KRS was 18% (7-34%, CI 95%) and 5% (1.8-9.1%, CI 95%) respectively. At DDRF the infection incidence in exposed sinus vs non exposed sinus was 48% (30.8-66%, CI 95%) and 8% (3.0-14.7%, CI 95%) respectively. As horn size increased, so did the rate of sinus exposure (Table 4.1.12).

Table 4.1.11. Comparison of infection rate of exposed vs non exposed sinus following dehorning. Values in the same row with a different subscript differ significantly (P<0.05).

	Exposed sinus			Non exposed sinus		
Study site	Exposed sinus (n)	Infection (n)	Proportion (%)	Non exposed sinus (n)	Infections (n)	Proportion (%)
KRS	38	7	18_a	155	7	5_b
DDRF	31	15	48_a	112	9	8_b

Table 4.1.12. Proportion of animals at each horn size with an exposed sinus following dehorning.

Site	Small Horns	Medium Horns	Large Horns
DDRF	4%[a]	30%[b]	100%[c]
KRS	4%[a]	23%[b]	32%[b]

Values in the same row with a different superscript differ significantly (P>0.05).

Wound healing

Wound healing was recorded up to and including the day 56 at KRS, and up to day 79 at DDRR (all wounds had fully healed at day 156 inspection). There were no significant differences observed between treatment groups at either KRS or DDRF for dehorning wounds (Table 4.1.13 and Table 4.1.14 respectively) or castration wounds (Table 4.1.15 and Table 4.1.16). Castration wounds at both sites were almost all fully healed 8 weeks following the procedure. Dehorning wounds were observed to take longer to heal, with healing still occurring on day 56 at KRS and day 79 at DDRF. As there was no observable treatment effect, animals at each site were pooled together and a comparison done on wound healing between sites. There was no significant difference in distribution of wound healing for either castration or dehorning wounds between sites when compared at days 8/9, 28 and 56/57.

Table 4.1.13. Frequency of dehorning wound scores at designated times by treatment group following the procedure at KRS.

		Dehorning score KRS							
	Treatment group	1	2	3	4	5	6	7	Total
Day 8	Control	0	0	38	6	2	0	2	48
	Meloxicam	0	0	32	10	2	0	3	47
	Meloxicam + Trisolfen	0	0	36	6	4	0	3	49
	Trisolfen	0	0	33	6	3	0	6	48
Day 28	Control	0	10	34	2	2	0	0	48
	Meloxicam	0	12	35	0	0	0	0	47
	Meloxicam + Trisolfen	0	11	37	1	0	0	0	49
	Trisolfen	0	9	37	0	1	0	1	48
Day 56	Control	6	36	5	0	0	0	0	47
	Meloxicam	2	36	9	0	0	0	0	47
	Meloxicam + Trisolfen	7	32	10	0	0	0	0	49
	Trisolfen	9	28	11	0	0	0	0	48

Table 4.1.14. Frequency of castration wound scores between treatment groups at designated times following the procedure at KRS.

	Treatment group	Castration score- KRS					
		1	2	3	4	5	Total
Day 8	Control	0	0	21	6	2	29
	Meloxicam	0	0	18	5	2	25
	Meloxicam + Trisolfen	0	0	16	4	3	23
	Trisolfen	0	0	27	1	1	29
Day 28	Control	0	13	12	4	0	29
	Meloxicam	0	11	13	1	0	25
	Meloxicam + Trisolfen	0	9	10	4	0	23
	Trisolfen	0	8	17	4	0	29
Day 56	Control	23	5	0	0	0	28
	Meloxicam	20	5	0	0	0	25
	Meloxicam + Trisolfen	17	5	0	1	0	23
	Trisolfen	24	5	0	0	0	29

Table 4.1.15. Frequency of dehorning wound scores at designated times by treatment group following the procedure at DDRF.

		Dehorning score- DDRF							
	Treatment group	1	2	3	4	5	6	7	Total
Day 5	Control	0	0	26	12	2	0	1	41
	Meloxicam	0	0	17	11	3	0	2	33
	Meloxicam + Trisolfen	0	0	17	8	1	0	5	31
	Trisolfen	0	0	18	14	3	0	1	36
Day 9	Control	0	0	34	2	1	0	4	41
	Meloxicam	0	0	25	3	1	0	4	33
	Meloxicam + Trisolfen	0	0	20	4	0	0	7	31
	Trisolfen	0	0	22	6	1	0	7	36
Day 28	Control	0	12	26	0	0	0	0	38
	Meloxicam	0	9	21	0	0	0	1	31
	Meloxicam + Trisolfen	0	13	15	1	0	0	1	30
	Trisolfen	0	10	24	2	0	0	0	36
Day 57	Control	5	32	3	0	0	0	0	40
	Meloxicam	5	22	6	0	0	0	0	33
	Meloxicam + Trisolfen	1	23	6	0	0	0	0	30
	Trisolfen	3	26	7	0	0	0	0	36
Day 79	Control	15	25	0	0	0	0	0	40
	Meloxicam	12	20	1	0	0	0	0	33
	Meloxicam + Trisolfen	7	18	4	0	0	0	0	29
	Trisolfen	11	22	3	0	0	0	0	36

Table 4.1.16. Frequency of castration wound scores between treatment groups Castration wound score at designated times following the procedure at DDRF.

		Castration score - DDRF					
	Treatment group	1	2	3	4	5	Total
Day 5	Control	0	0	37	4	0	41
	Meloxicam	0	0	33	11	1	45
	Meloxicam + Trisolfen	0	0	39	6	0	45
	Trisolfen	0	0	40	5	0	45
Day 9	Control	0	0	29	11	1	41
	Meloxicam	0	0	29	8	8	45
	Meloxicam + Trisolfen	0	0	34	11	0	45
	Trisolfen	0	0	25	17	3	45
Day 28	Control	0	22	15	3	0	40
	Meloxicam	0	18	17	6	2	43
	Meloxicam + Trisolfen	0	15	24	2	0	41
	Trisolfen	0	18	19	6	0	43
Day 57	Control	38	3	0	0	0	41
	Meloxicam	43	2	0	0	0	45
	Meloxicam + Trisolfen	41	3	0	0	0	44
	Trisolfen	39	5	0	1	0	45
Day 79	Control	41	0	0	0	0	41
	Meloxicam	45	0	0	0	0	45
	Meloxicam + Trisolfen	43	0	0	0	0	43
	Trisolfen	44	0	1	0	0	45

Mortality

In the 7 days following the procedure, a mortality rate of 0.48% and 0.51% was observed at KRS and DDRF respectively. Mortalities were observed at KRS in the Meloxicam treatment group (n=1), and at DDRF in the Meloxicam treatment group (n=1). Both deceased animals were both castrated and dehorned, but the cause of death was not determined (no post-mortem conducted). The number of animals monitored in this project did not support a statistical comparison between treatment groups or sites, due to the low occurrence of mortalities.

4.1.2 On property trial results

Sex distribution

Sex distribution varied between sites, with males dominant at some sites, while others had a more even distribution (Table 4.1.17). This is due to some sites retaining females as replacements which were not part of the trial herds. A total of 1,958 females and 2,412 males were part of the trial herds.

Table 4.1.17. Breakdown of male and female weaners grouped by treatment and study site.

Treatment Group		Control	Meloxicam	Meloxicam+ Trisolfen®	Trisolfen®	Polled
DDRF 2020	Male	46	44	46	42	-
	Female	26	32	28	35	48
DDRF 2021	Male	44	41	42	44	-
	Female	3	6	5	7	41
DDRF 2022	Male	89	85	82	91	0
	Female	40	46	41	41	75
NT Site 1	Male	83	79	-	-	-
	Female	15	21	-	-	-
NT Site 3a	Male	21	31	35	32	-
	Female	44	35	33	39	44
NT Site 3b	Male	28	18	22	25	-
	Female	24	37	32	28	-
NT Site 2a	Male	13	12	17	23	16
	Female	12	13	13	13	27
NT Site 2b	Male	27	23	26	31	18
	Female	26	27	26	29	30
NT Site 2c	Male	22	28	22	29	-
	Female	25	16	23	16	59
Spyglass	Male	34	32	35	35	-
	Female	17	15	15	17	-
WA Site 1a	Male	45	44	41	31	-
	Female	30	31	34	44	-
WA Site 2a	Male	50	50	50	50	-
	Female	0	0	0	0	-
WA Site 3a	Male	63	58	55	65	-
	Female	10	18	19	8	-
WA Site 1b	Male	37	38	38	37	-
	Female	38	37	37	38	-
WA Site 2b	Male	75	77	72	73	-
	Female	-	-	-	-	-
WA Site 3b	Male	37	40	40	40	-
	Female	5	3	4	4	46

Liveweight

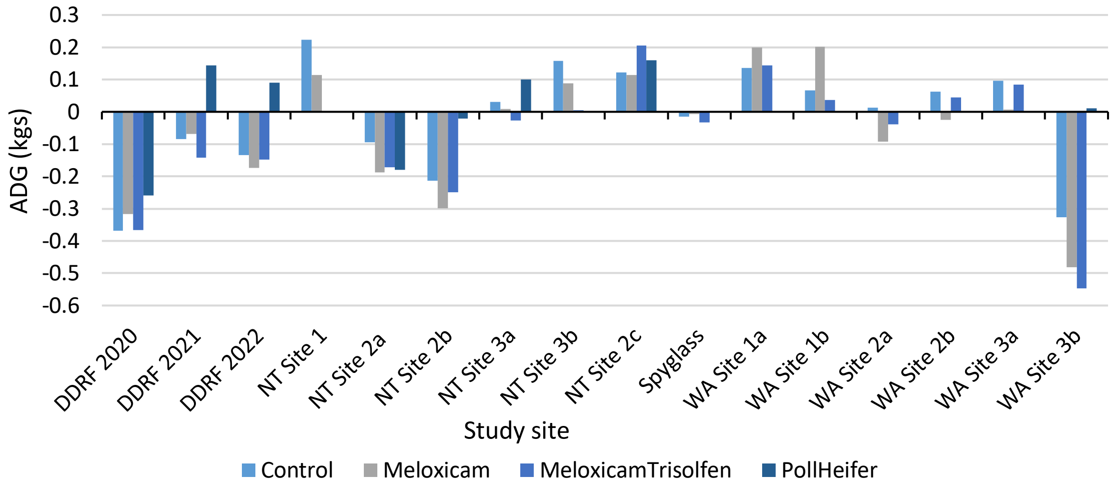
Change in liveweight from day 0 to the second inspection was assessed. Statistical differences could be observed at DDRF 2021, DDRF 2022, NT Site 2b, NT Site 2c, NT Site 3a and WA site 3b between some dehorned/castrated treatment groups and Poll., while at NT Site 1 and WA Site 2 a statistical difference could be observed between the Control and Meloxicam treatment groups. No statistically significant difference could be seen at DDRF 2020, NT Site 2a, Spyglass, WA Sites 1a, 2a, 3a, 1b and 2b (Table 4.1.18). There was no consistent effect of treatment on liveweight change and pain relief did not significantly improve liveweight change.

Average daily gain (ADG) was calculated for each study site, to be able to compare one site to another (Fig. 4.1.18). An average weight loss was observed in one or more treatment groups at 11 of the 16 herds.

Table 4.1.18. Average weight change between day of procedure to second weigh by treatment group. Weight measured in kgs (±StDev). Values in the same row with a different superscript differ significantly (P<0.05).

Treatment Group	Meloxicam	Trisolfen	Meloxicam +Trisolfen	Control	Poll Heifers
DDRF 2020	-7.6 (±9.9)	-7.4 (±7.1)	-7.7 (±7.1)	-7.7 (±7.0)	-5.4 (±6.2)
DDRF 2021	-1.5^{A} (±6.0)	-0.9^{A} (±6.8)	-3.1^{A} (±7.3)	-1.9^{A} (±6.3)	3.1^{B} (±5.2)
DDRF 2022	-3.6^{a} (±8.4)	-1.9^{a} (±9.1)	-3.1^{a} (±8.4)	-2.8^{a} (±8.8)	1.9^{b} (±8.6)
NT Site 1	3.1^{A} (±6.9)	-	-	6.0^{B} (±8.9)	-
NT Site 3a	0.2^{A} (±4.7)	-1.1^{A} (±6.5)	-0.8^{A} (±7.4)	0.9 (±6.2)	3.1^{B} (±7.5)
NT Site 3b	4.5 (±8.1)	2.5^{B} (±8.4)	0.1^{B} (±7.2)	-0.1^{A} (±9.2)	-
NT Site 2a	-8.66 (±7.9)	-7.5 (±7.2)	-7.9 (±6.2)	-4.3 (±8.5)	-7.6 (±6.0)
NT Site 2b	-4.5^{A} (±6.5)	-6.3^{A} (±9.5)	-5.2^{A} (±7.3)	-7.6 (±9.7)	-0.5^{B} (±6.1)
NT Site 2c	4.7 (±8.7)	4.4^{B} (±7.7)	7.8^{A} (±6.9)	0.9 (±7.4)	6.1^{A} (±6.9)
Spyglass	-0.2 (±11.9)	-1.8 (±9.0)	0.1 (±7.6)	-0.3 (±8.2)	-
WA Site 1a	4.2 (±7.7)	3.7 (±7.4)	3.0 (±7.8)	2.9 (±8.8)	-
WA Site 2a	-3.2^{A} (±7.8)	-0.7 (±8.1)	-1.4 (±8.1)	0.5^{B} (±8.4)	-
WA Site 3a	0.5 (±12.5)	1.5 (±13.9)	1.8 (±12.3)	2.0 (±14.1)	-
WA Site 1b	1.4 (±11.4)	4.2 (±11.8)	0.8 (±10.9)	2.2 (±11.3)	-
WA Site 2b	1.3 (±7.9)	-0.5 (±7.2)	0.9 (±5.2)	0.2 (±6.2)	-
WA Site 3b	-6.9^{A} (±10.8)	-10.1^{B} (±11.7)	-11.5^{A} (±9.7)	-3.5^{AB} (±10.3)	0.2^{C} (±7.3)

Figure 4.1.18. Comparison of average daily gain (ADG) in the time following castration/dehorning on each treatment site.



Procedure effect

As no consistent treatment effect was observed, the effect of procedure; castrated only, dehorned only or castrated + dehorned, was examined (Table 4.1.19). Dehorning had the most impact on liveweight change and castrated only animals tended to perform better than dehorned or dehorned + castrated animals, although this was not seen at all sites.

Table 4.1.19. Comparison of procedure effect (castration, dehorning, castration + dehorning) on liveweight by study site. Values in the same row with the same superscript differ significantly (P<0.05). *NT Site 2a, 2b and 2c and WA Site 2a excluded from analyses due to only having one procedure group.

Study site	Procedure (mean liveweight change (kgs))		
	Castrated only	Dehorned only	Castrated + Dehorned
DDRF 2020	-5.9[a]	-6.2[b]	-9.7[ab]
DDRF 2021	-0.03[a]	-3.0	-2.5[a]
DDRF 2022	-0.8[a]	-1.3[b]	-4.3[ab]
NT Site 1	6.9[ab]	-0.5[a]	1.2[b]
NT Site 3a	-	-1.4[a]	1.3[a]
NT Site 3b	-	2.9	0.9
NT Site 2a*	-	-7.2	-
NT Site 2b*	-	-5.9	-
NT Site 2c*	-	-4.8	-
Spyglass	-0.4	0.4	-2.3
WA Site 1a	5.0	3.2	3.3
WA Site 1b	5.5	1.9	2.0
WA Site 2a*	-	-	4.2
WA Site 2b	-0.7	-	0.6
WA Site 3a	0.5	3.3	1.7
WA Site 3b	-8.0	-7.0	-8.3

Infection

Infections, defined as a visually observable purulent wound exudate, were observed at 15 of the 16 sites. No infections were observed at NT Site 2. This may be due to the extended time before the second inspection, allowing any infections to have resolved. Prevalence of infection can be seen in Table 4.1.20 (dehorning wound infections) and Table 4.1.21 (castration wound infections). The only occurrence of significant difference (P<0.05) between treatment groups was recorded at DDRF 2020, DDRF 2022, NT Site 3b, NT Site 2b, WA Site 1a and WA Site 2a.

The impact of infection on ADG was examined. It was observed at all sites that animals that developed an infection had lower ADGs than animals that did not develop an infection, however this was only significant (P<0.05) at DDRF 2020, DDRF 2021, DDRF 2022, NT site 3b and WA Site 2a, with a trend (P<0.1) at Spyglass and WA site 3b (Fig. 4.1.22).

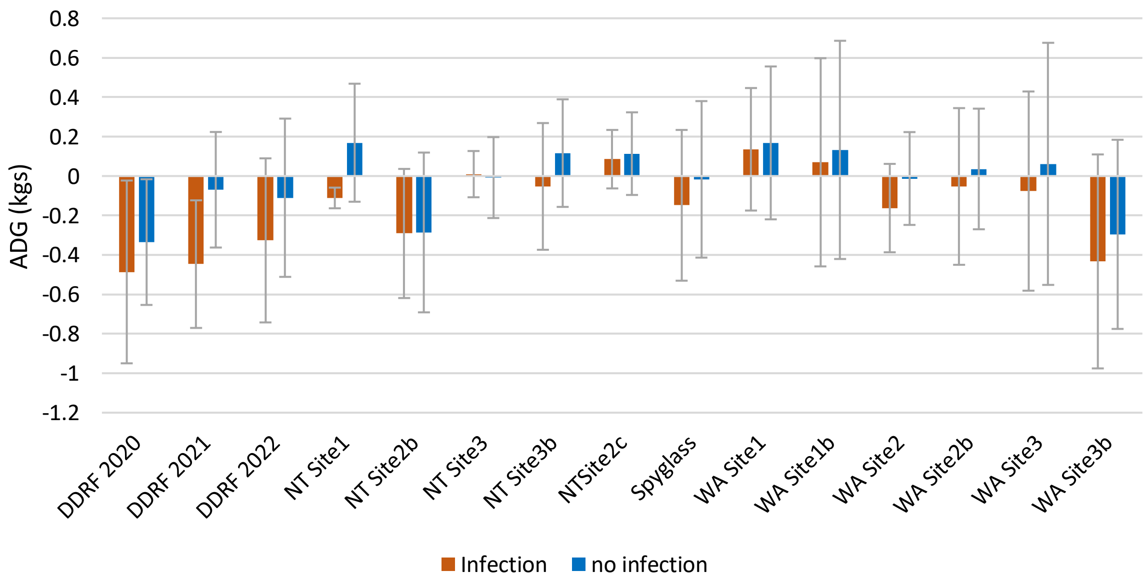
Table 4.1.20. Breakdown of infection rates observed at each study site by treatment group and infection site. Infection rates are expressed as a % for each treatment group at each site (number of animals that developed an infection/number of animals that had a dehorning wound). Values in same row with a different superscript letter differ significantly (P<0.05).

Treatment group	Dehorning wound				
	Control	Meloxicam	Meloxicam+Trisolfen®	Trisolfen®	**All Animals**
DDRF 2020	8.77%	1.49%^{B}	6.35%	12.90%^{A}	**7.17%**
DDRF 2021	0%	0%	0%	5.56%	**1.45%**
DDRF 2022	3.88%	1.72%	7.77%^{A}	2.65%^{B}	**3.91%**
NT Site 1	5.71%	0%	-	-	**2.86%**
NT Site 3a	0%	1.54%	1.47%	5.63%	**2.46%**
NT Site 3b	15.38%^{A}	30.91%^{B}	44.44%^{B}	33.96%	**31.31%**
NT Site 2a	0%	0%	0%	0%	**0%**
NT Site 2b	4%	0%^{A}	10%^{B}	9%^{B}	**6%**
NT Site 2c	0%	0%	2.50%	7.32%	**2.53%**
Spyglass	18.80%	9.40%	18.90%	16.20%	**15.80%**
WA Site 1a	5.90%^{A}	8.80%	17.40%^{B}	14.50%	**12.40%**
WA Site 1b	47.69%	48.53%	40.30%	43.94%	**45.11%**
WA Site 2a	2.00%^{B}	14%^{A}	16%^{A}	14%^{A}	**11.60%**
WA Site 2b	8.06%	14.06%	7.02%	8.77%	**9.58%**
WA Site 3	0%	2.63%	2.63%	0%	**1.32%**
WA Site 3b	21.05%	16.67%	22.73%	16.67%	**19.72%**

Table 4.1.21. Breakdown of infection rates observed at each study site by treatment group and infection site. Infection rates are expressed as a % for each treatment group at each site (number of animals that developed an infection/number of animals that had a castration wound). Values in same row with a different superscript letter differ significantly (P<0.05).

Treatment Group	Castration wound				
	Control	Meloxicam	Meloxicam+Trisolfen®	Trisolfen®	**All Animals**
DDRF 2020	7%	9%	2%	7%	**6%**
DDRF 2021	2%	5%	5%	0%	**3%**
DDRF 2022	17%	21%	17%	15%	**18%**
NT Site1	0%	0%	-	-	**0%**
NT Site2a	-	-	-	-	**-**
NT Site2b	-	-	-	-	**-**
NT Site3	0%	0%	0%	0%	**0%**
NT Site3b	14%^{A}	6%	9%^{B}	12%	**11%**
NTSite2c	-	-	-	-	**-**
Spyglass	15%	6%	6%	21%	**12%**
WA Site1	3%	0%	0%	0%	**1%**
WA Site1b	26%	24%	35%	36%	**30%**
WA Site2a	2%	6%	4%	0%	**3%**
WA Site2b	16%	11%	7%	6%	**10%**
WA Site3a	7%	4%	2%	2%	**3%**
WA Site3b	62%	62%	63%	56%	**61%**

Figure 4.1.22. Comparison of ADG by site for animals that developed an observable infection vs animals that did not.



Sinus exposure was compared to the incidence of infection in dehorning wounds (Table 4.1.23) noting NT Site 2b was excluded due to lost data. It was observed that exposed sinus' increased the chance of developing an infection (P<0.05) in 10 of the 16 herds. NT Site 1 was excluded from analyses due to having no exposed sinuses, due to using cautery dehorning.

Table 4.1.23. Comparison of infection rates for exposed vs non-exposed sinuses by treatment site. Values in the same row with a different superscript differ significantly (P<0.05). Proportion calculated as total number of infections observed for animals recorded as non-exposed sinus/total number of animals with non-exposed sinus or total number of infections observed for animals recorded as exposed sinus/total number of animals recorded as exposed sinus at each treatment site.

	Non-exposed sinus			Exposed sinus		
	Non-exposed sinus (n)	Infections (n)	**Proportion (%)**	Exposed sinus (n)	Infections (n)	**Proportion (%)**
DDRF 2020	178	1	**0.56%^{A}**	74	17	**22.97%^{B}**
DDRF 2021	106	0	**0%^{A}**	31	2	**6.45%^{B}**
DDRF 2022	312	1	**0.32%^{A}**	142	16	**11%^{B}**
NT Site 1	71	2	**2.82%**	-	-	**-**
NT Site 3a	55	0	**0%**	214	6	**2.80%**
NT Site 3b	53	8	**15.09%^{A}**	161	59	**36.65%^{B}**
NT Site 2a	89	0	**0%**	27	0	**0%**
Spyglass	52	2	**3.85%^{A}**	87	20	**22.99%^{B}**
WA Site 1a	143	10	**6.99%^{A}**	124	22	**17.74%^{B}**
WA Site 1b	106	30	**28.30%^{A}**	175	90	**51.43%^{B}**
WA Site 2a	43	0	**0%^{A}**	155	23	**14.84%^{B}**
WA Site 2b	165	6	**3.64%^{A}**	95	17	**17.89%^{B}**
WA Site 3a	124	1	**0.81%**	32	1	**3.13%**
WA Site 3b	47	3	**6.38%^{A}**	29	11	**37.93%^{B}**

Horn size was also recorded at the time of dehorning. Horn size was assessed as small, medium, or large. Small horns were assessed as unattached horn buds or horns less than 2.5cm in diameter at the base, medium horns were horns between 2.5cm and 4cm in diameter at the base, while large horns were greater then 4cm diameter at the base or protruded more than 2.5cm from the head. Summary of horn size can be seen in Figure 4.1.25. It can be seen in Table 4.1.24 that as horn size increases so does the proportion of animals with exposed sinuses, this relationship was significant at all sites. Horn size vs initial weight at each site was analysed for covariance using a regression model. It can be seen in Table 4.1.26 that there was a significant relationship (P<0.05) for horn size vs starting weight at all study sites. Animals with a higher starting weight were likely to have larger horns. While this relationship was significant at all sites, it can be seen that the R^2 values at all sites were quite low, this is likely due to the fact horns size was ranked rather than measured exactly.

Table 4.1.24. Proportion of animals at each site with an exposed sinus by horn size. Note, NT Site 1 excluded due to using cautery dehorning. Values in the same row with a different superscript differ significantly (P<0.05).

Study Site	Size of horn vs proportion with exposed sinus		
	Small	Medium	Large
DDRF 2020	0%[a]	33.9%[b]	94.6%[c]
DDRF 2021	1.4%[a]	25%[b]	90.5%[c]
DDRF 2022	5%[a]	19%[b]	66%[c]
NT Site 3a	48.9%[a]	92.7%[a]	100%[c]
NT Site 3b	64.7%[a]	85.7%[b]	59.1%[a]
NT Site 2a	7%[a]	30.8%[b]	75%[c]
Spyglass	42.3%[a]	75%[b]	100%[c]
WA Site 1a	42.2%[a]	75%[b]	87.5%[b]
WA Site 1b	39.5%[a]	77.5%[b]	95.0%[c]
WA Site 2a	63.7%[a]	95.3%[b]	95.7%[b]
WA Site 2b	6.5%[a]	43.6%[b]	92.9%[c]
WA Site 3a	11.2%[a]	20%[a]	45.8%[b]
WA Site 3b	2.9%[a]	41.7%[b]	100%[c]

Figure 4.1.25. Horn size by treatment group at each trial site. NT Site 2c excluded from graph as horn size not recorded.

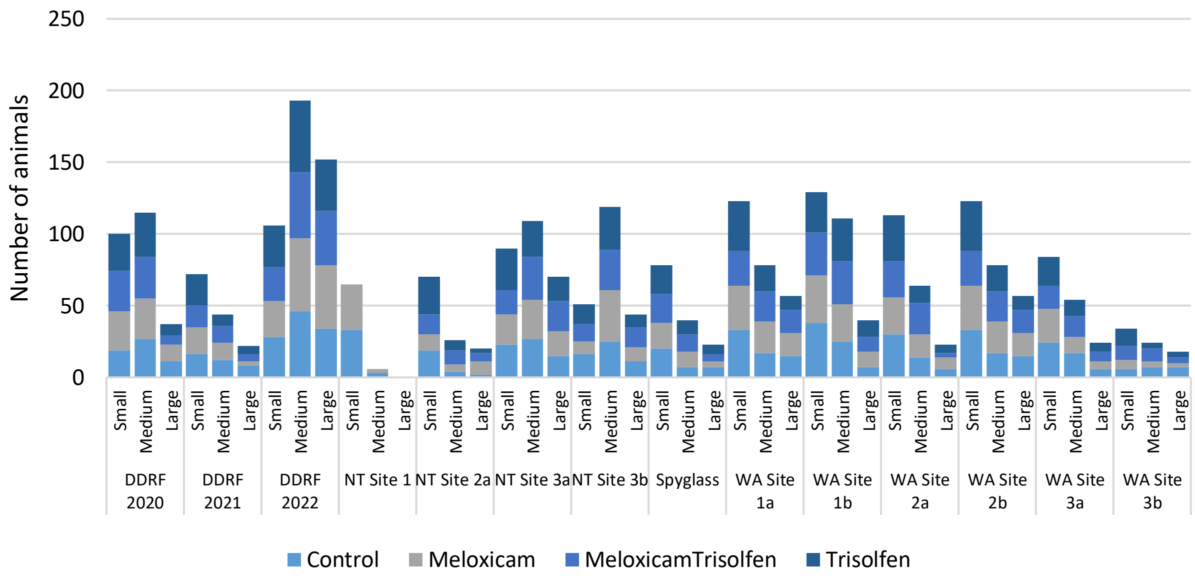


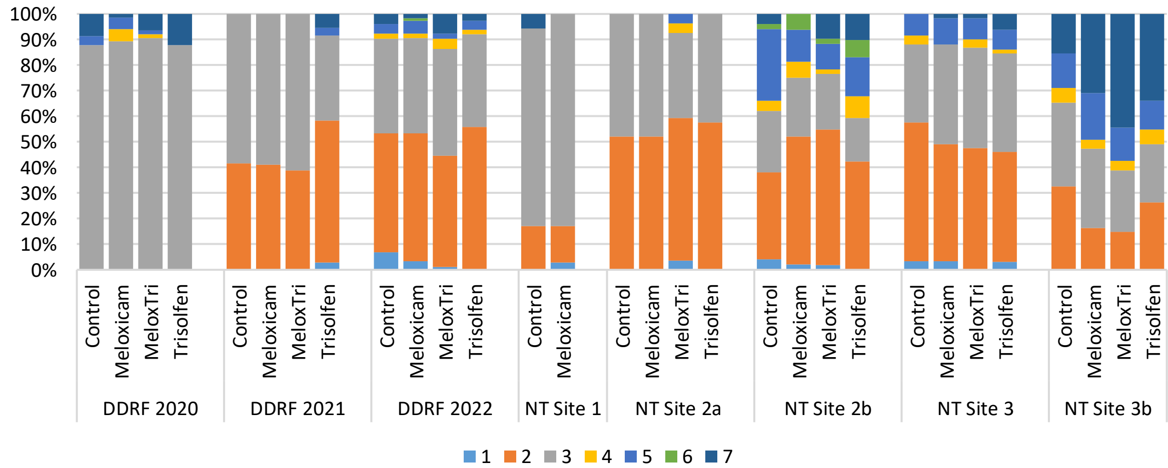
Table 4.1.26. Regression analyses of horn size vs starting weight at each study site.

Study site	R^2	P-Value
DDRF 2020	0.0611	<0.001
DDRF 2021	0.1995	<0.001
DDRF 2022	0.17	<0.001
NT Site 1	0.1694	<0.001
NT Site 3a	0.1304	<0.001
NT Site 3b	0.19	0.045
NT Site 2a	0.1182	<0.001
Spyglass	0.03146	0.0353
WA Site 1a	0.023	0.013
WA Site 1b	0.17	<0.001
WA Site 2a	0.07001	<0.001
WA Site 2b	0.045	0.00103
WA Site 3a	0.04237	0.00799
WA Site 3b	0.061	.031

Wound healing

Wound healing was also monitored at all study sites. Wounds were inspected at approximately 21 days (exact re-inspection day Table 3.1.7) and given a score (wound score description in Table 3.1.8). There were no significant differences in wound healing observed between treatment groups at any site (Figure 4.1.27 and 4.1.28). Wound healing was compared using the Kolmogorov-Smirnov test to compare the distribution of wound healing scores for each treatment group. The majority of dehorning wounds were observed to be at healing score 2-3, while castration wounds were at score 1-3.

Figure 4.1.27. Frequency of dehorning wound score by treatment group and study site.



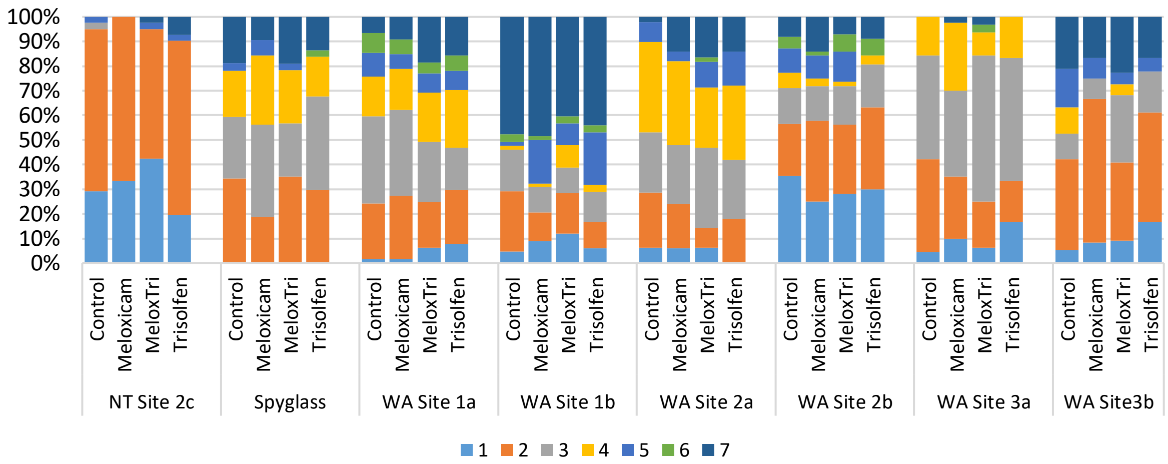
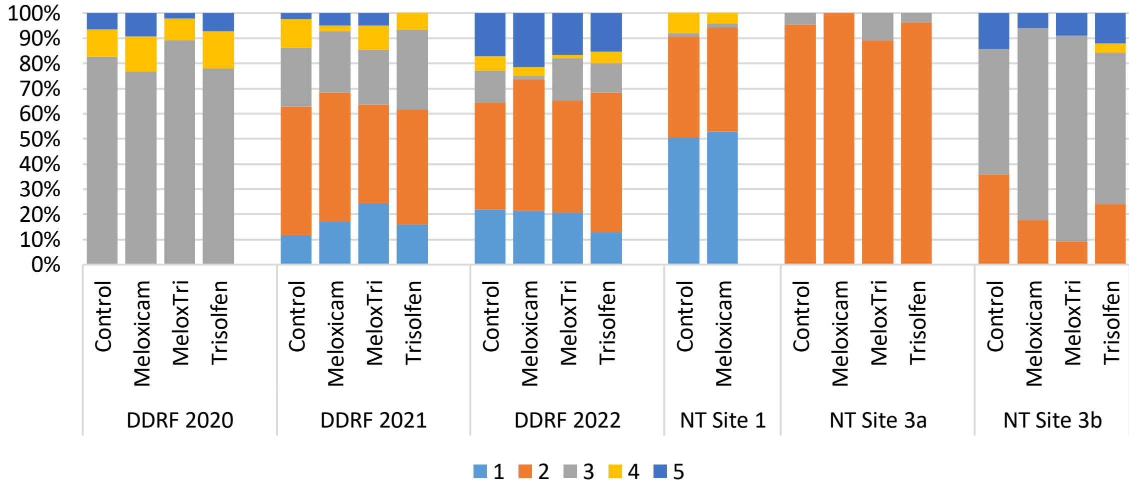
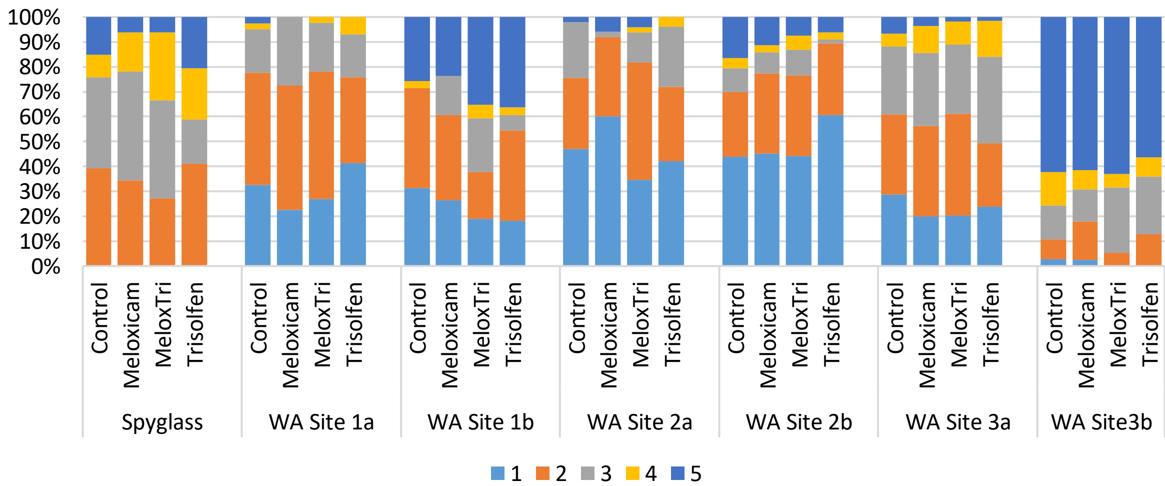


Figure 4.1.28. Frequency of castration wound score by treatment group and study site. NT Site 2a, 2b and 2c excluded due to having no castrated animals.





Mortality

No confirmed mortalities were observed at any on-property treatment site. There were some animals unaccounted for at the second inspection, but it could not be confirmed if these animals were deceased or simply missed in the muster. This uncertainty around "missingness" is common when working on extensive commercial cattle properties. The number of animals monitored in this project did not support a statistical comparison of mortalities between treatment groups or sites due to the low occurrence of mortalities (low occurrence of mortalities to be expected). To detect a 1% difference in mortalities between treatment groups, a treatment group size of 1,553 animals would be required.

GPS data

GPS data was collected for a total of 20 animals from the study sites DDRF 2021, DDRF 2022, NT Site 1, NT Site 2a and c, NT Site 3a & b, WA Site 1b, 2b & 3b (five animals per treatment group, the same animals that had accelerometer tags). Collars were removed at the second inspection. Examples of animal movement can be seen in Fig. 4.1.29. Data was analysed for average distance travelled per day (Figures 4.1.30 – 4.1.38), time spent stationary (assessed as movement of less than 10m in a 10 minute interval) (Figures 4.1.39 – 4.1.47) and time spent within 100m of water (Figures 4.1.48 – 4.1.55). Some collars stopped sending geolocation data before the second inspection, this was allowed for in the analyses.

When examining the total distance travelled per day by each treatment group it was observed that most animals usually walked approximately 10-20km per day. The total distance walked varied at each site, and was likely due to size of paddock, placement of waters and availability of feed. The initial spike in distance travelled, seen in the beginning at each site, was when the weaners were returned to the paddocks from the yards (at NT Site 2 this occurred on day 11 as animals were kept close to the yards on feed for the first 11 days where they could be monitored, as is standard practice for this producer). An additional spike was seen in the last few days at DDRF 2021, DDRF 2022, NT Site 1 and NT site3a, which was a result of the animals being walked from their paddock to the yards for the second inspection (for sites where paddocks were close to the yards, these spikes were not seen). The drop seen in total distance walked on the final day was due to the collars being removed, so a full 24 hours of distance travelled was not recorded. While some sporadic differences could be seen between treatment groups at each site, there was no consistent differences observed between treatment groups in either total distance travelled, time spent stationary or time spent within 100m of water ($P>0.05$).

Figure 4.1.29 Example of GPS track of one animal at study ①DDRF 2021, ② DDRF 2022, ③WA Site 1b, ④ WA Site 3b, ⑤ NT Site 2a, ⑥ NT Site 2c, ⑦ NT Site 3a, ⑧ NT Site 3b.

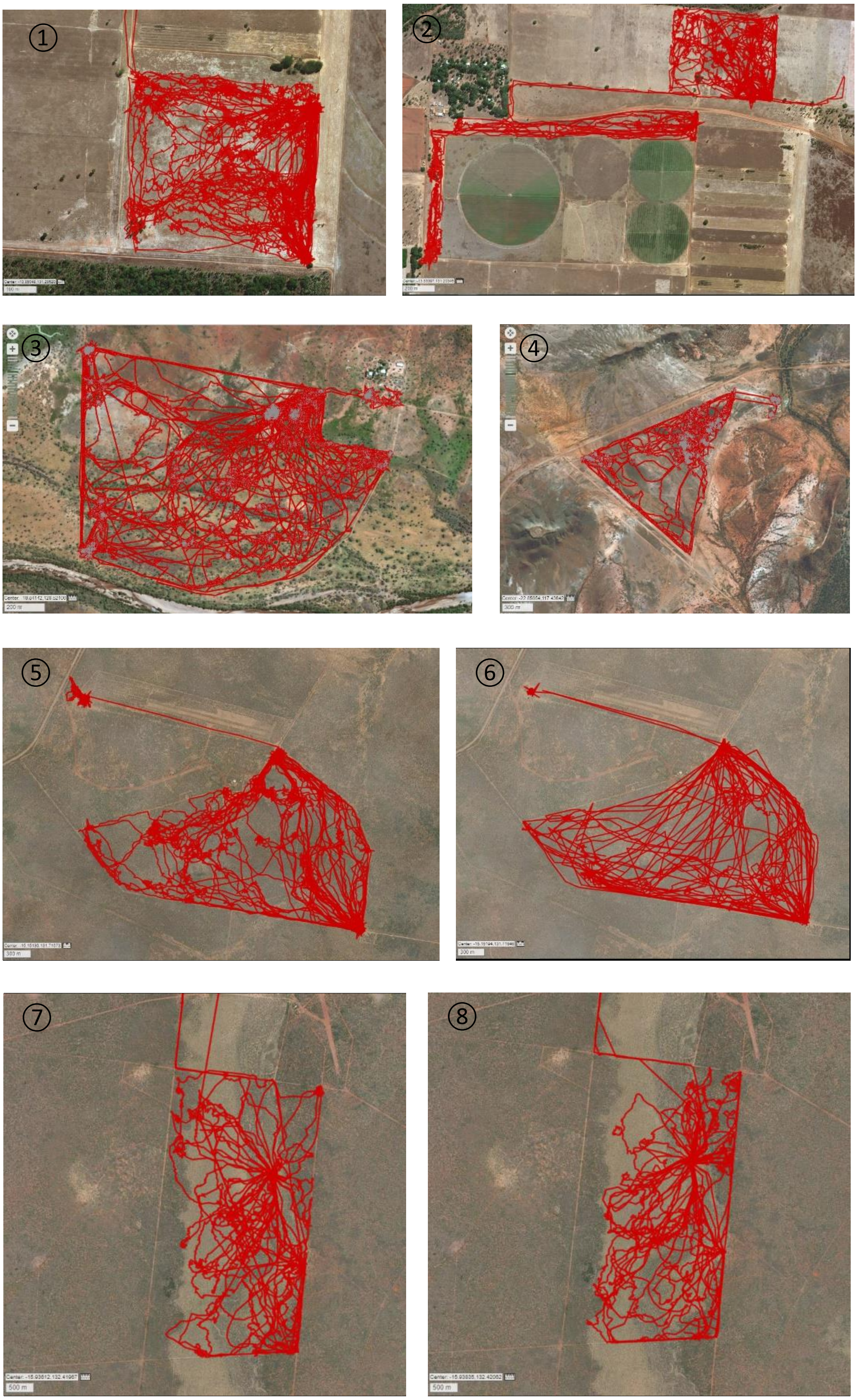


Figure 4.1.30. Average distance travelled per day (m) showing group variation (standard deviation) at DDRF 2021. Note final days' data only until 8:00am.

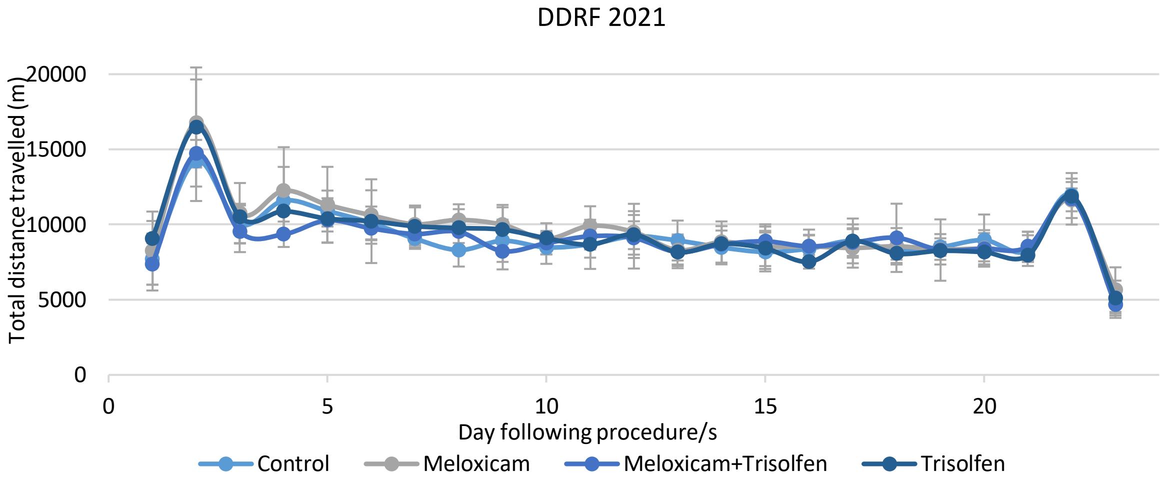


Figure 4.1.31. Average distance travelled per day (m) showing group variation (standard deviation) at DDRF 2022. Note final days' data only until 8:00am.

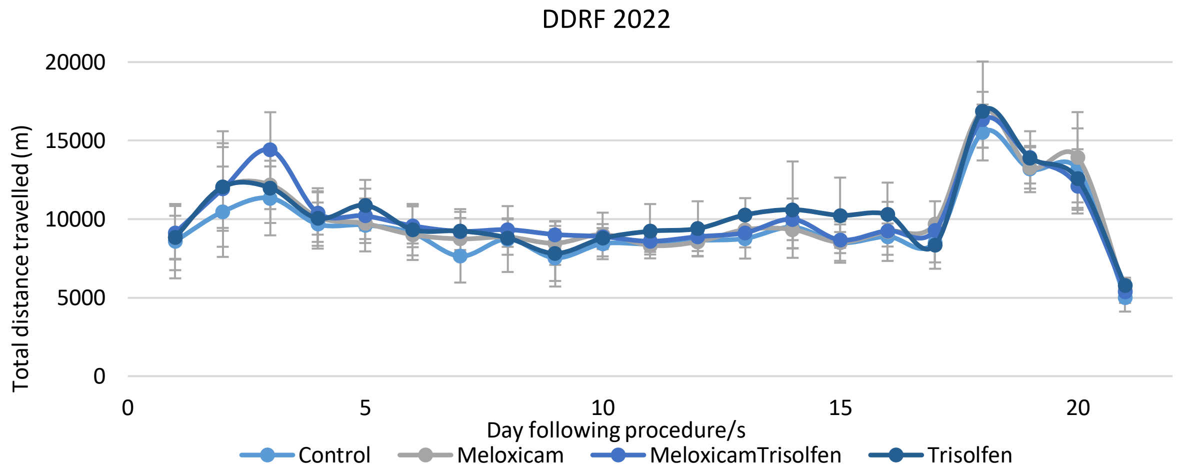


Figure 4.1.32. Average distance travelled per day (m/s) showing group variation at NT Site 3a. Note final days data only until 8:00am.

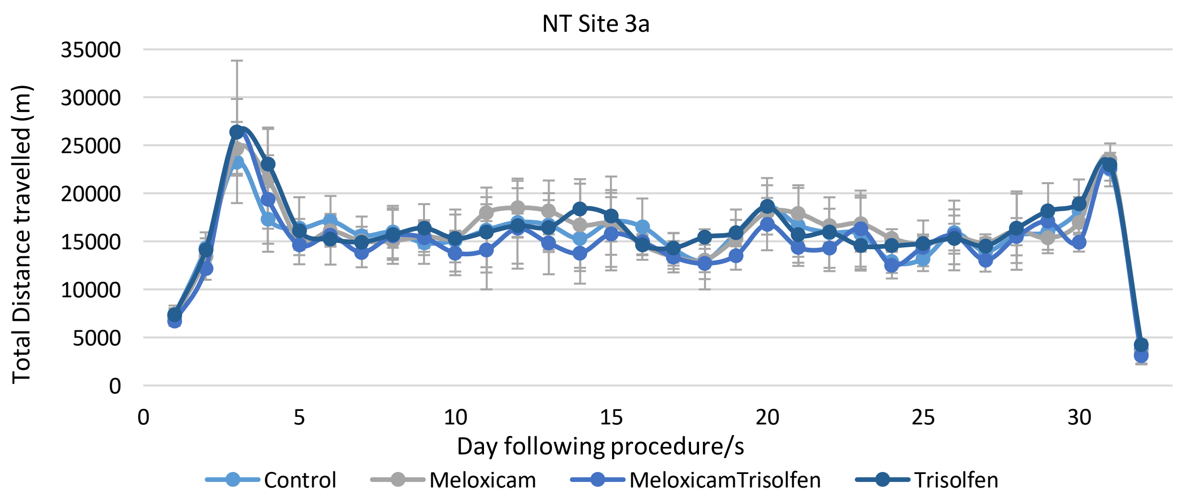


Figure 4.1.33. Average distance travelled per day (m/s) showing group variation at NT Site 3b. Note final days data excluded (day 21).

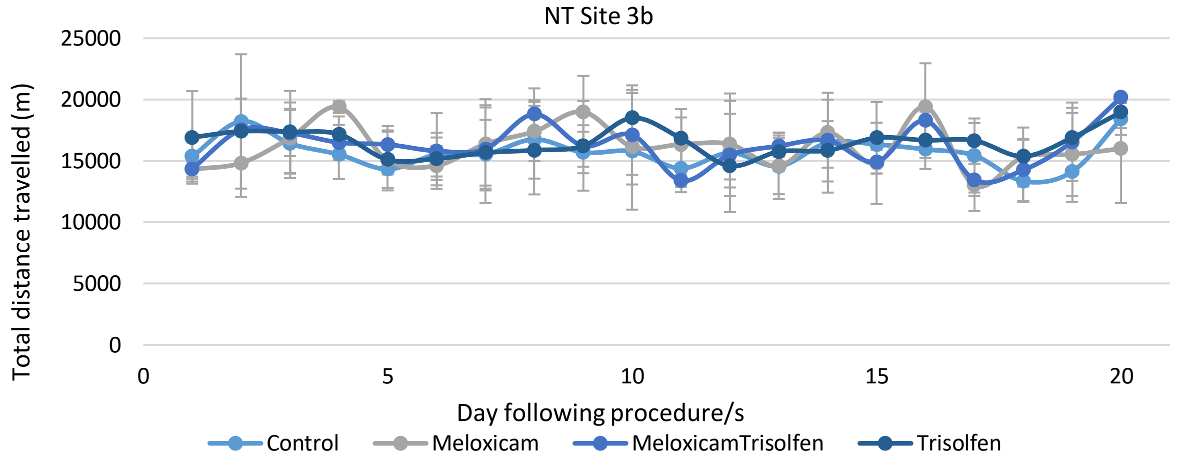


Figure 4.1.34. Average distance travelled per day (m/s) showing group variation at NT Site 1. Note final days data only until 8:00am.

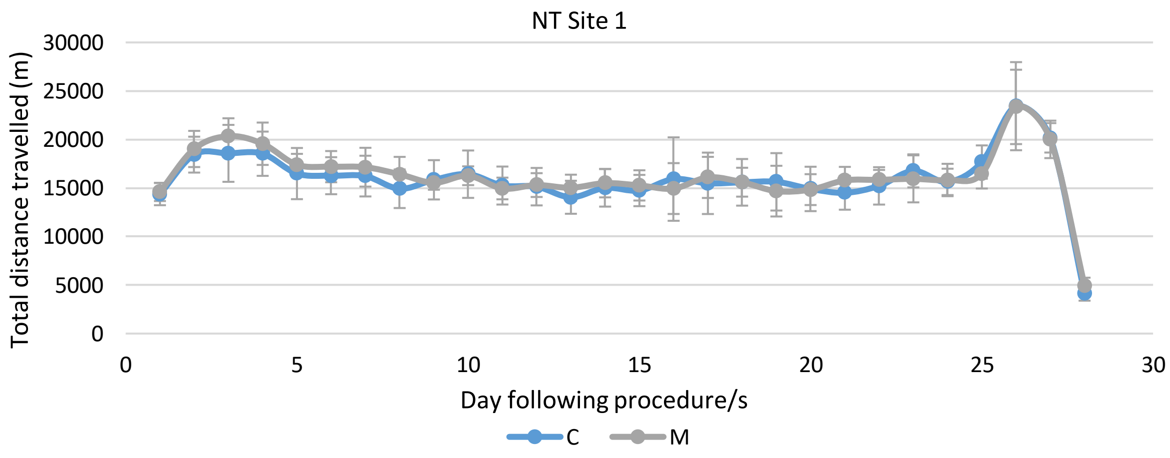


Figure 4.1.35. Average distance travelled per day (m) showing group variation at NT Site 2a. Note final days data only until 8:00am. Animals kept in yards for first 11 days before moved to large paddock.

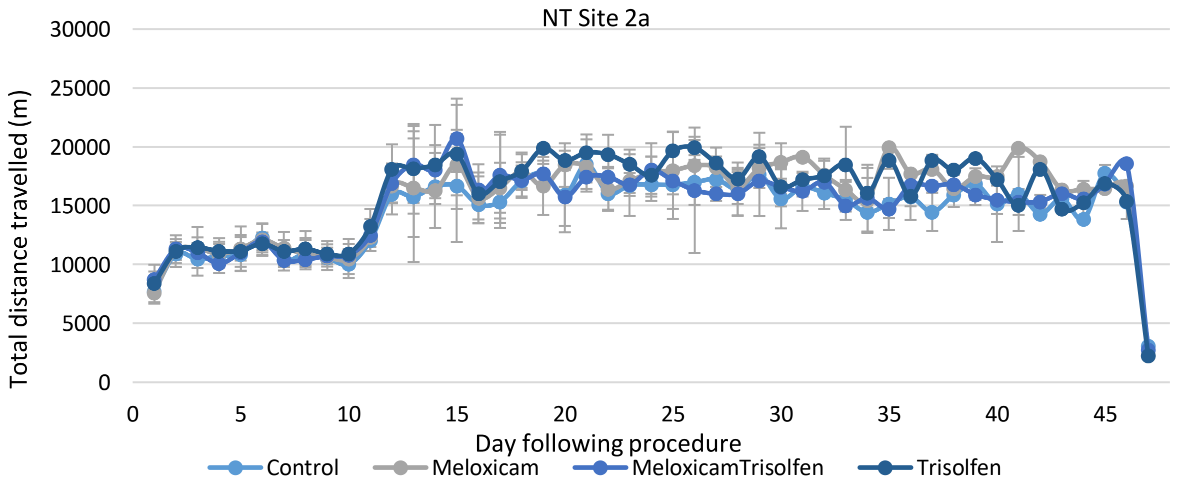


Figure 4.1.36. Average distance travelled per day (m) showing group variation at NT Site 2c. Note final days data only until 3:00pm. Animals kept in yards for first 4 days. Note Control group only has data for 1 animal.

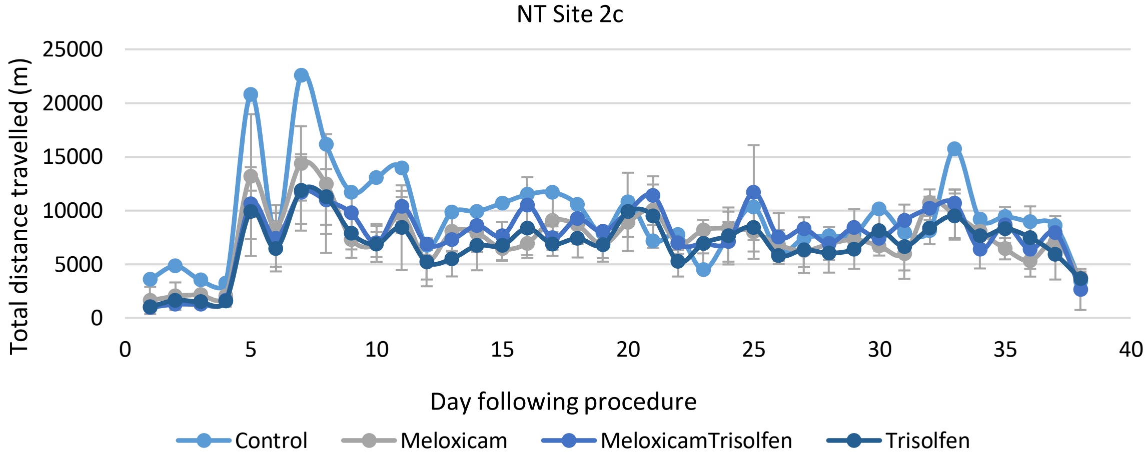


Figure 4.1.37. Average distance travelled per day (m/s) showing group variation at WA Site 1b. Note first two days excluded as weaners were kept in the yards during this time, final days data only until 12:00pm.

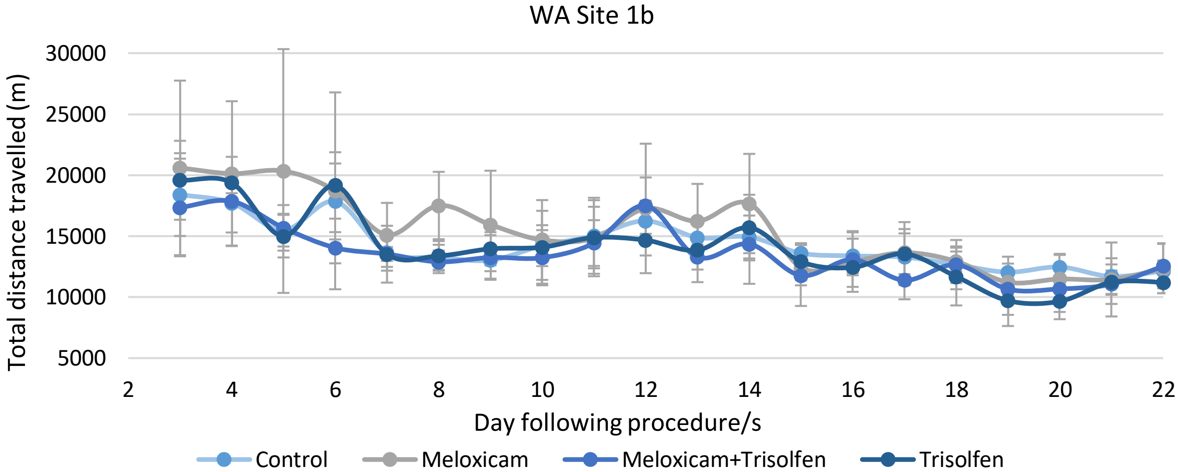
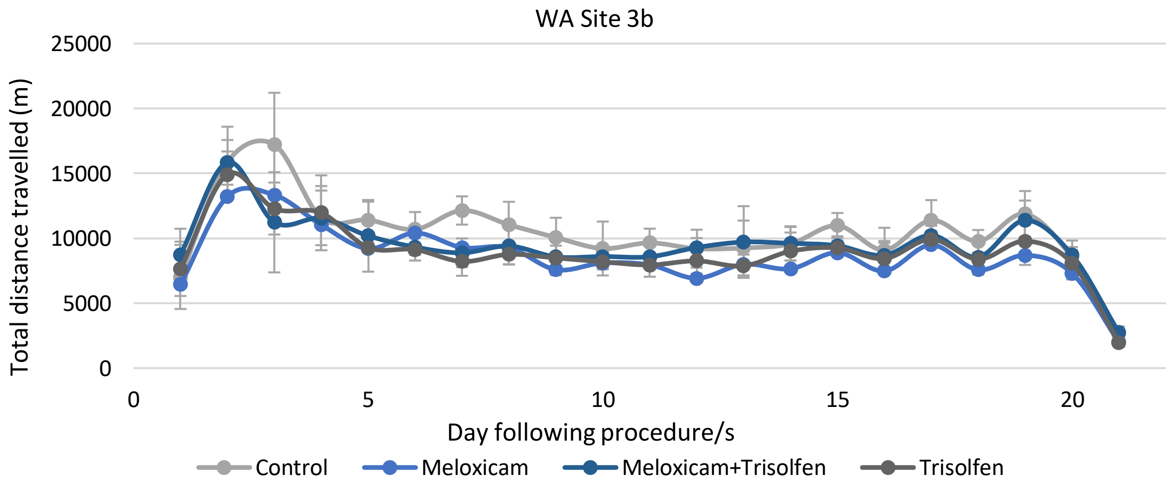


Figure 4.1.38. Average distance travelled per day (m/s) showing group variation at WA Site 3b. Note final days data only until 7am. Meloxicam Group STDEV excluded due to only having data for 1 animal.



Time spent stationary was included in the study to demonstrate if the provision of pain relief influenced grazing/camping/pacing behaviour. This was assessed as movement of less than 10m in 10 minutes and was done to allow for GPS error in each ping. The distance of 10m was decided upon based on an analysis of GPS devices by Duncan et al. 2013 that found the circular error probability (CEP) commonly used to quantify GPS accuracy of the i-gotU GT-600 fell within the 5-9.9m range. This was then analysed as minutes spent stationary per hour to assess changes over time and between treatment groups. Trends could be seen in the minutes spent stationary at each trial site. These trends were observed for all animals tending to be stationary or non-stationary at the same time, indicating time spent grazing vs time spent 'camped'. However the same trends were seen in all treatment groups, with only some sporadic differences seen between treatment groups which were likely due to chance ($P<0.05$). Fig. 4.1.39 – Fig. 4.1.47 show the average total time spent stationary per day by each treatment group at each site.

Figure 4.1.39. Total minutes per day spent stationary (movement of less than 10m in 10 minutes) at DDRF 2021. Final day (day 23 excluded).

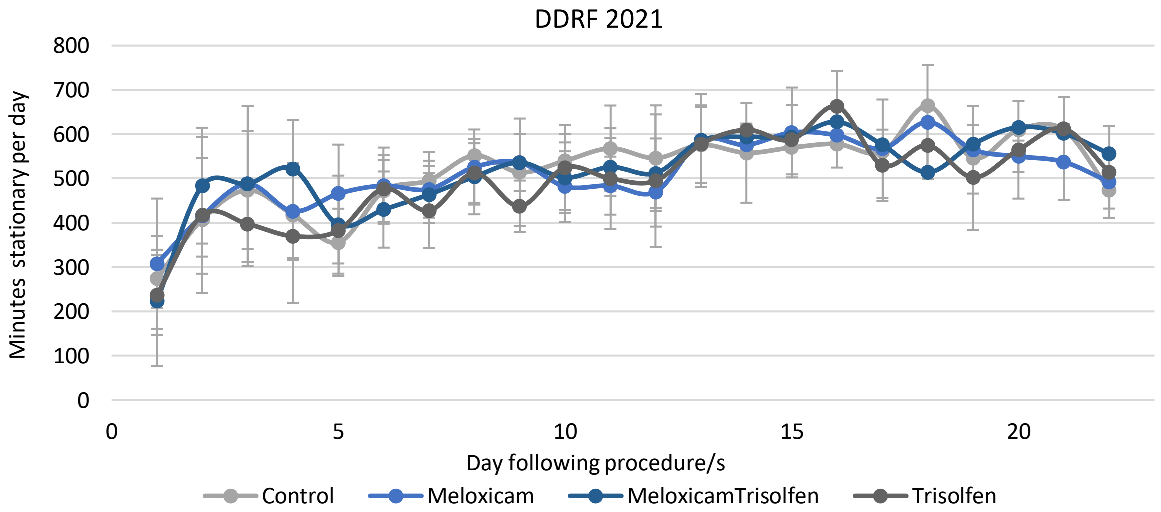


Figure 4.1.40. Total minutes per day spent stationary (movement of less than 10m in 10 minutes) at DDRF 2022. Final day (day 21 excluded).

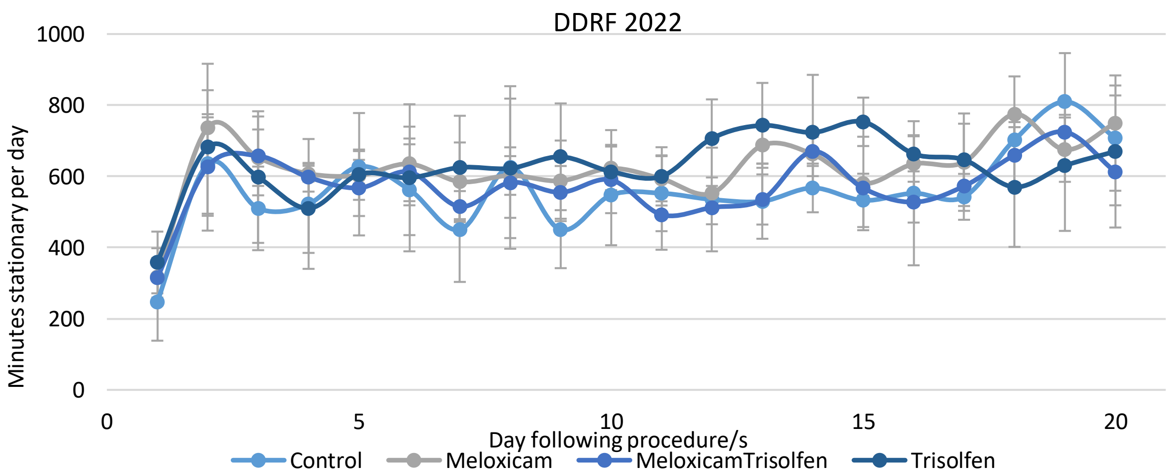


Figure 4.1.41. Total minutes per day spent stationary (movement of less than 10m in 10 minutes) at WA Site 1b. Final day (day 21 excluded).

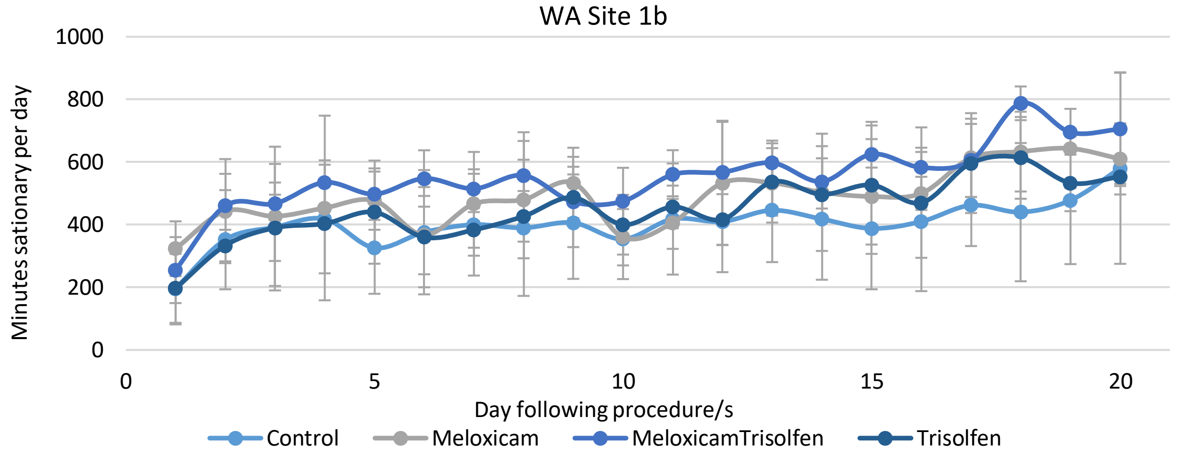


Figure 4.1.42. Total minutes per day spent stationary (movement of less than 10m in 10 minutes) at WA Site 3b. Final day (day 21 excluded). *Note Meloxicam group only had 1 animal.

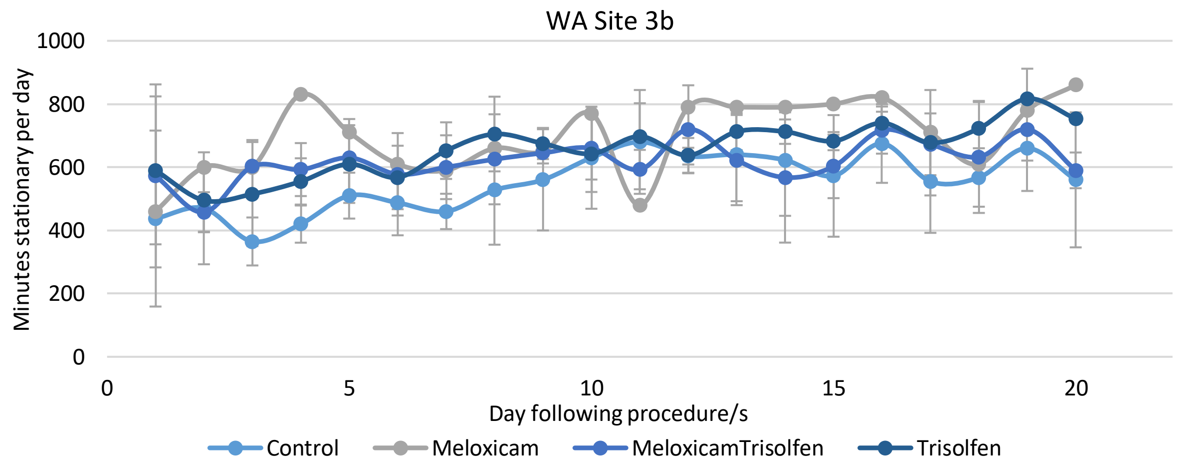


Figure 4.1.43. Total minutes per day spent stationary (movement of less than 10m in 10 minutes) at NT Site 1. Final day (day 28 excluded).

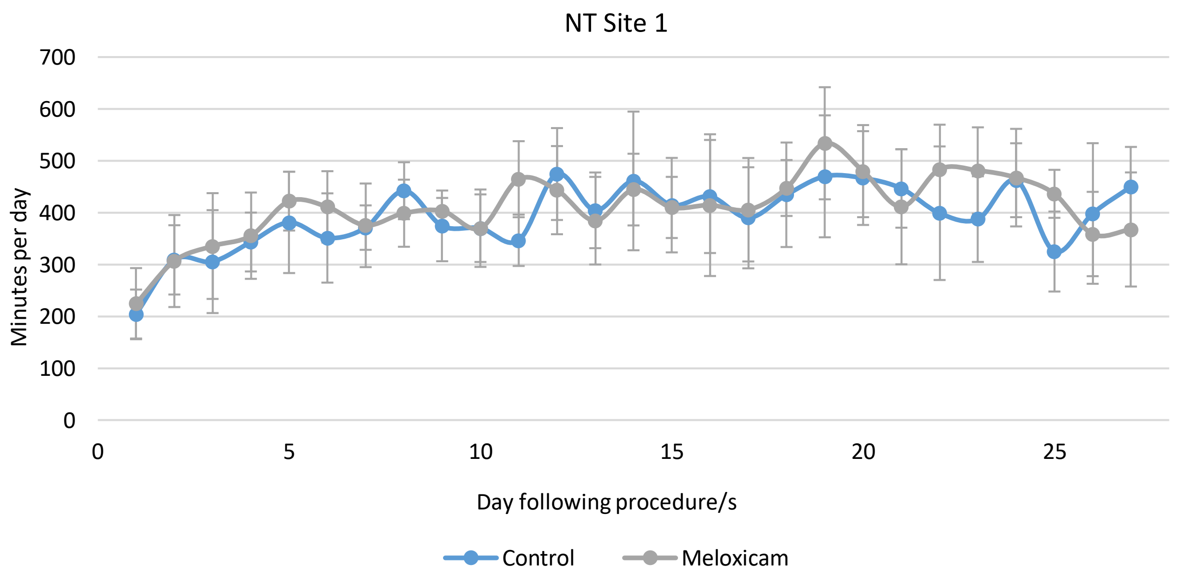


Figure 4.1.44. Total minutes per day spent stationary (movement of less than 10m in 10 minutes) at NT Site 3a. Final day (day 32 excluded).

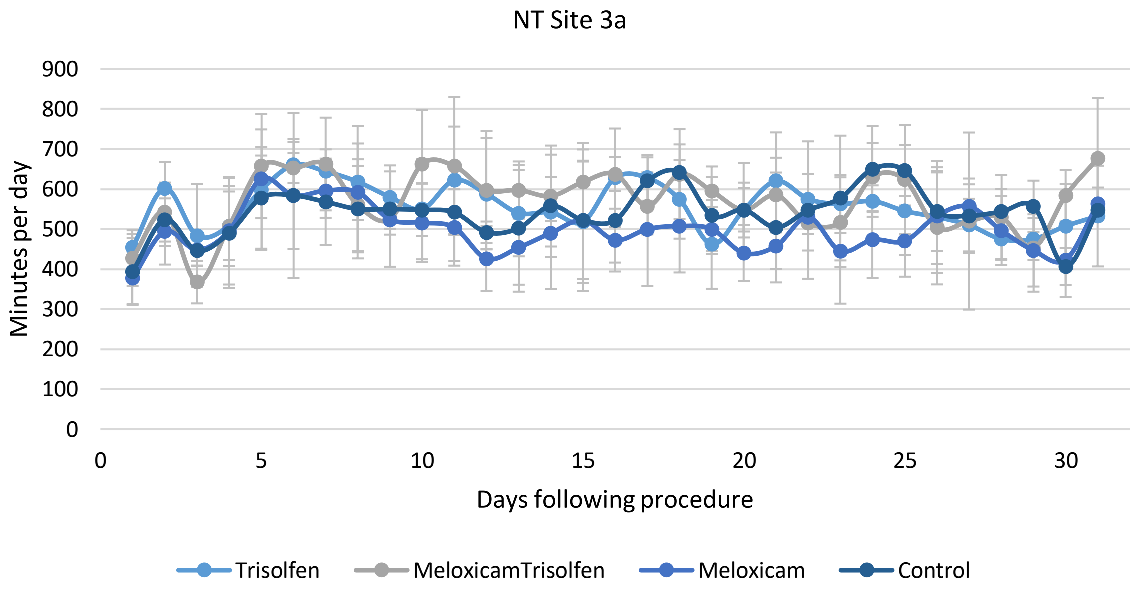


Figure 4.1.45. Total minutes per day spent stationary (movement of less than 10m in 10 minutes) at NT Site 3b. Final day (day 21 excluded).

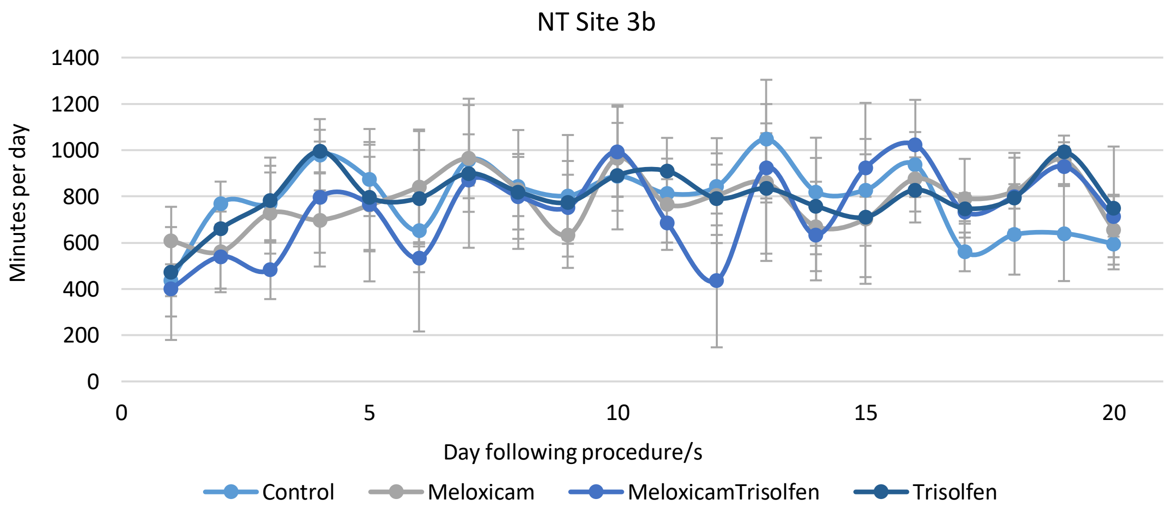


Figure 4.1.46. Minutes per day spent stationary (movement of less than 10m in 10 minutes) at NT Site 2a.

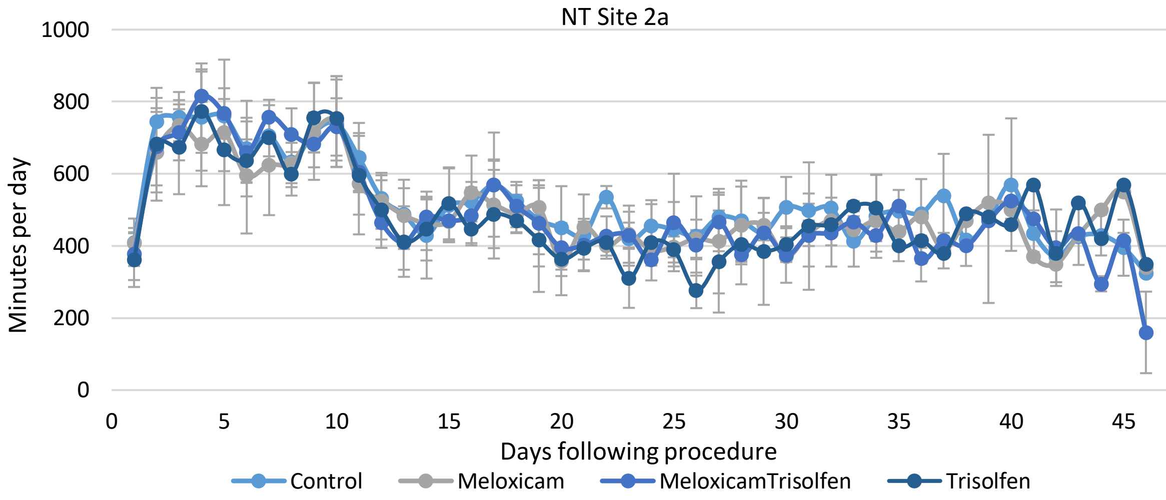
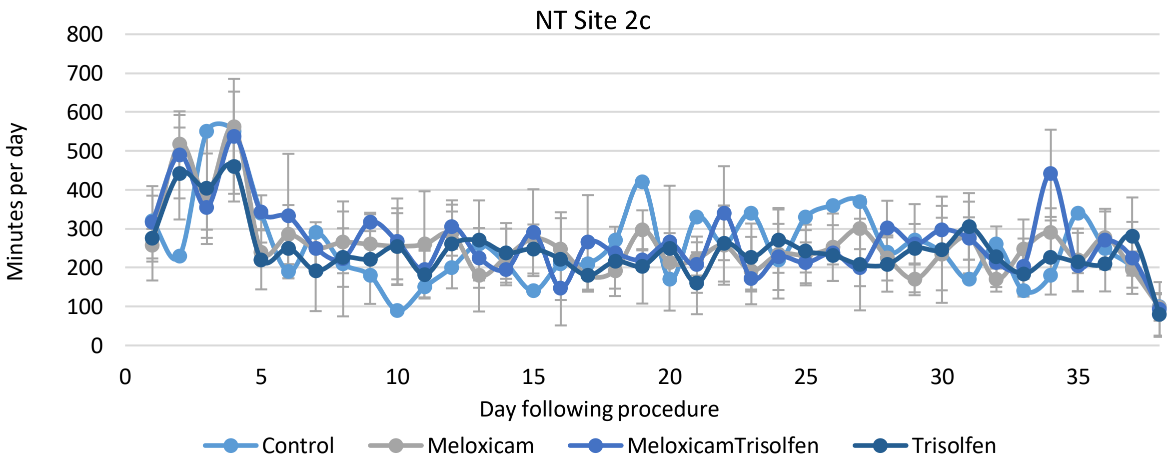


Figure 4.1.47. Minutes per day spent stationary (movement of less than 10m in 10 minutes) at NT Site 2c.



Time spent within proximity to water (within 100m) was also assessed to determine if the provision of pain relief influenced grazing/camping behaviour. It could be observed that time spent close to water when animals first returned to the paddock was more sporadic, before they appeared to settle into a defined grazing/watering pattern.

As with the time spent stationary, the trends were similar for all treatment groups, with only occasionally significant differences observed ($P<0.05$). These trends were for all animals to be either close to water or all animals away from water (likely grazing) at the same times, indicating the strong herd behaviour. There was no consistent treatment effect observed for time spent at water.

It must be noted some sites kept the weaners in the yards for a number of days following the procedure/s to observe them before moving them to a larger paddock, so time spent within 100m of water was calculated only for days weaners were in the paddock. NT Site 3 (A and B) had a creek running through the paddock which may still have had waterholes present but calculations for this paddock were based on the main watering point only. At site DDRF 2022 weaners were moved between several paddocks, so time close to water was not able to be calculated and was excluded.

Figure 4.1.48. Time spent within 100m of water (shown as minutes per hour spent within 100m of water) at DDRF 2021.

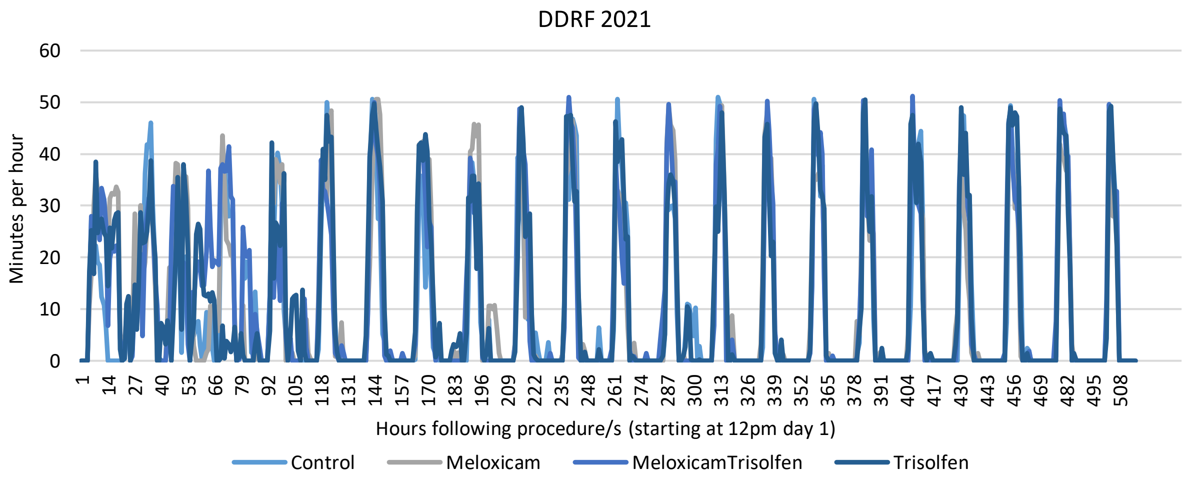


Figure 4.1.49. Time spent within 100m of water (shown as minutes per hour spent within 100m of water) at WA Site 3b. Note weaners kept in yard until 30hours following procedure when they were released into larger paddock and re-mustered to yard on day 19 (458hrs). *Note Meloxicam group had data from only one animal.

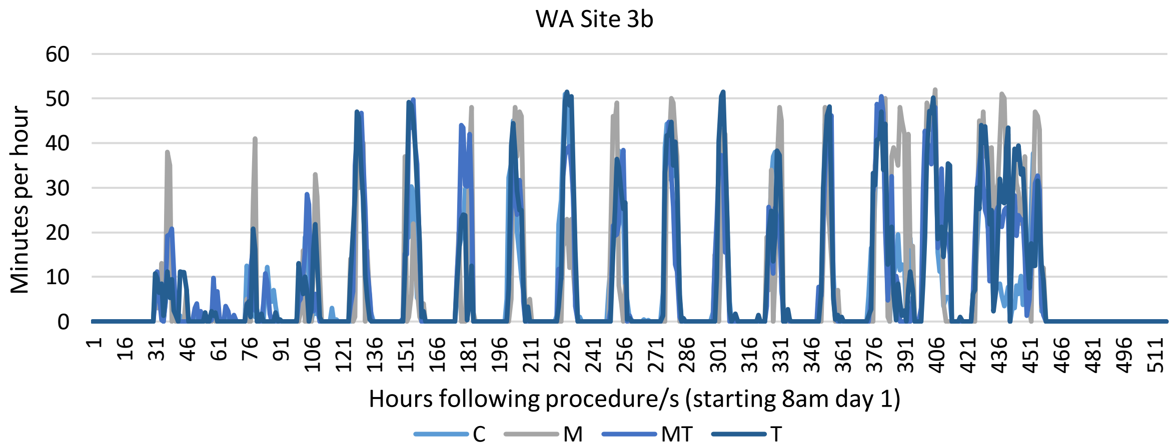


Figure 4.1.50. Time spent within 100m of water (shown as minutes per hour spent within 100m of water) at WA Site 1b.

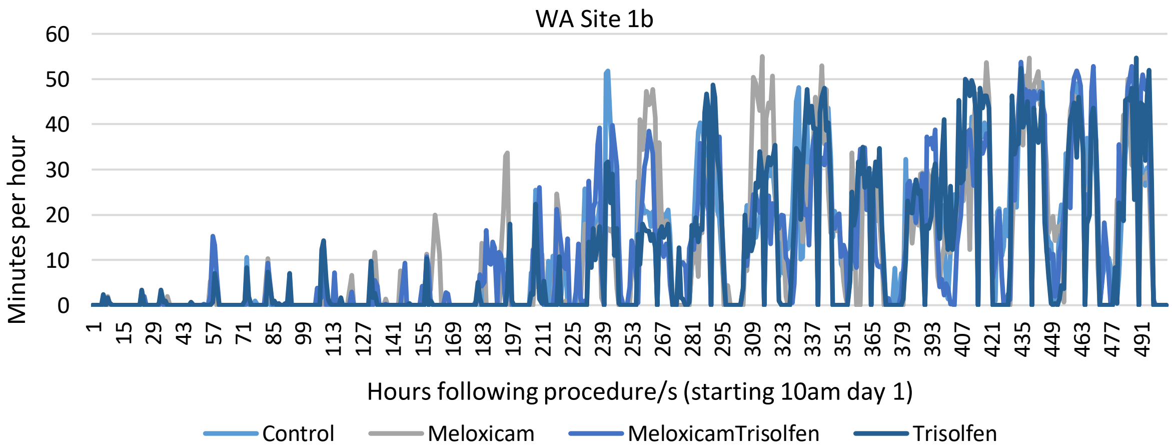


Figure 4.1.51. Time spent within 100m of water (shown as minutes per hour spent within 100m of water) at NT Site 2a. Note cattle spent first 11 days (256hrs) in cattle yards/holding yards following the procedures, so were close to water at all times. Graph displays time in paddock only from day 11 to day 21.

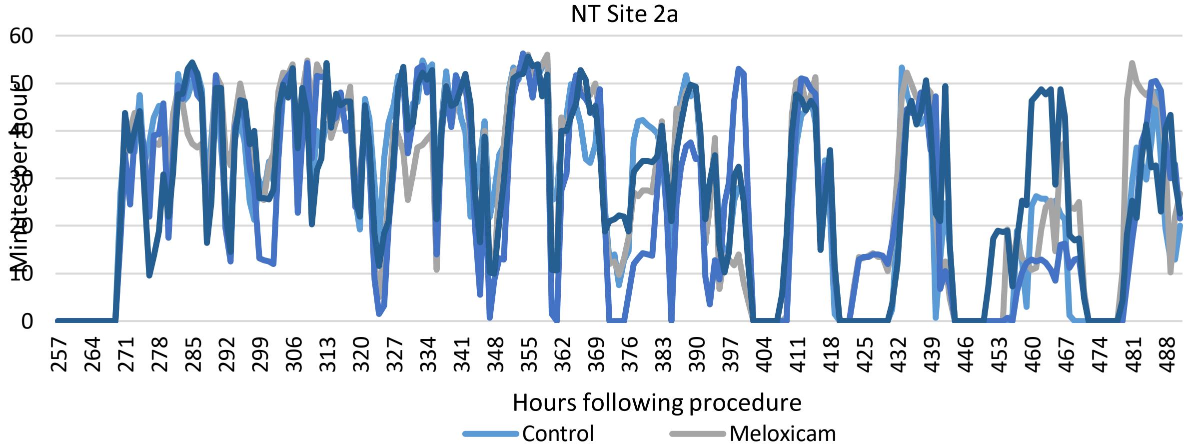


Figure 4.1.52. Time spent within 100m of water (shown as minutes per hour spent within 100m of water) at NT Site 3a. Note first 3 days weaners were in cattle yards/holding yards and close to water at all times. Graph displays time close to water while in the paddock.

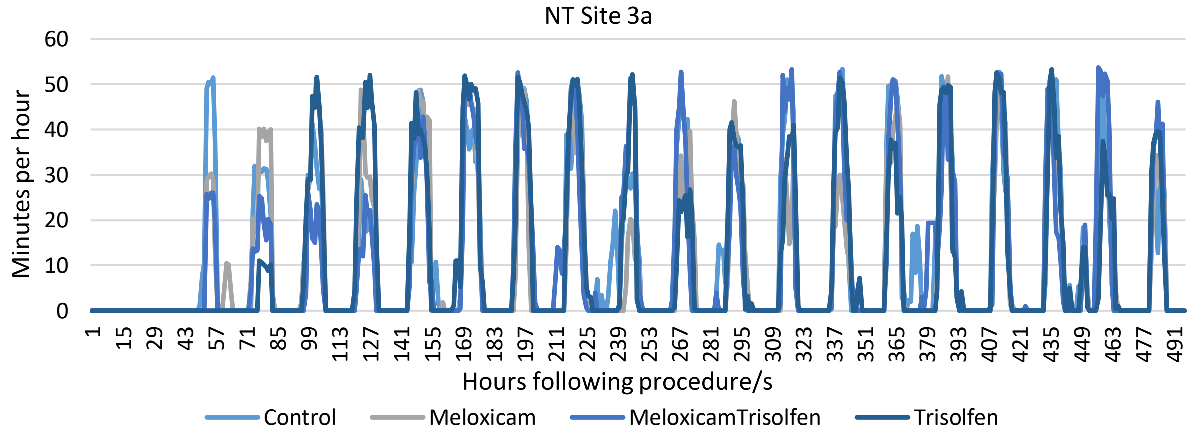


Figure 4.1.53. Time spent within 100m of water (shown as minutes per hour spent within 100m of water) at NT Site 3b.

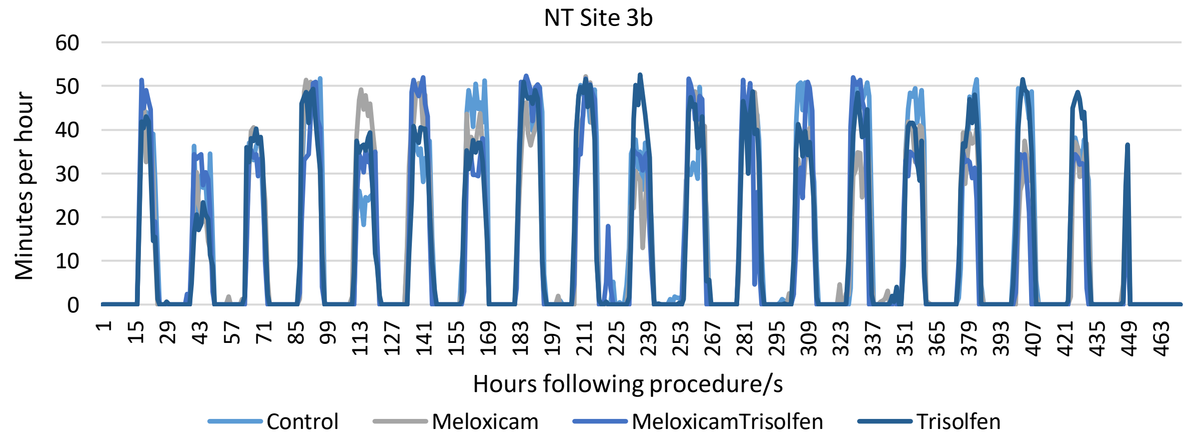


Figure 4.1.54. Time spent within 100m of water (shown as minutes per hour spent within 100m of water) at NT Site 1.

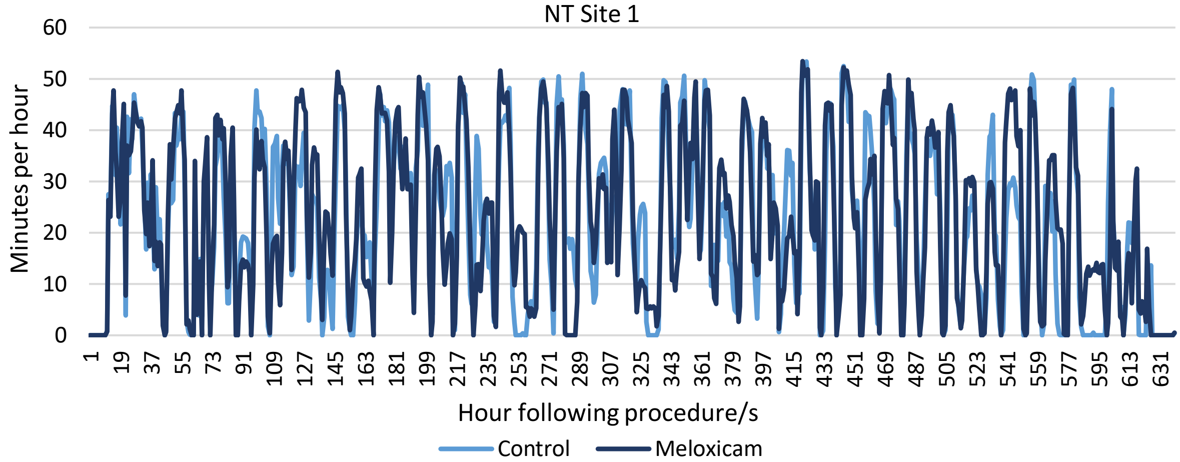
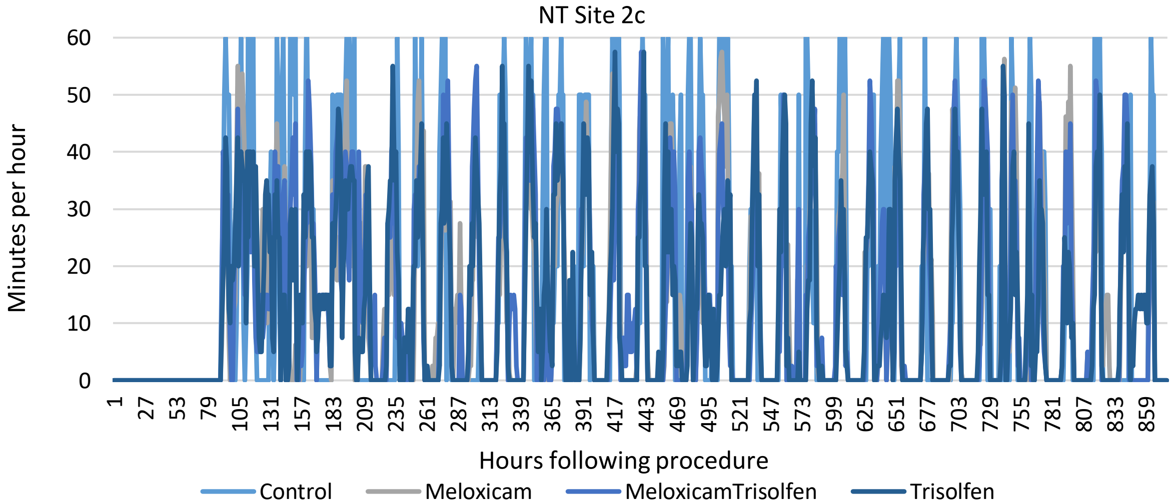


Figure 4.1.55. Time spent within 100m of water (shown as minutes per hour spent within 100m of water) at NT Site 2c. Note cattle spent first 4 days (96hrs) in cattle yards/holding yards following the procedures, so were close to water at all times.



GPS error

The control collar averaged 93±2.6 pings per day with an average GPS error of 15.5±16.6m. There was a total of 20,335 GPS pings recorded over the 220 days the collar was set up. Two pings were identified as extreme outliers (4469.6m and 7010.7m from the true location) and were removed from analyses. Of the remaining pings there were none greater than 400m from the true location and 80% of pings were within 20m of the true location (Table 4.1.56). An example of scatter pattern of recorded GPS locations for one day (day 2) can be seen in Figure 4.1.57. Daily average distance of error from true location can be seen in Table 4.1.58.

Table 4.1.56. Number of GPS pings within each distance range from true location.

	Distance of pings from true location (m)							
	0-5	5-10	10-20	20-50	50-100	100-200	200-300	300-400
Number of pings	2466	5601	8097	3618	432	93	23	3
% of total pings	12%	28%	40%	18%	2%	0.5%	0.1%	0.01%

Figure 4.1.57. Recorded GPS pings for one day with true location shown. It can be seen on this day all pings fell within a 155m diameter, shown on map.

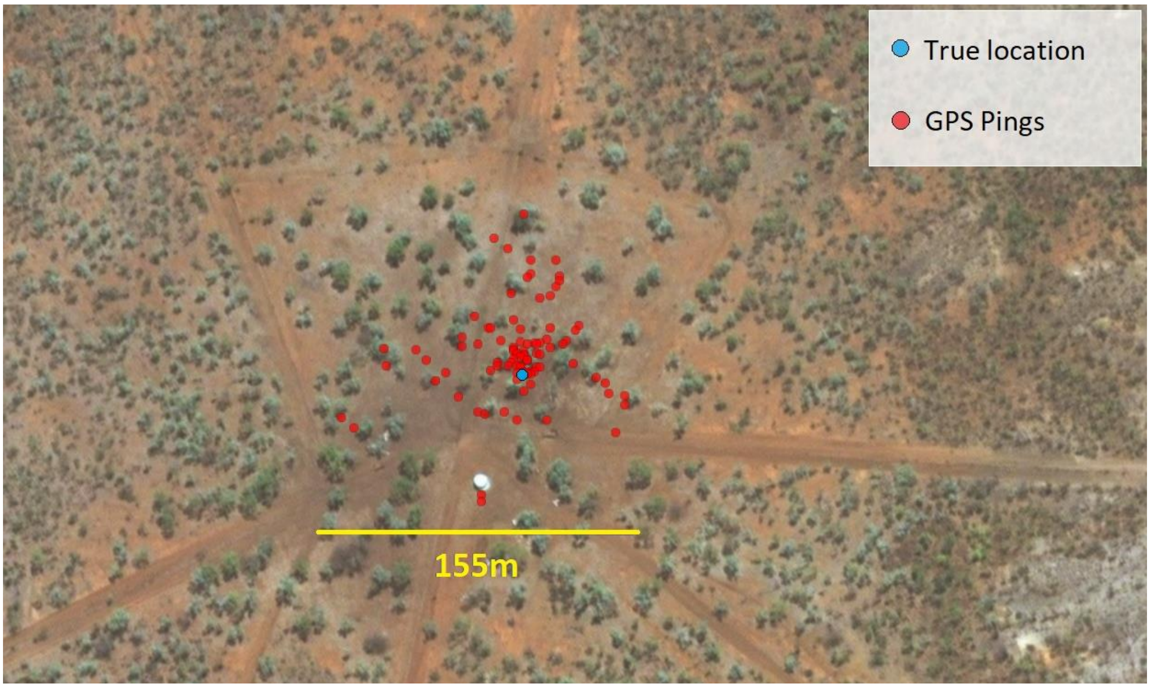
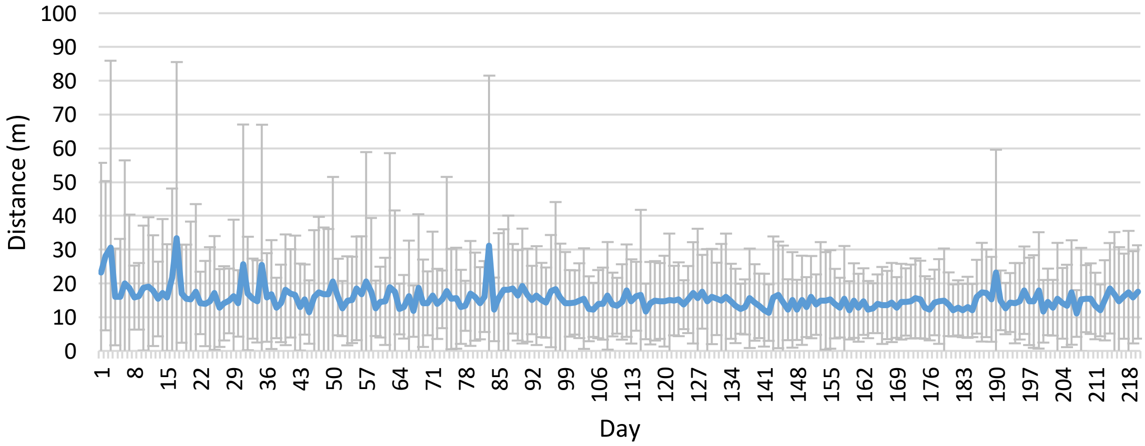


Table 4.1.58. Daily average distance of GPS pings from true location with daily standard deviation.



Accelerometer data

Data was collected by accelerometer tags attached to an ear tag on a total of 20 animals at the study sites of DDRF 2021, DDRF 2022, NT Site 2a, NT Site 2c, NT Site 3a, NT Site 3b, Spyglass, WA Site 1b, WA site 2b, WA Site 3b (5 animals per treatment group). Tags were set to record for the full 21 days until the animals were inspected and re-weighed and the tags removed, however some tags were found to stop recording after a few days. Analysis of the data has been completed for DDRF 2021, NT Site 2a, NT Site 3a, DDRF 2022 and NT Site 2c. Examination of the mean$_{mi}$ and mean$_{MV}$ shows no significant differences between treatment groups. An example of mean$_{MI}$ and mean$_{MV}$ can be seen in Fig. 4.1.59 – Fig. 4.1.63.

Figure 4.1.59. Mean$_{MI}$-and mean$_{MV}$ over the first 14 days by treatment group at DDRF 2021

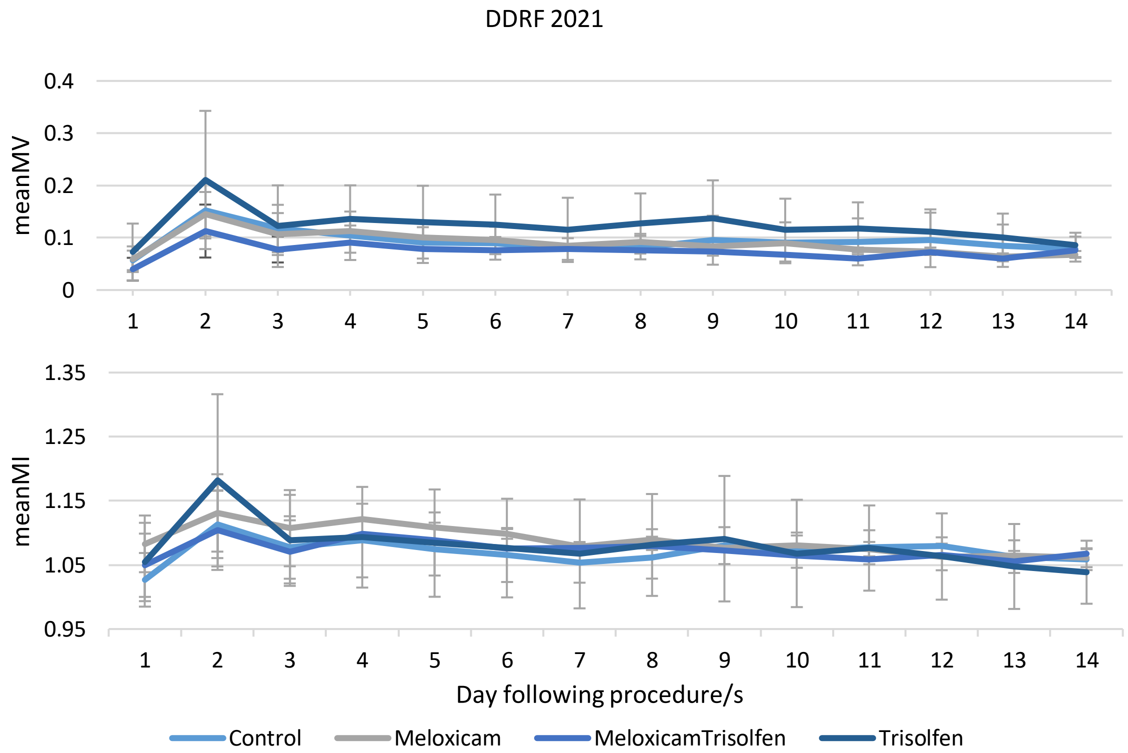
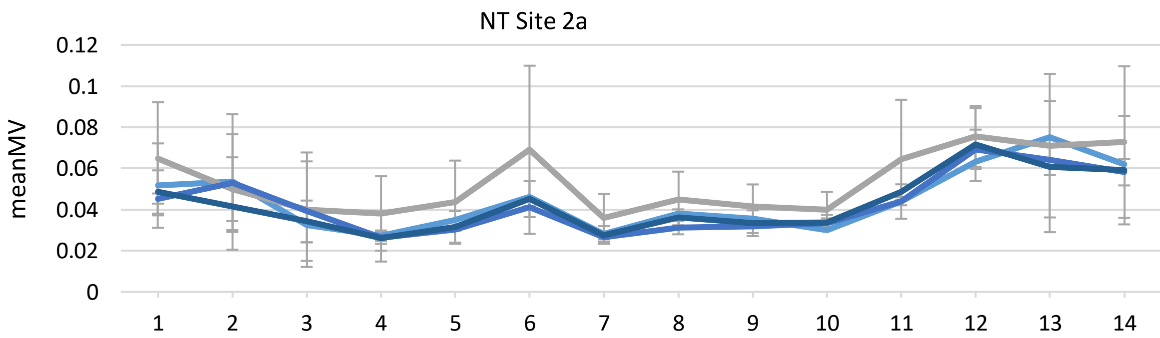


Figure 4.1.60. Mean$_{MV}$ and mean$_{MI}$ over first 14 days by treatment group at NT Site 2a. Note day 11 animals moved from yards to large paddock.



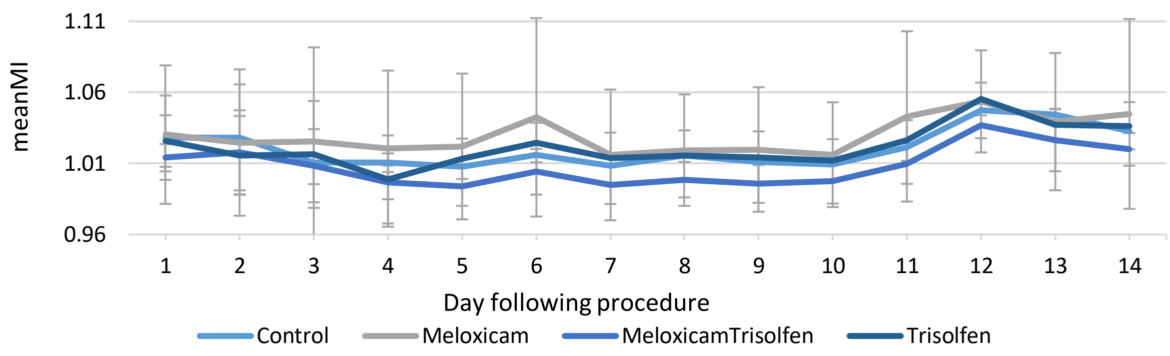


Figure 4.1.61. Mean$_{MV}$ and mean$_{MI}$ over first 14 days by treatment group at NT Site 3a.

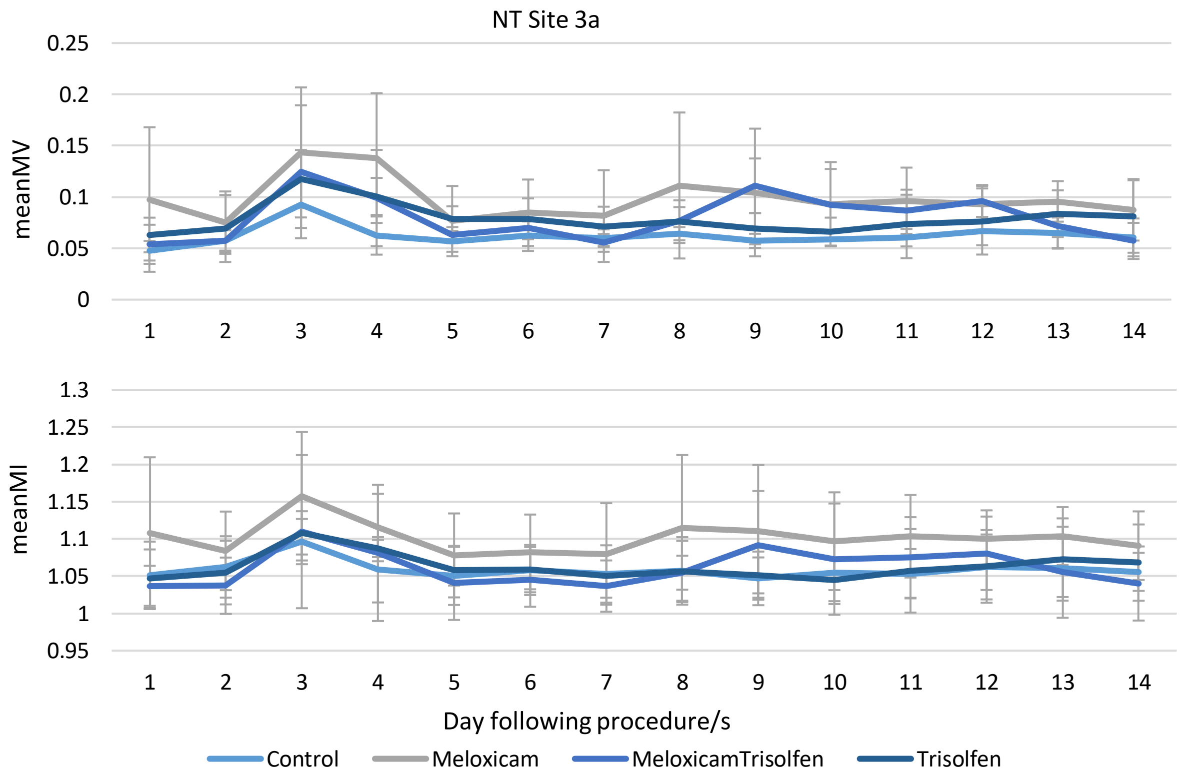


Figure 4.1.62. Mean$_{MV}$ and mean$_{MI}$ over first 15 days by treatment group at DDRF 2022.

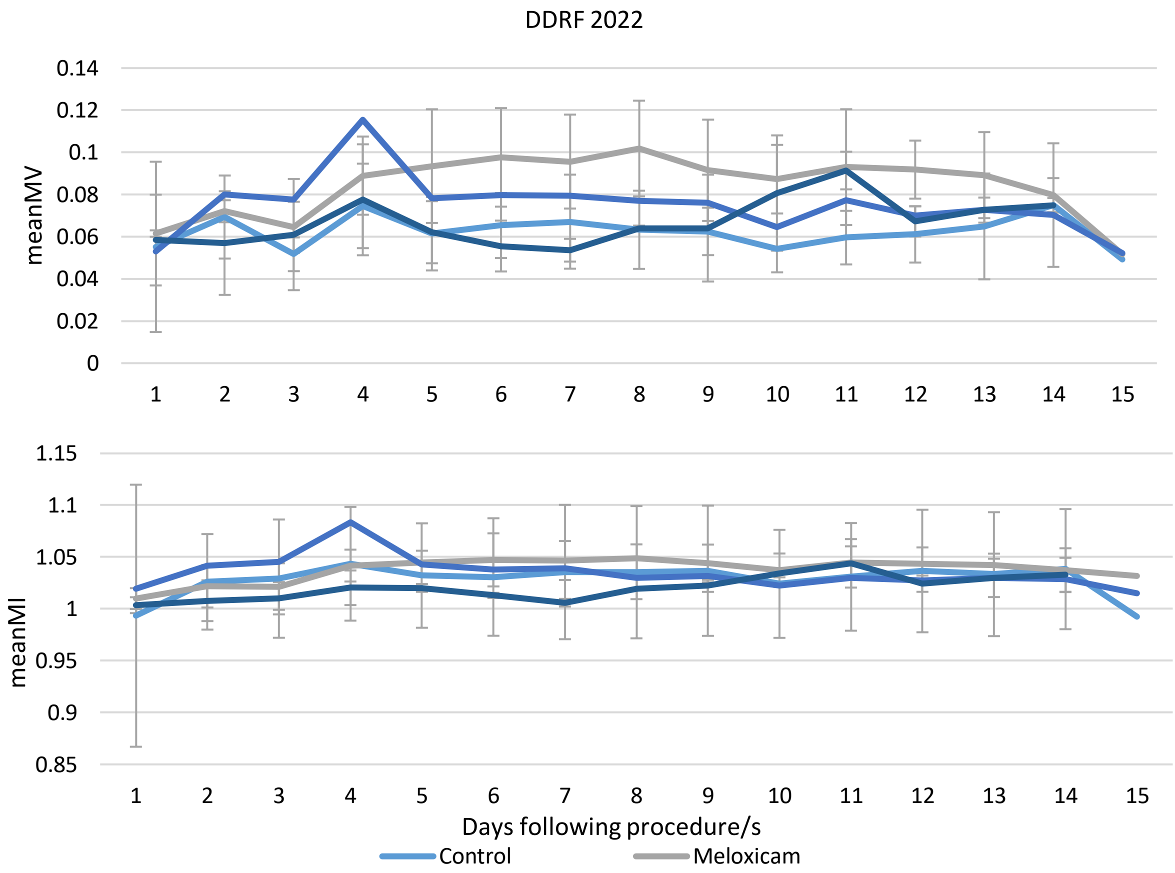
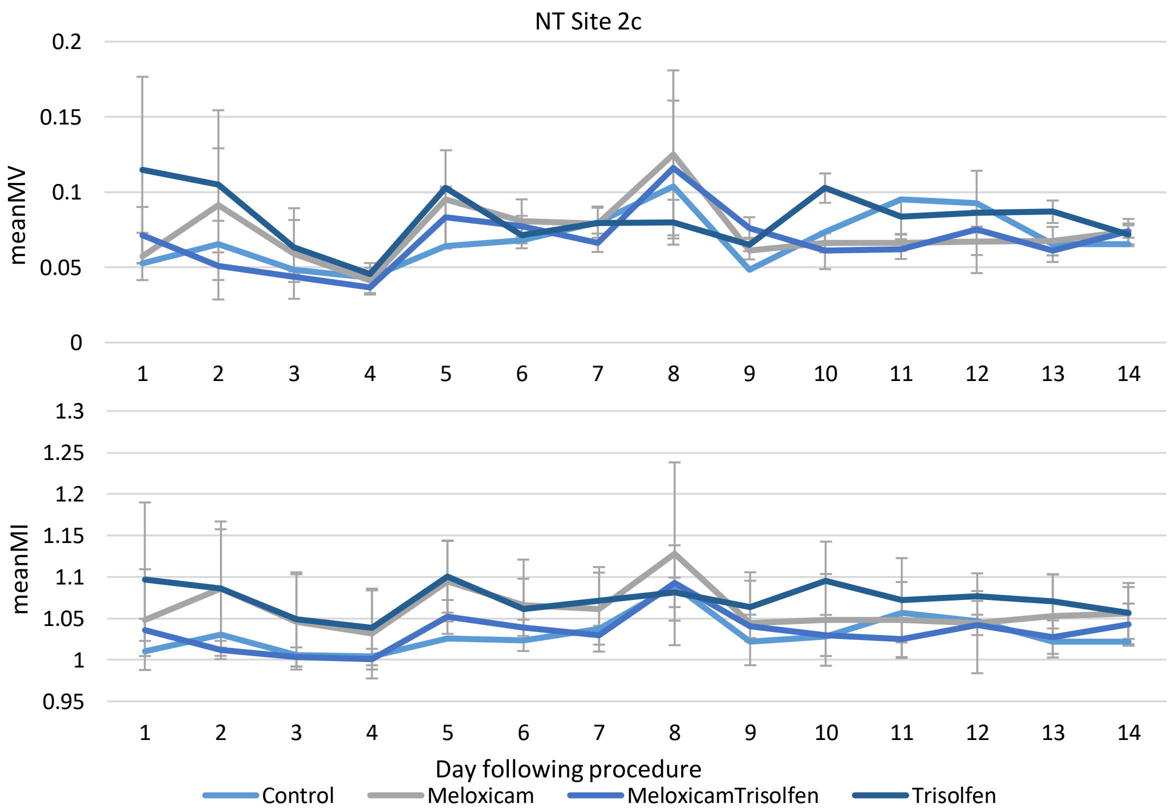


Figure 4.1.63. Mean$_{MV}$ and mean$_{MI}$ over first 14 days by treatment group at NT Site 2c.



Behavioural monitoring - video data

At each study site detailed in Table 4.1.61, four GoPro cameras were set up in the yard that the animals were held in immediately following dehorning/castration. The total time observations were recorded for varied from site to site due to slight variations in timing between setting up the cameras, processing animals and battery charge in cameras. All animals were marked using livestock marking paint to differentiate the treatment groups. The observer did not know which treatments the paint markings represented so as not to influence observations. All observations were made by the same observer so observations remained consistent.

The behaviours recorded are detailed in Table 3.1.6. An animal was identified in the video, then observed for a one-minute period. Each behaviour they expressed in that time, and the number of times they expressed it was recorded. No behavioural observations were made on an animal within the first 10 minutes of release from the branding cradle, to discount the influence of handling stress. No animal was observed more than once within a 10-minute period.

The total recording time at each site and total number of observations made can be seen below in Table 4.1.64.

Table 4.1.64. Total video recording time and observations made at each study site.

Study Site	Recording Time	Total observations
DDRF 2020	105 minutes	47
DDRF 2021	86 minutes	86
DDRF 2022	119 minutes	129
NT Site 3a	108 minutes	102
NT Site 3b	102 minutes	69
NT Site 2a	137 minutes	44
Spyglass Day 1	175 minutes	135
Spyglass Day 2	103 minutes	100
WA Site 1b	130 minutes	210
WA Site 2b	136 minutes	116
WA Site 3b	122 minutes	201

Proportion analysis

Behaviours were first assessed by the proportion of animals from each treatment group observed to express each of the behaviours (Tables 4.1.65 – 4.1.72). Data for each site was compared using the difference in proportions z-test. The behaviours of vocalisation and self-grooming were excluded as they were not expressed at any site. The comparison of standing or lying was excluded as the behaviour of lying was rarely seen in all behaviours. Head scratching behaviour was only observed and therefore included at the Spyglass study site. Similarly, reversing behaviour was only included in the Spyglass, DDRF 2021, DDRF 2022 and NT Site 3b site analyses. There were some statistically significant differences seen in all behaviours ($P<0.05$), but these were not consistent across study sites.

Table 4.1.65. Observations of the percentage of animals expressing head shaking behaviour. Values in the same row with the same superscript differ significantly (P<0.05).

Head shaking		Treatment group			
		Control	Meloxicam	Meloxicam+ Trisolfen	Trisolfen
Study site	DDRF 2021	28%	25%	17%	14%
	DDRF 2020	25%	11%	45%	36%
	NT Site 3a	12%	21%	10%	10%
	NT Site 2a	11%	0%a	45%a	15%
	Spyglass Day 1	15%	19%	6%	14%
	Spyglass Day 2	9%	23%[a]	5%	0%[a]
	DDRF 2022	19%	19%	13%	17%
	NT Site 3b	40%	39%	20%	24%
	WA Site 1b	20%[a]	38%[a]	35%	22%
	WA Site 2b	30%	25%	27%	21%
	WA Site 3b	36.1%[a]	24%	17%	31%[a]

Table 4.1.66. Observations of the percentage of animals expressing head scratching behaviour. Values in the same row with the same superscript differ significantly (P<0.05).

Head scratching		Treatment group			
		Control	Meloxicam	Meloxicam+ Trisolfen	Trisolfen
Study site	DDRF 2021	0%	0%	0%	0%
	DDRF 2020	13%	0%	0%	7%
	NT Site 3a	0%	0%	0%	0%
	NT Site 2a	0%	0%	0%	0%
	Spyglass Day 1	3%	0%	0%	3%
	Spyglass Day 2	3%	0%	0%	4%
	DDRF 2022	0%	8%	0%	4%
	NT Site 3b	0%	0%	0%	0%
	WA Site 1b	2%	5%	8%[A]	0%[A]
	WA Site 2b	3%	8%	6%	0%
	WA Site 3b	0%	2%	0%	2%

Table 4.1.67. Observations of the percentage of animals expressing ear flicking behaviour. Values in the same row with the same superscript differ significantly (P<0.05).

Ear flicking		Treatment group			
		Control	Meloxicam	Meloxicam+ Trisolfen	Trisolfen
Study site	DDRF 2020	50%%[ab]	0%[a]	9%[b]	21%
	DDRF 2021	24%	11%	21%	14%
	NT Site 3a	12%	14%	13%	10%
	NT Site 2a	0%	0%	0%	0%
	Spyglass Day 1	15%	22%	6%	20%
	Spyglass Day 2	3%	5%	0%	8%
	DDRF 2022	19%	15%	30%[a]	11%[a]
	NT Site 3b	20%	17%	32%	12%
	WA site 1b	33%[ab]	57%[ac]	12.5%[bcd]	42.9%[d]
	WA Site 2b	35%	40%[a]	21%	20.5%[a]
	WA Site 3b	36%	28%	27%	23%

Table 4.1.68. Observations of the percentage of animals expressing tail flicking/shaking behaviour. Values in the same row with the same superscript differ significantly (P<0.05).

Tail flicking		Treatment group			
		Control	Meloxicam	Meloxicam+ Trisolfen	Trisolfen
Study site	DDRF 2020	63%	78%	73%	79%
	DDRF 2021	32%	28%	17%	28%
	NT Site 3	12%	21%	22%	13%
	NT Site 2	22%	45%[a]	0%[a]	23%
	Spyglass Day 1	48%	48%	35%	50%
	Spyglass Day 2	53%[ab]	45%	20%[b]	19%[a]
	DDRF 2022	52%	35%[b]	35%[a]	68%[ab]
	NT Site 3b	60%[abc]	22%[a]	20%[b]	24%[c]
	WA site 1b	67%	64%	50%	54%
	WA Site 2b	62%[abc]	22.5%[a]	36%[b]	36%[c]
	WA Site 3b	64%	71%	71%	71%

Table 4.1.69. Observations of the percentage of animals expressing foot stamping behaviour. Values in the same row with the same superscript differ significantly (P<0.05).

Foot stamping		Treatment group			
		Control	Meloxicam	Meloxicam+ Trisolfen	Trisolfen
Study site	DDRF 2020	0%	11%	9%	0%
	DDRF 2021	24%[abc]	5%[a]	0%[b]	0%[c]
	NT Site 3	0%	0%	6%	3%
	NT Site 2	0%	0%	0%	0%
	Spyglass Day 1	3%	4%	4%	2%
	Spyglass Day 2	9%	9%	5%	0%
	DDRF 2022	10	0	4	6
	NT Site 3b	0	4	4	4
	WA site 1b	0%	2%	0%	2%
	WA Site 2b	8%[a]	3%	0%[a]	5%
	WA Site 3b	6%	9%[a]	2%	0%[a]

Table 4.1.70. Observations of the percentage of animals expressing pacing behaviour. Values in the same row with the same superscript differ significantly (P<0.05).

Pacing		Treatment group			
		Control	Meloxicam	Meloxicam+ Trisolfen	Trisolfen
Study site	DDRF 2020	13%	0%	9%	14%
	DDRF 2021	7%	10%	5%	0%
	NT Site 3	24%	7%	9%	10%
	NT Site 2	11%	0%	9%	15%
	Spyglass Day 1	12%	19%	13%	14%
	Spyglass Day 2	13%	0%[a]	0%[b]	23%[ab]
	DDRF 2022	24%	23%	22%	26%
	NT Site 3b	20%	13%	4%	12%
	WA site 1b	0%	0%	0%	0%
	WA Site 2b	5%	0%	0%	0%
	WA Site 3b	0%	0%	0%	2%

Table 4.1.71. Observations of the percentage of animals expressing ruminating/grazing behaviour. Values in the same row with the same superscript differ significantly (P<0.05).

Ruminating/grazing		Treatment group			
		Control	Meloxicam	Meloxicam+ Trisolfen	Trisolfen
Study site	DDRF 2020	0%	11%	0%	0%
	DDRF 2021	13%	14%	24%	25%
	NT Site 3	24%	7%	9%	10%
	NT Site 2	56%	55%	18%	38%
	Spyglass Day 1	3%	7%	6%	2%
	Spyglass Day 2	0%	5%	0%	4%
	DDRF 2022	0	0	0	0
	NT Site 3b	0	9	0	0
	WA site 1b	22%	13%	20%	11%
	WA Site 2b	35%	28%	15%	23%
	WA Site 3b	31%[a]	13%[a]	17%	21%

Table 4.1.72. Observations of the percentage of animals expressing reversing behaviour. Values in the same column with the same superscript differ significantly (P<0.05).

Reversing	Study site				
Treatment group	Spyglass Day 1	Spyglass Day 2	DDRF 2021	DDRF 2022	NT Site 3b
Control	15%[b]	6%	0%	5	30
Meloxicam	0%[ab]	9%	5%	19	35
Meloxicam +Trisolfen	3%	9%	10%	22	20
Trisolfen	14%[a]	6%	5%	11	8

Frequency analysis

Following the behaviour analyses, a frequency distribution of behaviours was completed. Comparison was done using a Kolmogorov-Smirnov test. The behaviours of ruminating/grazing, pacing and reversing were only counted as the animal did or did not display the behaviour, so are not included in the frequency analysis. No significant differences (P>0.05) were observed. This is likely due to the data not being normally distributed and the low number of expressed behaviours. The frequency of behaviour expression Tables 4.1.73 – 4.1.77.

Table 4.1.73. Frequency of head scratching behaviour by study site. (Head scratching not observed at DDRF 2021, NT Site 3a, NT Site 3b and NT Site 2a).

Study site	Treatment group	Frequency of head scratching behaviour						
		0	1	2	3	4	5	6
Spyglass Day 1	Trisolfen	42	2	0	0	0	0	0
	Meloxicam	27	0	0	0	0	0	0
	Meloxicam+Trisolfen	31	0	0	0	0	0	0
	Control	32	1	0	0	0	0	0
Spyglass Day 2	Trisolfen	25	1	0	0	0	0	0
	Meloxicam	22	0	0	0	0	0	0
	Meloxicam+Trisolfen	20	0	0	0	0	0	0
	Control	31	0	1	0	0	0	0
DDRF 2020	Trisolfen	9	1	2	0	1	0	1
	Meloxicam	8	1	0	0	0	0	0
	Meloxicam+Trisolfen	6	4	1	0	0	0	0
	Control	6	0	0	0	1	1	0
DDRF 2022	Trisolfen	45	2	0	0	0	0	0
	Meloxicam	24	2	0	0	0	0	0
	Meloxicam+Trisolfen	23	0	0	0	0	0	0
	Control	21	0	0	0	0	0	0
WA Site 1b	Trisolfen	63	0	0	0	0	0	0
	Meloxicam	53	3	0	0	0	0	0
	Meloxicam+Trisolfen	37	3	0	0	0	0	0
	Control	50	1	0	0	0	0	0
WA Site 2b	Trisolfen	39	0	0	0	0	0	0
	Meloxicam	37	2	0	1	0	0	0
	Meloxicam+Trisolfen	31	2	0	0	0	0	0
	Control	36	1	0	0	0	0	0
WA Site 3b	Trisolfen	51	1	0	0	0	0	0
	Meloxicam	53	1	0	0	0	0	0
	Meloxicam+Trisolfen	59	0	0	0	0	0	0
	Control	36	0	0	0	0	0	0

Table 4.1.74. Frequency of head shaking behaviour by study site.

Study site	Treatment group	Frequency of head shaking behaviour expression						
		0	1	2	3	4	5	6
DDRF 2020	Trisolfen	13	1	0	0	0	0	0
	Meloxicam	9	0	0	0	0	0	0
	Meloxicam+Trisolfen	11	0	0	0	0	0	0
	Control	13	1	0	0	0	0	0
DDRF 2021	Trisolfen	18	1	2	0	0	0	0
	Meloxicam	18	3	1	2	0	0	0
	Meloxicam+Trisolfen	19	3	0	1	0	0	0
	Control	13	2	3	0	0	0	0
DDRF 2022	Trisolfen	37	6	2	2	0	0	0
	Meloxicam	21	3	1	0	1	0	0
	Meloxicam+Trisolfen	20	0	3	0	0	0	0
	Control	17	4	0	0	0	0	0
NT Site 3a	Trisolfen	35	4	0	0	0	0	0
	Meloxicam	11	3	0	0	0	0	0
	Meloxicam+Trisolfen	28	3	0	0	0	0	0
	Control	15	1	0	1	0	0	0
NT Site 3b	Trisolfen	14	3	1	1	0	0	0
	Meloxicam	10	5	1	1	0	0	0
	Meloxicam+Trisolfen	14	2	1	0	0	0	0
	Control	5	3	1	0	0	0	0
NT Site 2a	Trisolfen	11	2	0	0	0	0	0
	Meloxicam	11	0	0	0	0	0	0
	Meloxicam+Trisolfen	6	4	1	0	0	0	0
	Control	8	0	1	0	0	0	0
Spyglass Day 1	Trisolfen	38	4	1	0	0	0	1
	Meloxicam	22	3	0	2	0	0	0
	Meloxicam+Trisolfen	29	2	0	0	0	0	0
	Control	28	4	1	0	0	0	0
Spyglass Day 2	Trisolfen	26	0	0	0	0	0	0
	Meloxicam	17	3	2	0	0	0	0
	Meloxicam+Trisolfen	19	1	0	0	0	0	0
	Control	29	1	0	1	0	0	1
WA Site 1b	Trisolfen	49	10	4	0	0	0	0
	Meloxicam	35	17	2	0	2	0	0
	Meloxicam+Trisolfen	26	11	3	0	0	0	0
	Control	41	7	1	1	1	0	0
WA Site 2b	Trisolfen	31	6	2	0	0	0	0
	Meloxicam	30	7	3	0	0	0	0
	Meloxicam+Trisolfen	24	8	1	0	0	0	0
	Control	26	7	1	1	2	0	0
WA Site 3b	Trisolfen	36	11	3	1	1	0	0
	Meloxicam	41	9	4	0	0	0	0
	Meloxicam+Trisolfen	49	6	2	0	2	0	0
	Control	23	9	4	0	0	0	0

Table 4.1.75. Frequency of ear flicking behaviour by study site.

Study site	Treatment group	Frequency of ear flicking behaviour					
		0	1	2	3	4	5
	Trisolfen	18	2	1	0	0	0
DDRF 2021	Meloxicam	21	3	0	0	0	0
	Meloxicam+Trisolfen	18	5	0	0	0	0
	Control	11	1	2	2	1	1
	Trisolfen	11	2	0	1	0	0
DDRF 2020	Meloxicam	9	0	0	0	0	0
	Meloxicam+Trisolfen	10	1	0	0	0	0
	Control	4	3	0	1	0	0
	Trisolfen	42	5	0	0	0	0
DDRF 2022	Meloxicam	24	2	0	0	0	0
	Meloxicam+Trisolfen	23	0	0	0	0	0
	Control	21	0	0	0	0	0
	Trisolfen	35	4	0	0	0	0
NT Site 3a	Meloxicam	12	2	0	0	0	0
	Meloxicam+Trisolfen	27	4	1	0	0	0
	Control	15	2	0	0	0	0
	Trisolfen	35	4	0	0	0	0
NT Site 3b	Meloxicam	12	2	0	0	0	0
	Meloxicam+Trisolfen	27	4	1	0	0	0
	Control	15	2	0	0	0	0
	Trisolfen	13	0	0	0	0	0
NT Site 2a	Meloxicam	11	0	0	0	0	0
	Meloxicam+Trisolfen	11	0	0	0	0	0
	Control	9	0	0	0	0	0
	Trisolfen	35	5	2	2	0	0
Spyglass Day 1	Meloxicam	21	6	0	0	0	0
	Meloxicam+Trisolfen	29	2	0	0	0	0
	Control	28	5	0	0	0	0
	Trisolfen	24	2	0	0	0	0
Spyglass Day 2	Meloxicam	21	0	1	0	0	0
	Meloxicam+Trisolfen	20	0	0	0	0	0
	Control	31	1	0	0	0	0
	Trisolfen	36	18	5	4	0	0
WA Site 1b	Meloxicam	24	20	10	2	0	0
	Meloxicam+Trisolfen	36	18	5	4	0	0
	Control	35	4	1	0	0	0
	Trisolfen	31	6	2	0	0	0
WA Site 2b	Meloxicam	24	10	3	3	0	0
	Meloxicam+Trisolfen	26	5	2	0	0	0
	Control	24	6	6	1	0	0
	Trisolfen	40	9	1	1	1	0
WA Site 3b	Meloxicam	39	9	3	1	2	0
	Meloxicam+Trisolfen	43	10	3	2	1	0
	Control	23	10	2	0	1	0

Table 4.1.76. Frequency of tail flicking/shaking behaviour by study site.

Study Site	Treatment Group	Frequency of tail flicking/shaking behaviour expression								
		0	1	2	3	4	5	6	7	8+
DDRF 2020	Trisolfen	3	2	2	3	2	1	1	0	2
	Meloxicam	2	1	3	2	0	1	0	0	0
	Meloxicam+Trisolfen	3	1	2	1	1	1	1	1	0
	Control	3	2	2	3	2	1	1	0	0
DDRF 2021	Trisolfen	12	2	2	1	0	0	0	0	1
	Meloxicam	14	0	3	0	1	0	1	0	0
	Meloxicam+Trisolfen	13	1	1	0	0	0	0	0	0
	Control	9	2	2	2	1	1	0	0	0
DDRF 2022	Trisolfen	15	11	7	7	4	3	0	0	0
	Meloxicam	17	6	1	1	0	1	0	0	0
	Meloxicam+Trisolfen	14	5	2	0	0	1	1	0	0
	Control	9	4	3	3	0	1	0	1	0
NT Site 3a	Trisolfen	34	4	0	1	0	0	0	0	0
	Meloxicam	11	1	2	0	0	0	0	0	0
	Meloxicam+Trisolfen	25	3	2	2	0	0	0	0	0
	Control	15	1	1	0	0	0	0	0	0
NT Site 3b	Trisolfen	15	1	1	1	1	0	0	0	0
	Meloxicam	14	1	0	0	2	0	0	0	0
	Meloxicam+Trisolfen	14	1	0	0	2	0	0	0	0
	Control	3	1	1	2	2	0	0	0	0
NT Site 2a	Trisolfen	10	3	0	0	0	0	0	0	0
	Meloxicam	11	0	0	0	0	0	0	0	0
	Meloxicam+Trisolfen	6	3	1	1	0	0	0	0	0
	Control	7	2	0	0	0	0	0	0	0
Spyglass Day 1	Trisolfen	22	10	5	4	1	0	1	1	0
	Meloxicam	14	6	4	0	2	0	1	0	0
	Meloxicam+Trisolfen	20	7	4	0	0	0	0	0	0
	Control	17	7	3	2	2	1	1	0	0
Spyglass Day 2	Trisolfen	21	4	0	1	0	0	0	0	0
	Meloxicam	12	4	3	2	0	0	1	0	0
	Meloxicam+Trisolfen	16	3	0	1	0	0	0	0	0
	Control	15	6	7	1	2	0	0	1	0
WA Site 1b	Trisolfen	29	13	5	5	6	1	3	1	0
	Meloxicam	20	8	10	5	3	2	5	3	1
	Meloxicam+Trisolfen	20	8	5	3	1	1	2	0	0
	Control	17	16	6	4	3	2	0	1	2
WA Site 2b	Trisolfen	25	7	3	1	3	0	0	0	0
	Meloxicam	31	5	3	1	0	0	0	0	0
	Meloxicam+Trisolfen	21	9	2	0	0	1	0	0	0
	Control	14	12	5	1	3	1	0	1	0
WA Site 3b	Trisolfen	15	6	8	8	5	2	2	3	3
	Meloxicam	15	13	6	6	6	2	1	0	3
	Meloxicam+Trisolfen	17	13	11	3	5	7	0	1	0
	Control	13	8	3	4	1	1	3	0	3

Table 4.1.77. Frequency of foot stamping behaviour by study site.

Study Site	Treatment Group	Frequency of foot stamping behaviour expression			
		0	1	2	3
DDRF 2020	Trisolfen	14	0	0	0
	Meloxicam	8	1	0	0
	Meloxicam+Trisolfen	10	1	0	0
	Control	8	0	0	0
DDRF 2021	Trisolfen	21	0	0	0
	Meloxicam	23	1	0	0
	Meloxicam+Trisolfen	23	0	0	0
	Control	14	1	3	0
DDRF 2022	Trisolfen	44	3	0	0
	Meloxicam	26	0	0	0
	Meloxicam+Trisolfen	22	1	0	0
	Control	19	0	1	1
NT Site 3a	Trisolfen	38	0	1	0
	Meloxicam	14	0	0	0
	Meloxicam+Trisolfen	30	2	0	0
	Control	17	0	0	0
NT Site 3b	Trisolfen	18	0	1	0
	Meloxicam	17	0	0	0
	Meloxicam+Trisolfen	17	0	0	0
	Control	9	0	0	0
NT Site 2a	Trisolfen	13	0	0	0
	Meloxicam	11	0	0	0
	Meloxicam+Trisolfen	11	0	0	0
	Control	9	0	0	0
Spyglass Day 1	Trisolfen	43	1	0	0
	Meloxicam	26	1	0	0
	Meloxicam+Trisolfen	30	1	0	0
	Control	32	1	0	0
Spyglass Day 2	Trisolfen	20	6	0	0
	Meloxicam	22	0	0	0
	Meloxicam+Trisolfen	20	0	0	0
	Control	28	4	0	0
WA Site 1b	Trisolfen	62	1	0	0
	Meloxicam	55	1	0	0
	Meloxicam+Trisolfen	40	0	0	0
	Control	51	0	0	0
WA Site 2b	Trisolfen	37	1	1	0
	Meloxicam	39	1	0	0
	Meloxicam+Trisolfen	33	0	0	0
	Control	34	3	0	0
WA Site 3b	Trisolfen	52	0	0	0
	Meloxicam	49	5	0	0
	Meloxicam+Trisolfen	58	1	0	0
	Control	34	1	1	0

Procedure effect analysis

As there was no significant effect of treatment group on behaviours expressed, animals were assessed by procedure group; castrated only, dehorned only and castrated + dehorned. This allowed for the comparison of procedure effect on behaviour. This was able to be done on Spyglass day 1 & 2, DDRF 2021, DDRF 2022 and NT site 3b. The proportion of animals from each procedure group to display behaviours can be seen in Table 4.1.78.

Statistical differences ($P<0.05$) could be seen on Spyglass Day 1 in ear flicking, tail flicking/shaking and reversing behaviours, with the castrated only group showing higher levels of ear flicking and tail flicking/shaking than the dehorned only and dehorned + castrated groups, and lower levels of reversing behaviour when compared to the other groups. This varied from the results seen at Spyglass Day 2, in which statistical differences could be seen in the behaviours tail flicking/shaking and foot stamping only, with the castrated only group showing higher levels of foot stamping behaviour and the dehorn only group showing higher levels of tail flicking/shaking behaviour. At DDRF 2021 pacing behaviour was observed more in the dehorned only group when compared to the castrated only group. All statistical differences can be seen in Table 4.1.78.

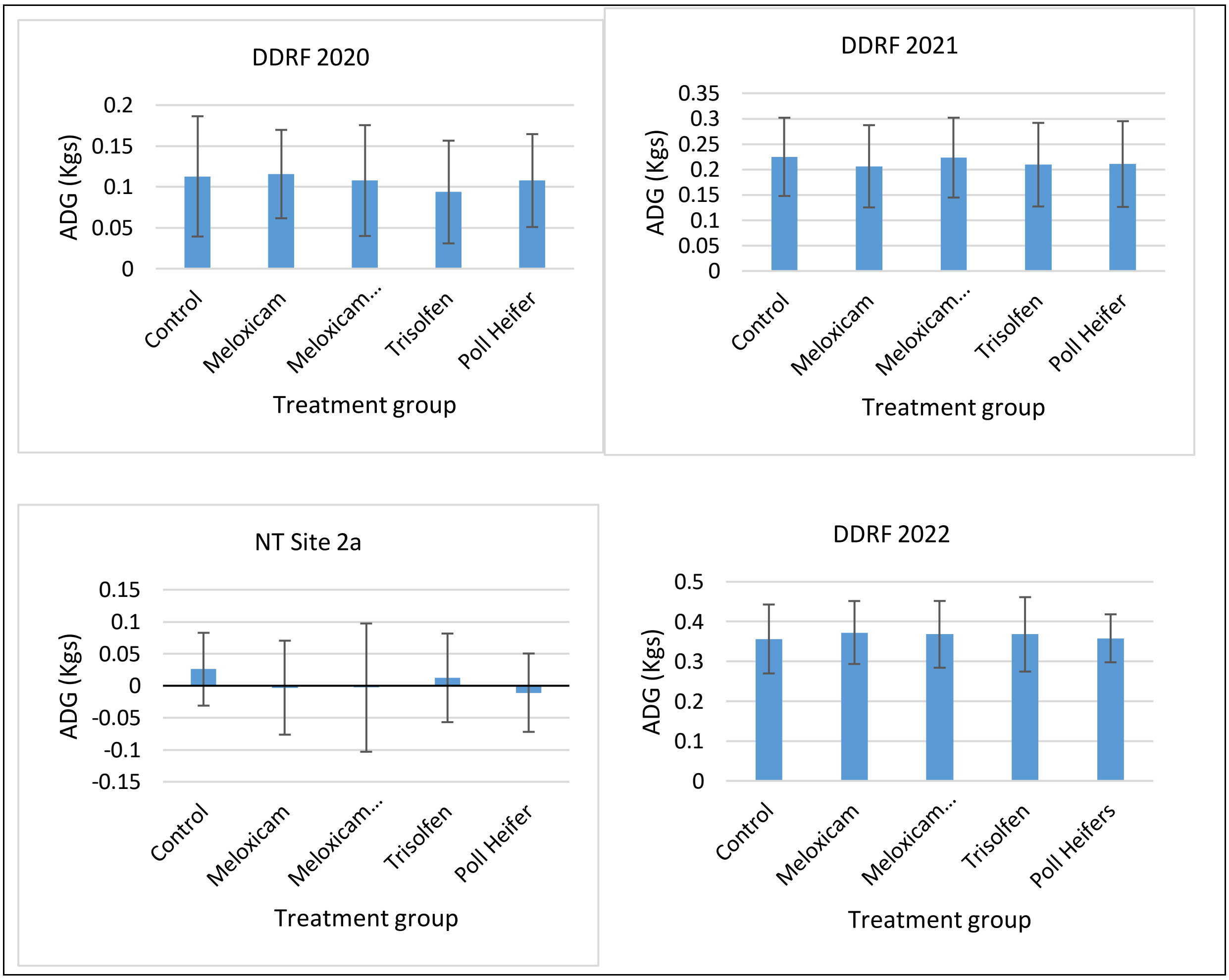
Table 4.1.78. Percentage of animals expressing behaviours based on the procedure performed on the animal. Values in the same behaviour group, in the same column that have the same superscript differ significantly (P<0.05).

Behaviour	Treatment group	Study site vs proportion of animals expressing behaviour Spyglass Day 1 CO (n= 28) DO (n= 52) C+D (n= 55)	Spyglass Day 2 CO (n= 32) DO (n= 31) C+D (n= 37)	DDRF 2022 CO (n=8) DO (n=58) C+D (n=51)	NT Site 3b CO(n=0) DO (n=26) C+D (n=27)	DDRF 2021 CO (n=21) DO (n=9) C+D (n=56)
Head shaking	Castration only	11%	3%	13%	-	10%
	Dehorn only	13%	16%	14%	22%	22%
	Castrated + dehorned	15%	8%	25%	35%	25%
Head scratching	Castration only	0%	0%	0%	-	0%
	Dehorn only	2%	3%	3%	0%	0%
	Castrated + dehorned	4%	0%	4%	0%	0%
Ear flicking	Castration only	29%[a]	19%	38%	-	10%
	Dehorn only	15%	6%	19%	27%	22%
	Castrated + dehorned	11%[a]	5%	12%	14%	21%
Tail flicking/shaking	Castration only	64%[a]	38%	38%	-	29%
	Dehorn only	38%[a]	52%[a]	43%[a]	15%[a]	44%
	Castrated + dehorned	42%	19%[a]	67%[a]	36%[a]	29%
Foot stamping	Castration only	7%	13%[a]	25%[a]	-	14%
	Dehorn only	2%	0%[a]	0%[ab]	0%	0%
	Castrated + dehorned	2%	3%	8%[b]	7%	4%
Pacing	Castration only	11%	6%	0%	-	0%[a]
	Dehorn only	19%	19%	29%	10%	22%[a]
	Castrated + dehorned	11%	5%	22%	12%	5%
Ruminating/grazing	Castration only	7%	3%	0%	-	33%[a]
	Dehorn only	6%	0%	0%	2%	33%
	Castrated + dehorned	2%	3%	0%	2%	13%[a]
Reversing	Castration only	0%[a]	3%	13	-	0%
	Dehorn only	9%[ab]	10%	14	17	0%
	Castrated + dehorned	4%[b]	5%	14	26	7%

Follow-up liveweight

On properties DDRF 2020, DDRF 2021, DDRF 2022 and NT Site 2a, a follow-up measurement of liveweight was conducted to monitor any long term impact of the procedures on weight gain. This occurred on day 168, 232, 190 (some variation at this site) and 123 respectively. Liveweight change from the 2nd to 3rd weigh was assessed as ADG. There were no significant differences seen between treatments groups at any of the four sites (Fig. 4.1.77).

Figure 4.1.77. Change in weight results for muster 3 by treatment site (with St Dev). Note Site DDRF 2022 calculated as ADG as there was some variation in time for the third weigh between animals).



4.2 Economic analysis

An economic analysis was undertaken to consider the financial impact/benefit of the use of pain relief. As there was no production (change in liveweight) benefit for animals administered pain relief, when compared to animals that did not receive pain relief, there was nothing to offset the cost of the product. The products tested in this study (Trisolfen® and Meloxicam injectable) vary in purchase cost between the two products. There is also variation in dose rate of the products based on the weight of the animal (for Meloxicam injectable) or the procedure/s undertaken (for Trisolfen®). A product per animal cost was able to be generated (Table 4.2.1).

Table 4.2.1 Breakdown of treatment cost per animal *cost of product as of September 2023.

Product	Cost	Treatment cost per 200kg animal		Dosage guide
Trisolfen® 5 L	$950	Castration only	$ 1.71	(Label directions 9ml for calves over 100kg)
		Dehorning only	$ 1.52	(Label directions for dehorning 4ml per horn)
		Castration + Dehorning	$ 3.23	(Label directions 9ml for calves over 100kg for castration + label directions for 4ml per horn for dehorning)
Meloxicam20 injectable 100ml	$200	Castrated only	$ 10.00	(Label directions 2.5ml/100kg liveweight)
		Dehorned only	$ 10.00	
		Castrated + dehorned	$ 10.00	
Trisolfen + Meloxicam injectable		Castrated only	$ 11.71	(dosage of Trisolfen and Meloxicam injectable as per above)
		Dehorned only	$ 11.52	(dosage of Trisolfen and Meloxicam injectable as per above)
		Castrated + dehorned	$ 13.23	(dosage of Trisolfen and Meloxicam injectable as per above)

4.3 Extension and communication

The following extension and communication activities were delivered as part of this project:

Activity	Further detail	Presenter/author	Audience	Audience
Presentation	Charters Towers BeefUp 2021, as part of the Northern Beef Producers Expo	Melissa Wooderson	Producers and public	~50
Presentation	KPIAC Meeting 2020 KPIAC Meeting 2021 KPIAC Meeting 2022	Melissa Wooderson	Producers	~6
Presentation	Victoria River Research Station Field Day 2022	Melissa Wooderson	Producers	~70
Presentation	Katherine Research Station Field day 2021	Melissa Wooderson	Producers	~15
Presentation	Douglas Daly Research Farm Field Day 2021	Melissa Wooderson	Producers	~30
Presentation	Western Queensland Regional Beef Research Committee meeting 2023	Powerpoint presentation sent to Leanne Hardwick (QLD DAF)	Producers	~10
Advisory Panel	Broome BeefUp 2023	Sarah Gwynne	Producers	~50
Advisory Panel	Kununurra BeefUp 2023	Melissa Wooderson	Producers	~50
FutureBeef webpage	https://futurebeef.com.au/resources/pain-relief-during-castration-and-dehorning-project/ original posting in 2020 Update with results awaiting publication on webpage, forwarded to FutureBeef in June 2023	Melissa Wooderson	Producers and public	TBC
Presentation/ publication	Northern Beef Research Update Conference 2023- Paper title *'Impact of sinus exposure during dehorning on wound healing, infection and liveweight'*	Melissa Wooderson	Producers and researchers	~100
Radio Interview	ABC Radio June 2021	Melissa Wooderson	Public	unknown
Poster	Katherine Rural Show Tennant Creek Rural Show	Melissa Wooderson	Public	~1000
Flyer	Developed 'Husbandry Procedure best practice for young cattle' brochure. In process of final approvals before publication. Attached in appendix.	Melissa Wooderson	Producers and public	Yet to be published
Producer Training	Discussions/demonstrations on property for staff involved in the trial on pain relief use and aseptic technique	Melissa Wooderson Georgia Glasson Gretel Bailey-Preston Elle Fordyce Sarah Gwynne	Producers	~40

4.4 Monitoring and evaluation

Producers in the NT, Queensland and WA were surveyed before and after participation in the study to record their experiences and thoughts on the use of pain relief products, Table 4.4.1. Of the properties that completed the questions (7 of 8 properties), four had used pain relief products before, while the other three had not. Following the trial, producers were questioned on their experiences in the trial. Five producers responded that they noticed a difference in the behaviour of their animals (less time spent lying, faster return to grazing), while two responded that they did not notice a difference. Six of the seven properties responded they will continue to use pain relief products (either Trisolfen or Meloxicam) in the future, with only one property responding that they would likely not continue using pain relief products. When questioned about what would have to happen for them to continue using pain relief products, the response was that there would have to be a demonstrated economic return for the investment (either a production benefit or a marketing benefit).

Table 4.4.1. Responses to producer survey. Note responses are anonymous.

	Have you used pain relief products before	**Did you notice a difference in the cattle? Behaviour, grazing, lying etc?**	**Will you continue to use pain relief? If not why not?**	**If no, what would have to happen for you to start using pain relief products?**
Producer 1	No	Yes, returned to grazing quicker when walked out	Yes, Trisolfen and possibly Meloxicam	-
Producer 2	No	Yes, appear to return to normal behaviours quicker	Yes, Trisolfen as it is easier to use as the Meloxicam requires injection several minutes before castration/dehorning	-
Producer 3	Yes, Meloxicam	Yes, less time spent lying down/sulking	Yes, Meloxicam	-
Producer 4	No	No, didn't notice any difference	No. Didn't notice any welfare or production benefit. It is an added expense.	Would have to have a proven benefit, or become required
Producer 5	Yes, Trisolfen	Not really	Yes, Trisolfen	-
Producer 6	Yes, Trisolfen and Meloxicam	Yes, less lying down and would start grazing quicker	Yes, Trisolfen and Meloxicam	-
Producer 7	Yes, Trisolfen and Meloxicam	Yes, Metacam® seemed to work better than Trisolfen. Believe Trisolfen washes of the horn area to easily and is wasted.	Yes, Meloxicam and Trisolfen. But think Trisolfen is likely not a great benefit for dehorning as most is washed away	-

5. Conclusion

5.1 Key Findings

- Castration and dehorning cause reduced weight gains in the time following procedures when compared to animals that have not been castrated and dehorned.
- Dehorning tended to have a greater impact on liveweight than castration.
- Across all sites, an average wound infection rate of 12% was observed for both castration and dehorning wounds.
- Sinus exposure during dehorning increased the chances of developing an infection by an average of four times. Animals with higher a starting weight (likely the older animals) had a higher proportion of exposed sinus during dehorning.
- The provision of pain relief alone was not enough to overcome the decrease in weight gains observed in the 21 days (approximately) following castration and dehorning.
- The provision of pain relief is only part of weaner management during husbandry procedures, which must also include good handling, nutrition and aseptic techniques.
- Producers involved in the project were very supportive of continued use of pain relief products into the future (85% of participating properties will continue using pain relief products). However concerns over the cost of the products was raised by some producers. Currently there are only two products commercially available for producers to use during husbandry procedures; Trisolfen® and Meloxicam (either as an injectable or oral administration). Further research in this area may see other products come onto the market that may be able to provide stronger, longer lasting or more affordable pain relief options.

5.2 Benefits to industry

Addressing public concerns over livestock welfare is critical to maintaining the social license of the Australian beef industry. The administration of pain relief products during standard husbandry procedures is one way that has potential to improve current practices. This project not only aimed to demonstrate the use of these products in an extensive environment, but also collect epidemiological data on the impact of these husbandry procedures on liveweight, behaviour and wound healing, and if this was influenced by the provision of pain relief.

While this study did not demonstrate a measurable benefit following the provision of pain relief during husbandry procedures, it was important to demonstrate how these new technologies could be applied in the 'real world' environment of extensive beef production in northern Australia. Data on the impact of castration and dehorning was able to be gathered, addressing a significant knowledge gap in the northern beef production sector.

As a result of this project, an updated 'best practice' guideline was developed, incorporating the use of pain relief products. The importance of good aseptic technique during husbandry procedures to reduce instances of infections was clearly demonstrated, as an infection rate averaging 12% across all sites was observed.

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7. Appendix

7.1 Best practice during husbandry procedures guide

Livestock Industries

Department of **Industry, Tourism and Trade**

THE TERRITORY

Husbandry procedure best practice for young cattle

What are husbandry procedures?

Husbandry procedures include:

- castration (done to improve carcase quality and reduce unwanted breeding)
- dehorning (the removal of developing horns in young animals to prevent further horn growth to reduce risk of injury to stock and stock handlers)
- branding
- vaccination
- ear-tagging and marking
- weaning.

While these procedures are often necessary, it is important that they are performed in the best way possible to reduce discomfort and potential complications such as infections and weight loss in animals.

NORTHERN TERRITORY GOVERNMENT

What is best practice?

The term 'best practice' describes recommended guidelines to achieve the best results, and is paramount to maintain a successful, sustainable and ethical business. Below is a quick overview of these recommendations. For further information you should discuss with your vet or livestock officer.

General principles

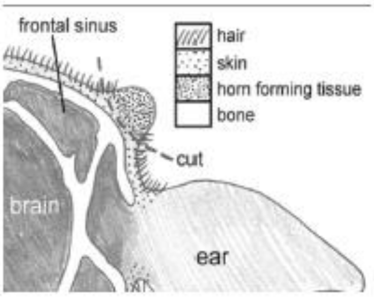
- Always be aware of all legislation relevant to your state, and industry standards such as *The Australian Animal Welfare Standards and Guidelines for Cattle 2016*.
- While not always practical, perform husbandry procedures on animals when they are as young as possible (preferably under 6 months of age).
- Practice 'low stress' stock handling, move animals as quietly and calmly as possible and minimise time spent in the yards. Try to minimise stress for animals.
- Weaner training or education (such as 'tailing', handling animals and working them through yards and races) is recommended to produce calm, quiet cattle. Time spent educating weaners is a good investment, as it will help cattle to be better to handle for the rest of their lives.
- Use adequate numbers of well-trained and experienced staff, and good planning and process.
- Ensure all equipment is in good, safe working order.
- Good restraint is essential. This is for both the safety of the animal and the staff. A calf cradle is generally recommended.
- Practice aseptic technique and keep equipment clean. Disinfect all equipment (dehorners, scalpels etc) between each animal and get fresh disinfectant frequently.
- Following any husbandry procedures, monitor animals frequently over the next 10 days.
- Provide good nutrition. On many properties in northern Australia, husbandry procedures occur at the same time as weaning. As such, it is important to provide these animals with the best nutrition possible at this time to establish good rumen function, reduce the chance of negative weight gain and to improve wound healing.
- Ensure all cattle have access to good, clean water at all times.
- Plan ahead. Check weather forecasts and never perform husbandry procedures before wet or bad weather. Where possible undertake husbandry procedures in the coolest parts of the day.
- Water down yards prior to conducting husbandry procedures, this reduces contamination from dust.
- Never perform the husbandry procedures of castration, dehorning or branding on wet, weak, sick or emaciated animals.
- Release animals from the yards as soon as possible after branding, castration and dehorning. It is preferable to do weaner training before husbandry procedures and to move the newly processed animals to a fresh paddock rather than hold them in the yards after branding.
- Provide pain relief (discussed in greater detail later in this document).

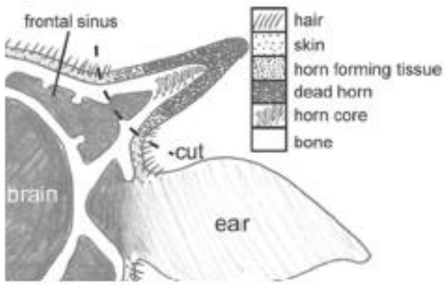
Castration principles

- Castrate calves as young as possible.
- Disinfect scalpel blades between each animal and replace the blade frequently (every 10-15 calves).
- Before undertaking castration, ensure both testes can be easily palpated and moved within the scrotum.
- If castrating with elastic bands/rings follow guidelines regarding correct placement of the ring and age of animals, currently only recommended for cattle under 8 weeks of age, as use in older animals runs a higher risk of infection.

Dehorning principles

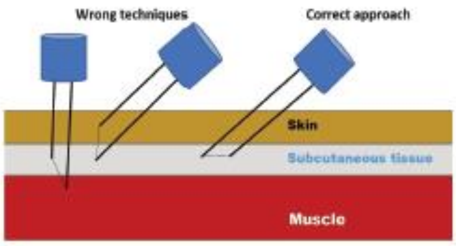
- Dehorning animals as young as possible (recommended under 6 months of age) will reduce stress and the risk of potentially exposing the frontal sinus. Sinus exposure can increase the risk of infection developing.
- Avoid removing more tissue than is necessary to stop the horn from regrowing, this will reduce excess bleeding. However it is necessary to remove 1 cm of skin from around the base of the horn for dehorning to be effective.
- Whichever dehorning instrument is used, it must be well maintained, clean and sharp.
- The need for dehorning can be eliminated by breeding polled cattle (naturally hornless).





Vaccination principles

- Store all vaccines at the correct temperature.
- Ensure vaccines are used in the recommended timeframes from first use of the vaccine. Some vaccines must be used within 8 hours, while others can be used for up to 28 days.
- Change vaccine needles frequently to avoid the needle going blunt.
- Ensure the needle is mounted so that the bevel is angled correctly for injection.
- Use vaccines according to label directions.



Providing pain relief

Several pain relief products have become available for producers to use on cattle during husbandry procedures. Currently available products (as of 2023) are:

- Trisolfen® this is a topically applied wound gel that contains Lignocaine and Bupivacaine (local anaesthetics), Cetrimide (a disinfectant) and adrenaline (to reduce bleeding). The gel is applied by a hand held, spray gun and is reported to last up to 12hrs.
- Meloxicam Injectable is a non-steroidal anti-inflammatory drug (NSAID) which is administered by subcutaneous injection prior to a husbandry procedure (recommendation is 15 minutes prior to procedure) with dose rate determined by weight. It acts by reducing the inflammatory response which reduces pain and is reported to be active for up to 36 hours.

Providing pain relief cont.

- Meloxicam Oral (Buccalgesic®) much like meloxicam injectable. This is administered prior to a husbandry procedure being undertaken, however this form is administered orally and is absorbed through the cheeks and gums (rather than being swallowed).

Always follow directions on the label when it comes to the use, storage and administration of these products.

While there are currently only a small number of products available, this may change in the future.

Results of the northern 'Managing production and welfare at weaning' trial

Between 2020 and 2022 the Northern Territory Department of Industry, Tourism and Trade, Western Australia Department of Primary Industries and Regional Development and Queensland Departments of Agriculture and Fisheries conducted a joint project funded by Meat and Livestock Australia (MLA) to demonstrate best practice husbandry, including the use of pain relief products, in the 'real world' commercial environment of northern Australia. Sixteen extensive cattle herds were included in the trial. On each property, cattle underwent husbandry procedures at the normal time and pain relief products were used.

Animals were randomly split into four treatment groups:

- Trisolfen®
- Meloxicam injectable
- Meloxicam Injectable + Trisolfen®
- Control

All calves were weighed prior to any husbandry procedure and then monitored and reweighed approximately 28 days later, at which times all wounds were inspected for stage of healing. In addition to weight and wound healing, cattle behaviour in the yards in the hours following processing was recorded and some animals were monitored in the paddock using GPS collars and accelerometer ear tags to record movement and activity.

The following observations were made:

- Castration and/or dehorning impacted liveweight in the time following these procedures. Whilst the provision of pain relief products did not overcome this impact, it is a recommended part of the process for animal wellbeing.
- The development of an infection in either the castration or dehorning wound site negatively impacted liveweight, with infections occurring in around 12% of animals for both castration and dehorning. The best practice procedures outlined above should be used to reduce the risk of infection.
- Castration wounds on average took a little over a month to heal, while dehorning wounds frequently took longer than two months to heal.
- The occurrence of an exposed sinus during dehorning increased the risk of developing an infection by four times on average.

For more information, refer to the MLA's A guide to best practice husbandry in beef cattle, second edition.

For more information, go to industry.nt.gov.au
Department of Industry, Tourism and Trade