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Attitudes towards pain relief and wound management, and their on-farm use during cattle dehorning in northern Australia

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ABSTRACT

Context. Dehorning remains a common procedure across the northern Australian beef industry due to the widespread use of horned breeds and management constraints in extensive operations. Amputation dehorning has cattle welfare and production implications, including haemorrhage, infection, flystrike, weight loss and mortality. The use of and producer attitudes towards pain relief and wound treatments are not well documented. **Aims.** This study aimed to document cattle dehorning practices in northern Australia and identify producer-defined priorities for effective wound management treatments in extensive beef systems. **Methods.** An online survey targeting Australian beef cattle producers was conducted between February and August 2023. Four online focus groups involving producers and industry stakeholders from northern Australia were conducted to explore attitudes, practices, experiences, and priorities related to pain relief and wound management for dehorning of cattle. Quantitative data were analysed using Fisher's exact test and qualitative data were analysed thematically. **Key results.** Dehorning was performed by 92.5% of northern Australian survey respondents, most commonly using surgical methods. Pain relief was used by 75% of producers, most commonly Tri Solfen® (65%) and meloxicam (28%). Multimodal analgesia was used by only a minority (15%). Relief from pain (91%) and improved wound healing (74%) were the most common perceived benefits of pain relief, with efficacy (87%) and practicality (81%) of the product being the most important factors determining adoption. Focus group participants emphasised progress towards breeding a polled herd, while highlighting the importance of being proactive towards animal welfare by using pain relief. Haemorrhage and infection are major welfare and production concerns following dehorning, particularly in extensive systems with limited postoperative monitoring. An ideal wound treatment was described as one that is effective, simple to apply, affordable, robust under field conditions, and capable of reducing pain, bleeding and infection. **Conclusions and implications.** Dehorning remains a prevalent procedure in northern Australian beef enterprises. Although uptake of pain relief is increasing, effective strategies for managing complications caused by amputation dehorning wounds are sought after. Producer-defined priorities provide a clear framework for refining dehorning protocols and developing novel wound treatments that align with the realities of extensive beef systems.

Keywords: dehorning, northern Australia, pain relief, post-operative care, post-operative complications, producer perceptions, wound healing, wound management.

Introduction

Northern Australian beef enterprises are typically extensive operations, with high numbers of primarily *Bos indicus* and *Bos indicus* content cattle (Cowley *et al.* 2010) managed over large areas of land with often limited capabilities for intervention (Patinson *et al.* 2019). However, operations in these regions can vary considerably in terms of property size, herd size, location and wet season (Petherick 2005; McLean *et al.* 2014; Cowan *et al.* 2024), influencing breeding periods and mustering frequency (O'Rourke *et al.* 1992; Cowley *et al.* 2010; Fordyce *et al.* 2022). Year-round or continuous mating is a common practice in extensive areas, such as the northern regions of Western Australia and the Northern Territory, and North West, North and Central West Queensland (Bortolussi *et al.* 2005;

Cowley *et al.* 2010). Controlled mating is more common in the southern regions of northern Australia; however, the duration of mating periods is generally longer than the recommended period for mature cows of 8–9 weeks (Gunn 2016), often lasting from 3 to 7 months (Fordyce *et al.* 2022). Given the large areas and cattle numbers managed, cattle are generally mustered only once or twice a year, at which time calves are generally processed and weaned (Bortolussi *et al.* 2005; Cowley *et al.* 2010).

As a result of the extended breeding periods and limited musters common of northern Australian enterprises, calves of a range of ages are likely to require processing. Calves are often processed and weaned at their first muster, with weaning depending on calf weight and cow condition (Tyler *et al.* 2025), occurring on average around the age of 5.9–6.9 months, with a range of 3.5–10 months (Bortolussi *et al.* 2005). Processing calves generally involves performing any relevant husbandry procedures, such as disbudding or dehorning. Disbudding or dehorning of cattle is performed to remove horns and horn-producing tissue to prevent injury, and improve safety and ease of handling (Meat and Livestock Australia 2023), reduce space required for transport (Department of Agriculture Fisheries and Forestry 2012), and meet requirements for feedlots (Bertram *et al.* 2004) and live export (Department of Agriculture and Water Resources 2017). Disbudding is the removal of the horn bud before fusion with the frontal bone of the skull (Rousseau 2022), performed before approximately 2 months of age and is preferred over dehorning for animal welfare reasons (Newman 2007; Animal Health Australia 2014). Once the horn bud has fused to the skull, amputation dehorning is required, which involves removal of the entire horn and approximately 1 cm of surrounding tissue to prevent horn regrowth (Newman 2007). Around 6 months of age, the horn becomes pneumatised, where the horn core hollows and opens into the frontal sinus of the skull (Algra *et al.* 2023). Dehorning after this point often results in large open wounds, increasing the risk of haemorrhage and infection, which may lead to increased mortality (Sinclair 2012; Espinoza *et al.* 2013; Fordyce *et al.* 2014; Wooderson 2024).

In the context of northern Australia, dehorning calves before 2 months of age is not always possible, and as a result, open wounds with exposed sinuses that bleed excessively and are vulnerable to infection are common. The Australian Animal Welfare Standards and Guidelines for Cattle dictate that pain relief must be used on calves being dehorned over the age of 6 months, or 12 months if at their first yarding, depending on the relevant jurisdiction (Animal Health Australia 2014). Currently available pain relief products used for dehorning of cattle include a topical anaesthetic and antiseptic gel, Tri-Solfen® (Dechra Pharmaceuticals PLC, Northeich, UK) and non-steroidal anti-inflammatory drugs (NSAIDs), such as meloxicam. The administration of pain relief can improve welfare outcomes of dehorning by inducing wound anaesthesia (Espinoza *et al.* 2013), reducing wound inflammation (Scerri *et al.* 2025), improving post-operative behaviour (Van der Saag *et al.* 2018*b*) and improving post-operative weight gain (Coetzee *et al.* 2012). However, these pain relief products are unlikely to significantly mitigate haemorrhage, infection or the associated risk of mortality, highlighting the need for a wound treatment that effectively addresses these outcomes.

Although research has evaluated the welfare impacts of dehorning and the efficacy of available analgesic options, limited information exists regarding contemporary dehorning practices, producer attitudes towards pain relief and producer perceptions of wound management needs under extensive production conditions. Understanding these practices and priorities is important for guiding future refinement of dehorning protocols and development of practical wound-management solutions. Therefore, this study aimed to: (1) describe current dehorning practices in northern Australian beef enterprises, including timing, methods and pain-relief use; (2) investigate producer attitudes towards pain relief and dehorning-related complications; and (3) identify producer-defined priorities for future wound management strategies suitable for extensive beef production systems

Methods

A mixed-methods approach combining quantitative survey data and qualitative focus group discussions was used to characterise current dehorning practices, and identify unmet needs relating to pain and wound management under commercial conditions in the unique context of extensive beef enterprises in northern Australia. A survey and series of workshops were conducted separately from February to August of 2023. The survey analyses presented here represents a subset from a larger survey evaluating husbandry procedures in beef cattle. The survey and the content of the focus groups were developed by The University of Sydney and were conducted in accordance with the National Statement on Ethical Conduct in Human Research (2007). The survey and focus groups were approved by the University of Sydney's Human Ethics Committee (approval number 2022/946). The survey was developed and distributed via Qualtrics XM (Qualtrics, Provo, UT).

Survey

Participant recruitment and survey dissemination

The survey was targeted at Australian cattle producers and was not restricted by location, herd size or land area. Participants were required to be over the age of 18 years and be working with or involved in cattle production. An online survey was developed to investigate the management decisions surrounding husbandry procedures in cattle including age, method, and pain relief usage and considerations. To prevent skewing of the data, survey participants were asked to complete

the survey once per property. The survey link was emailed to the chairperson of each of the 11 Regional Beef Research Councils (RBRCs) within the Northern Australia Beef Research Council (NABRC) to be distributed to their members. Additionally, the survey link was sent to members of the Future Northern Territory Cattleman's Association (Future NTCA), Young Livestock Exporters Network (YLEN) and Monaro Farming Systems (MFS) and were encouraged to share the link to other beef producers within their networks. The survey link was also featured in Meat and Livestock Australia's (MLA) website under 'Participate in industry research' within the and Development" page for approximately 6 weeks. The survey was open for 6 months from 3 February to 24 August 2023.

Survey design

A total of nine questions from the survey were relevant to this project and were grouped into four areas: (1) demographics, (2) dehorning methods and ages when performed, (3) use of pain relief and perception of benefits, and (4) dehorning-related mortality (Table 1). Responses allowing multiple selections were analysed as binary variables indicating whether a respondent selected a given option.

Demographic questions included location (region) and total area managed (hectares), and total livestock numbers operated annually. Total number of cattle was used for the data analysis in this paper despite possible discrepancies at different times of the year, as it was the only figure that accounted for breeding enterprises, as well as feedlot and trading operations. Answers to husbandry-related questions were recorded binomially (yes or no). Participants were asked to indicate if they performed disbudding or dehorning using one or more of the following methods: cautery, caustic paste, knife, scoop/cup (amputation) or not performed. Participants were then asked to indicate at approximately what ages they performed disbudding/dehorning: <2 weeks, 2–6 weeks, 6 weeks to 3 months, 3–6 months, 6–12 months or >12 months. Participants were able to select multiple ages. The use of pain relief for disbudding/dehorning was asked, with participants able to select multiple pain relief products, including local anaesthetic, topical anaesthetic, transmucosal meloxicam, injectable meloxicam and injectable flunixin, or select 'other' and detail different products used. Participants were asked what benefits they believe exist as a result of using pain relief for husbandry procedures in cattle and were able to select one or more of the following responses: reduced pain and distress, improved healing of wounds, improved production performance, meeting guidelines for markets or programs, no benefit or 'other' where they were able to detail their own response. The considerations that participants make when deciding to use or not use pain relief for husbandry procedures was asked, selecting one or more of the following responses: cost, practicality, efficacy of product, ease of access, public opinion or 'other' where they were able to detail their own response. Finally, participants were asked if they had documented post-operative mortalities following disbudding or dehorning, what percentage of their herd was affected.

Focus groups

Recruitment

Beef producers from northern Australia were targeted for the focus groups. Participants were recruited through the NABRC via an email sent to the chairperson of each of the 11 RBRCs. Committee members were able to select times that suited them best to participate in an online focus group,

Table 1. Questionnaire structure used for the survey, describing each section and the outcomes evaluated.

Section	Type of response	No. of questions	Information gathered
1. Demographics	Type-in response	3	• Location (region) • Total area (hectares) • Total number of cattle
2. Dehorning practices	Dichotomous (e.g. yes or no)	2	• Dehorning methods used (cautery, caustic paste, knife, scoop/cup (amputation) or not performed)
	Multiple options were able to be selected		• Ages when dehorning is performed (<2 weeks, 2–6 weeks, 6 weeks to 3 months, 3–6 months, 6–12 months or >12 months)
3. Pain relief usage and perception	Dichotomous	3	• Pain relief products used for dehorning (local anaesthetic, topical anaesthetic, transmucosal meloxicam, injectable meloxicam and injectable flunixin, or other)
	Multiple options were able to be selected		• Perceived benefits from pain relief usage (reduced pain and distress, improved healing of wounds, improved production performance, meeting guidelines for markets or programs, no benefit, or other)
	Where 'other' was selected, respondents were able to provide their own response		• Considerations made for the use of pain relief (cost, practicality, efficacy of product, ease of access, public opinion, or other).
4. Dehorning related mortality	Type-in response	1	• Percentage of mortalities observed following the procedure.

allowing groups to be run at a time that allowed the majority of potential participants to attend, resulting in a range of producers representing different areas and production systems across northern Australia at each meeting. One focus group was opportunistically incorporated into an RBRC's regular meeting. A total of four online focus groups were held in July of 2023. The aim of these meetings was to further discuss dehorning practices, and pain and wound management strategies. The focus groups were scheduled and recorded via Zoom (Zoom Video Communications), with participants' permission. Information and consent forms were distributed with the link to the focus group that detailed to participants how the information collected would be used. All information collected was deidentified, and participants had the option to 'opt out' at their discretion at any time. The sample size was not predetermined and was subject to interest from producers.

Focus group content

Introductions. The focus groups were opened with an introduction to the research team and the MLA Donor Company-funded project, 'novel wound treatments for dehorning wounds in cattle'. The survey and focus group data would form the basis of the project, providing the researchers with an understanding of the dehorning practices in northern Australia. Participants were then asked to introduce themselves and their operations if they were comfortable to do so. Participants were asked their location (region), type of enterprise, size of property, total number of cattle and the specifics of their dehorning practices, including calf ages at dehorning, tools and techniques used, technician skills and training, and pain relief and/or other treatments used. Additionally, participants were asked about the factors that influence the timing of dehorning, such as weather conditions, pasture quality and availability, and markets.

Presented information. Following these introductions, some preliminary findings from the aforementioned survey were presented, specifically: age at dehorning, pain relief for dehorning, benefits of pain relief and considerations for use of pain relief. These data were included to initiate further discussion of these topics. Information on horn anatomy and reported complications of dehorning were presented, with participants encouraged to interject at any time. Discussions were then held regarding participants' observations of haemorrhage, infection, wound healing, morbidity and mortality associated with dehorning. Some unpublished research was also presented by the research team regarding the impact of dehorning on weight gain and behaviours, such as eating, ruminating and panting.

Project information. The goals and objectives of the overall project were presented to participants, highlighting each stage of the project to help participants understand how their input to the focus group discussions would contribute to the project's trajectory. Some results from unpublished pilot studies conducted by the research team on novel wound treatments for dehorning wounds were presented, and participants were asked their experiences with the use of wound products used specifically for dehorning wounds. The final portion of the focus group asked participants to consider what their ideal solution for management of dehorning wounds would be. A discussion was held to delve into the factors that are important to producers regarding the design of a wound treatment, such as cost, application or storage. These discussions were aimed towards developing a set of criteria to refer to when designing a novel treatment for dehorning wounds that is both effective and practical for use in extensive systems.

Statistical analysis

Survey

Survey data presented in this paper were extracted from a broader survey investigating husbandry procedures in Australian beef cattle enterprises. Responses were screened before analysis. Duplicate responses were identified based on identical combinations of location, property size and cattle numbers, and removed. Surveys that were incomplete or contained insufficient information to answer the questions relevant to dehorning practices were excluded from further analysis. Because respondents could select multiple responses for dichotomous questions (e.g. dehorning methods, ages at dehorning, pain-relief products and perceived benefits), each response option was converted into an individual binary variable indicating whether a respondent selected a given response option. All disbudding and dehorning data were combined due to the overlap of disbudding and dehorning results, as both options were able to be selected. In Section 3 of the survey, for the question regarding pain relief usage, injectable and transmucosal meloxicam, and injectable flunixin were combined and reported as 'NSAIDs'. Also in Section 3 of the survey, for the question regarding the considerations for use of pain relief, time taken to administer, skill level of workers, and practicality were combined and reported as 'practicality', as each of these factors relate to the practicality of a product. Written responses provided under 'other' categories were reviewed and either assigned to an existing category where appropriate or reported as a separate category where conceptually distinct.

The unit of analysis was the individual cattle enterprise (property). Demographic variables were categorised before analysis. Geographic location was classified as northern Australia (Queensland, Northern Territory and northern Western Australia) or southern Australia (New South Wales, Victoria, Tasmania, the Australian Capital Territory, South Australia and southern Western Australia representing areas south of the Pilbara region) because of limited responses within individual regions. Herd size was categorised as small (<1000 cattle), medium (1000–9999 cattle) or large (≥10,000 cattle) based on classifications reported for northern Australian beef enterprises by McLean *et al.* (2014), Cowley *et al.* (2010) and Oxley *et al.* (2004). All data were deidentified for analysis.

Analyses were conducted in R ver. 4.5.2 (R Core Team 2025) using RStudio ver. 2026.1.0.392 (Posit Software, Boston, MA, USA), and data were collated and stacked using Microsoft® Excel (Microsoft Corporation, Redmond, WA, USA). The survey generated predominantly categorical data and sample sizes within several categories were small. A contingency table was first created for two categorical variables, which were then analysed using Fisher's exact test, calculating the exact probabilities of the observed data, associated *P*-values ($\alpha = 0.05$) and 95% confidence intervals. Odds ratios were calculated for appropriate 2 × 2 contingencies to determine the strength and directionality of the relationships. Analyses were exploratory and intended to identify patterns within producer responses, rather than to quantify practices and perceptions.

Focus groups

An inductive thematic analysis was undertaken following the approach described by Kiger and Varpio (2020). Audio recordings were automatically transcribed using Zoom's built-in transcript function and were manually corrected according to the original recording by the primary researcher. Initial codes were generated from recurring concepts related to dehorning practices, pain relief use, wound-management experiences and treatment priorities. Codes were subsequently grouped into broader themes, reviewed against the original transcripts and refined through discussion among the research team. The resulting themes were used to contextualise and interpret survey findings rather than provide statistically representative estimates.

Results

Survey

Demographics

A total of 104 survey responses were received. Fifty responses were excluded due to incomplete data, resulting in 54 responses available for analysis. Of these, 40 (74%) originated from northern Australia and 14 (26%) from southern Australia (Fig. 1).

The total and average hectares and number of cattle between northern and southern Australia are detailed in Table 2. The stocking density reported for southern Australia was more than 24 times greater than reported for northern Australia.

The distribution of cattle as herd size reported in northern and southern Australia is represented in Fig. 2. There were no large-sized herds reported by southern Australian participants.

Dehorning

Method of dehorning. Three out of 14 (21%) southern Australian respondents indicated that they performed dehorning. Of these three producers, one reported performing cautery disbudding, one reported performing amputation dehorning, and one reported performing both cautery and amputation dehorning.

Among northern Australian survey respondents, 92.5% reported undertaking dehorning on their property. Of these respondents, amputation dehorning (72.5%; $P = 0.017$) and knife dehorning (65%; $P = 0.037$) were the most commonly reported techniques compared with 7.5% who indicated

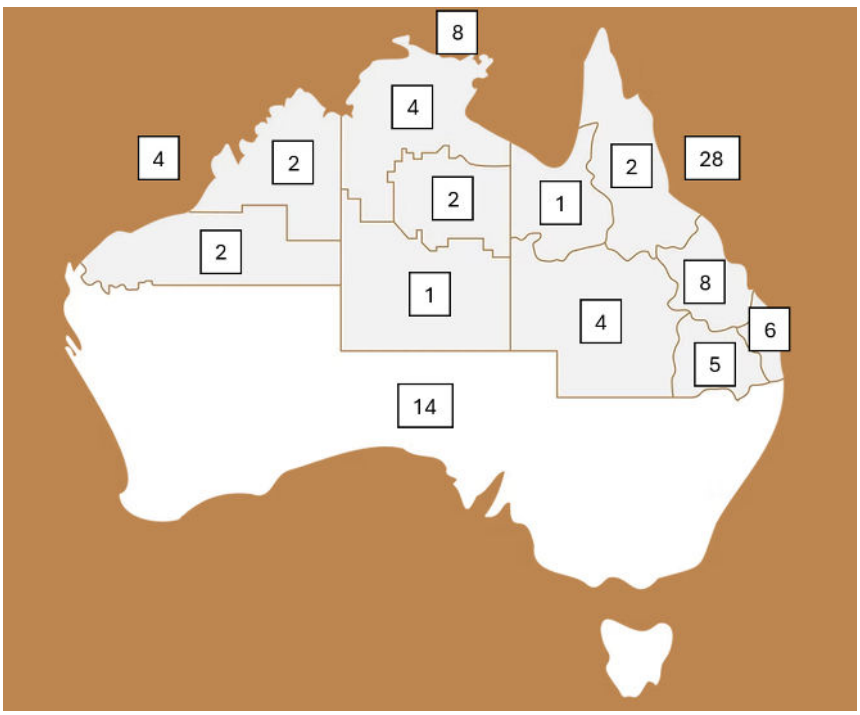


Fig. 1. Map of locations of survey participants from different regions of northern Australia and southern Australia. Where applicable, the number of responses from each region of northern Australia was reported, with the total number of responses from each state visible outside of the state. Where discrepancies occur, the specific region was not reported. In the survey analysis, northern Australia referred to Queensland, the Northern Territory and northern Western Australia, shown in this image shaded grey. Southern Australia referred to all southern areas, shown in this image in white. Image copied from: https://www.nabrc.com.au/committees.

Table 2. The total, average, median and range of reported area, and number of cattle reported by survey respondents from northern and southern Australia.

	Northern Australia				Southern Australia			
	Total	Mean	Median	Range	Total	Mean	Median	Range
Area (ha)	6,980,215	178,980	29,960	1,032,899	5985	428	300	1992
Cattle numbers	514,212	13,532	3000	69,935	5530	395	275	1196
Stocking density (*n*/ha)	0.07				0.92			

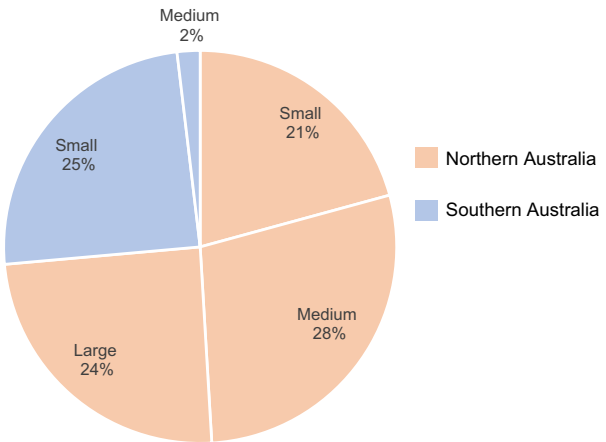


Fig. 2. The distribution of cattle reported by survey respondents categorised into herd size, and divided into northern (orange) and southern (blue) Australia. Herd size was categorised into 'small' (<1000 head), 'medium' (1000–9999 head) or 'large' (≥10,000 head).

they did not dehorn cattle. Survey respondents with small herds of cattle were more likely not to perform dehorning (50%; $P = 0.002$) than producers with medium- (6%) or large- (8%) sized herds. Producers with medium- and large-sized herds were significantly more likely to perform amputation (69% and 77%, respectively; $P = 0.035$) and knife (69% and 77%, respectively; $P < 0.001$) dehorning compared with small-sized herds (38% and 17%, respectively). Producers with small-sized herds were significantly more likely to not perform dehorning than to perform amputation dehorning ($P < 0.001$). There were no significant differences between dehorning methods used by producers with medium and large herds. No producers with large herds performed cautery disbudding.

Age of animals at dehorning. The most common age of calves at dehorning was 6 weeks to 3 months of age (57.5%) and 3–6 months (47.5%). For northern Australian producers, dehorning was more likely to be conducted on calves aged 6–12 months (20%) than calves aged ≥12 months (7.5%; $P = 0.006$). Of northern producers who perform dehorning, 78% dehorn all calves <6 months of age, whereas all southern producers who performed dehorning did so <6 months of age. Dehorning was performed at multiple ages by 32.5% of northern Australian respondents ($n = 13$), and 7% of southern Australian respondents ($n = 1$). Significantly more producers with small-sized herds perform dehorning at the age <6 months compared with producers with medium-sized herds ($P = 0.020$).

Pain relief usage and attitudes

All southern Australian producers who performed dehorning used a multi-modal approach to pain relief products (33% Tri-Solfen, 100% NSAIDs and 67% injectable local anaesthetic (LA)). Significantly more northern Australian producers reported using pain relief (75%) than not using pain relief (25%; $P = 0.029$). Tri-Solfen was used by 65%, NSAIDs (specifically meloxicam) was used by 28%, and only one producer reported using injectable local anaesthetic (3%). A total of 15% of northern Australian producers reported using a multimodal approach to pain relief (combination of Tri-Solfen or injectable local anaesthetic and an NSAID).

Across all survey respondents, relief from pain (91%) was perceived as more important than improved wound healing (74%; $P = 0.013$) and improved performance (56%; $P = 0.013$; Fig. 3). Three producers (6%) reported believing there to be no benefit from the use of pain relief; however, two of these producers did not indicate performing dehorning.

Product effectiveness (87%) and practicality (81%) were the most commonly selected considerations influencing the use of pain relief for husbandry procedures (Fig. 4).

Morbidity and mortality

Responses regarding dehorning-related mortality were limited, with only 16 respondents providing an estimate. Reported mortality ranged between 0 and 1%. Given that the survey did not define dehorning-related mortality and relied on participant recollection rather than production records, these findings should be interpreted as producer estimates rather than measured mortality rates.

Focus groups

Participation

The focus groups had a total of 37 participants, with 51% females and 49% males, averaging nine participants per focus group. These meetings ran for an average of 1 h and 20 min (range 1 h to 1 h 35 min). All participants were involved in the northern Australian beef industry as producers ($n = 15$), extension officers/consultants ($n = 7$) and veterinarians

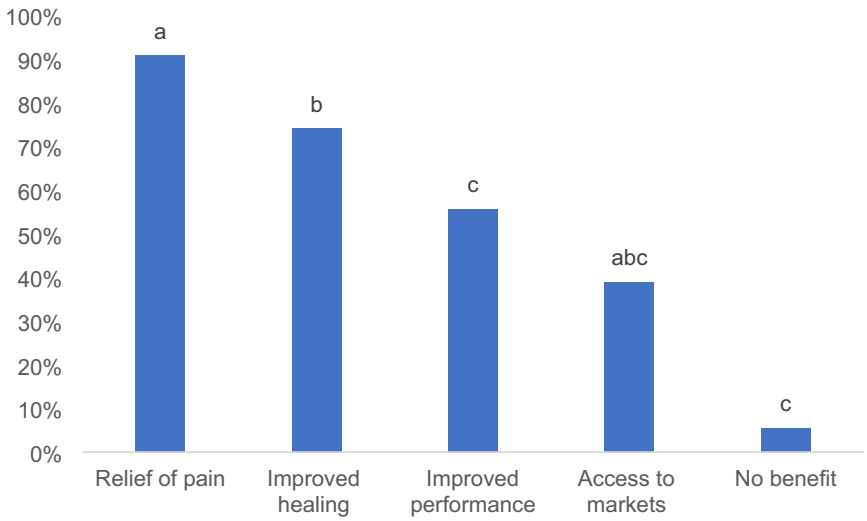


Fig. 3. The percentage of producers who perceive various benefits or no benefit from the use of pain relief for husbandry procedures in cattle. Different lowercase letters indicate significant differences between outcomes ($P < 0.05$).

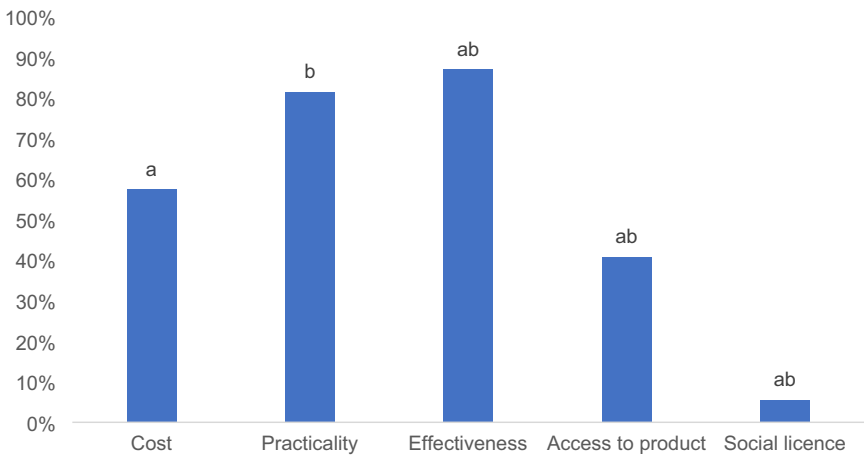


Fig. 4. The percentage of Australian producers reporting the most important factors considered when deciding to use pain relief for husbandry procedures in cattle. Different lowercase letters indicate a significant difference ($P < 0.05$).

($n = 1$). Demographic information has not been reported to maintain participant privacy.

Dehorning practices

Dehorning was performed by all producer-participants in the focus groups, with 93% reporting using pain relief for dehorning. The six major themes relating to dehorning practices and management priorities identified in the focus groups identified through thematic analysis are presented in Table 3.

Although the 93% of producer-participants reported using pain relief, the point was made that members of the RBRCs are generally engaged with research, are familiar with best practice and are progressive in their production systems. It was suggested that the use of pain relief by producers in northern Australia outside of the NABRC networks may be substantially lower than what was reported in the survey and focus groups. One beef extension officer suggested that uptake among their client base may be as little as '1–2 in 15 people'. These observations were anecdotal and reflected participant perceptions rather than measured adoption rates. Although some producers could justify the use of pain relief with anecdotal evidence, such as improved behaviour, it was suggested that producers who do not implement pain relief want to see supporting research and a cost-effective benefit of improved production, to establish a 'return on investment'.

One critical point that was raised throughout each of the different focus groups was maintaining the 'social license to operate', with multiple participants agreeing that pain relief is necessary irrespective of production benefit. One participant cited the 2004 Australian Merino wool boycott initiated by animal welfare activists as a cautionary tale of what could happen to beef producers if dehorning was targeted.

Ideal wound treatment solution

Participants were asked what they view as an ideal treatment for dehorned cattle. Producer-defined characteristics of an ideal wound-management product were consolidated into preferred attributes, undesirable characteristics and future product concepts (Table 4).

Table 3. The six major themes relating to dehorning practices and management priorities identified through thematic analysis of focus groups with beef producers from northern Australia.

Theme	Producer practices/observations	Key considerations
1. Tools and techniques	• Tool choice depends on horn size/shape. • Dehorning usually performed by experienced staff. • All participants reported using surgical methods rather than cautery.	• Appropriate tool selection prevents regrowth and excessive tissue removal. • Poor technique increases haemorrhage, infection, healing time and mortality. • Equipment hygiene is essential to minimise infection.
2. Age at dehorning	• All producer-participants who stated the ages when they dehorn reported dehorning <6 months of age. • Timing influenced by herd size and labour availability.	• Older calves have larger wounds, greater haemorrhage and infection risk. • Seasonal conditions affect outcomes; autumn dehorning associated with fewer losses due to reduced heat stress and fly pressure. • Extreme heat, rain and dust increase postoperative complications.
3. Pain relief	• 93% report using pain relief, 71% use Tri-Solfen®, 64% use meloxicam, 43% use multi-modal analgesia. • Strong agreement that minimising pain is important. • Lack of organic-certified options is a barrier. • Cost is an important consideration.	• Pain relief improves calf behaviour and recovery; some producers note reduced acute mortalities. • Adoption influenced by access, storage, shelf-life and ease of use (spray-on favoured). • Emotional welfare of staff positively influenced by providing analgesia. • No organic-certified pain relief currently available. • One producer suggested that cost can be justified by benefit; however, the benefit may be improvement in behaviour rather than production.
4. Complications (morbidity and mortality)	• Weight loss and mortality rarely quantified due to extensive systems. • Calves typically experience compensatory gain following initial weight loss or reduced gain.	• Excessive haemorrhage identified as the main cause of acute deaths. • Post-mortems rarely performed; causes of death often unclear. • Mortality rate is estimated by participants to be < 2.1% reported by Bunter *et al.* (2013). • Polled vs dehorned cattle show minimal long-term weight differences. • Producers agreed morbidity and mortality remain important welfare and productivity issues.
5. Existing wound treatments	• Producers use or have used flystrike preventative and wound-healing products.	• Diazinon products used historically but now uncommon due to toxicity concerns. • Spinosad widely used for fly control. • Stockholm tar-based products provide protection but are difficult to apply. • Aluminium sprays valued for ease and effectiveness.
6. Breeding for polled cattle	• Breeding for polled cattle emerged as a recurring theme.	• Considered a long-term solution, but must be balanced with maintaining key production traits.

Discussion

This study provides insights into cattle dehorning practices within northern Australian beef systems, with a specific focus on producer attitudes towards pain relief and wound management under extensive conditions. By integrating survey data and focus group discussions, findings demonstrate that although the adoption of pain relief for dehorning is increasing, key welfare and production challenges persist, particularly those associated with post-operative wound complications. These challenges are exacerbated by limited opportunities for monitoring and intervention in extensive systems. Collectively, the results highlight the need for refined protocols to improve management practices. In addition, the development of a targeted wound treatment that is practical and effective in the unique context of northern Australian beef production environments would greatly benefit the welfare of calves undergoing disbudding and dehorning.

Dehorning prevalence among northern Australian beef producers (92.5%) in our study was higher than national estimates (33%) reported by the Australian Beef Sustainability Framework (ABSF) (Sloane and Walker 2024). The ABSF results are more heavily represented by smaller, southern enterprises (65%) despite >64% of the national beef herd being located in Queensland, the Northern Territory and Western Australia (Australian Bureau of Statistics 2026). The contrast between these figures is reflective of the differences in the scale and types of operations, and the challenges faced

Table 4. Producer-identified attributes of ideal dehorning wound treatments, determined by focus group participants from the northern Australian beef industry.

Ideal	Avoid	Ideas
• Seal and protect the wound	• Long or restrictive withholding periods	• Spray- or paint-on formulations preferred
• Promote clotting and reduce blood loss	• Need for additional labour for application	• Packaging that is easy to open and protects contents from dust
• Support rapid, effective wound healing	• Residues in meat or pasture	• Different package sizes
• Remain adhered	• Safety risks to users; need for PPE	• Products capable of sealing an open sinus
• Rapid and easy application; no specialised skill required	• Sensitivity to heat, light or dust	• Hard-setting foam sealants
• Durable adherence	• Single-use only once opened	• Applicators that improve safety, accuracy and adherence
• Long shelf-life; stable at room temperature	• Need for refrigeration	• Ability to reapply if initial application is disrupted (e.g. calf movement)
• Affordable and over-the-counter		
• Suitable for wounds of varying sizes		
• Organic certified option available		
• Impregnated with antimicrobials, pain relief and/or insecticide		
• Weather resistant		
• Biodegradable		

between northern and southern beef production systems. Although dehorning remains a widely performed procedure in northern Australian beef systems, limited literature exists quantifying the prevalence of the procedure, the ages performed and the tools used specifically within these production systems. Several surveys have been conducted evaluating beef cattle management practices in northern Australia (Oxley *et al.* 2004; Bortolussi *et al.* 2005; Cowley *et al.* 2010); however, none detail dehorning practices, and the most recent is >15 years older than this study.

Surgical dehorning methods, specifically knife and amputation, were used by all focus group participants and northern Australian survey respondents who reported performing dehorning, and were more common in medium- and large-sized herds than in small herds. The method and tool of horn removal largely depend on the size, shape and development of the horn (FutureBeef 2011). Knife disbudding involves the excision of horn buds and small horns before ossification of the attachment to the skull (FutureBeef 2011; Thakur *et al.* 2026), and is the second most common method of disbudding used in Australian beef enterprises (Sloane and Walker 2024). Once the attachment of the horn bud to the skull has ossified at approximately 2 months of age (Rousseau 2022), amputation dehorning is required for permanent horn removal, typically performed using scoop or cup dehorners, which excise the entire horn with associated bone and tissue, often creating a large open wound (Sylvester *et al.* 1998*b*; FutureBeef 2011). Surgical methods of dehorning are considered practical and efficient in extensive systems, particularly where horn size varies between calves (Anderson 2010). Some variation exists around the age when fusion of the horn bud and skull occurs (DairyNZ n.d.; AHDB 2026), indicating that some flexibility with tools used may be required, which is reflected in the cross over between knife and amputation dehorning methods. Cautery disbudding was only reported to be used by 5% of northern Australian producers surveyed, which was consistent with national reporting of 10% (Sloane and Walker 2022), as it is only suitable for use on horn buds that have not yet fused with the skull, requiring application before 2 months of age (Aleri *et al.* 2022; Rousseau 2022). Surgical dehorning is associated with greater tissue trauma and more prolonged pain responses than cautery disbudding (Petrie *et al.* 1996; Stafford and Mellor 2011), reinforcing the importance of supportive pain and wound management strategies when these techniques are used.

The majority of survey respondents and focus group participants reported dehorning calves <6 months of age, aligning with best-practice recommendations to minimise wound size and associated welfare risks (Animal Health Australia 2014). Focus group participants acknowledged that dehorning <6 months of age is not always feasible in northern Australian systems. Extensive land areas and large herd sizes often require extended mating periods (Fordyce *et al.* 2022), or year-round matings (Cowley *et al.* 2010), with the majority of producers across the various regions of northern Australia performing only one or two weaning rounds (Bortolussi *et al.* 2005). Consequently, calves of a wide range of ages are often mustered for processing (Windsor 2021), resulting in variation in the extent of horn development. Despite these challenges, 78% of northern survey respondents that perform

dehorning reported dehorning calves under the age of 6 months. Calves dehorned over the age of 6 months are at risk of exposing the frontal sinus (Algra *et al.* 2023), increasing the pain associated with the procedure, and the risk of haemorrhage and infection, and potentially mortality (Sinclair 2012; Espinoza *et al.* 2013; Fordyce *et al.* 2014; Wooderson 2024). Focus group participants acknowledged that management and seasonal factors (e.g. wet season) can lead to calves being dehorned at an older age. The wet season generally extends from November to April (Cowan *et al.* 2024), with weaning and processing most commonly performed from April to July (Bortolussi *et al.* 2005; Cowley *et al.* 2010). It is recommended that dehorning is performed in cool, dry weather to reduce haemorrhage and infection risks (Newman 2023), which may lead to a delay in processing to prioritise ideal weather conditions for wound management.

Reported mortality associated with dehorning was low among survey respondents, with estimates ranging from 0 to 1%, with focus group participants consistently emphasising that mortality and morbidity following dehorning are difficult to quantify in extensive systems. Limited post-operative monitoring, infrequent post-mortem examinations and large paddock sizes mean that deaths may go undetected or be attributed to unknown causes (Bunter *et al.* 2013; Van der Saag *et al.* 2018*b*). This aligns with previous findings from a northern Australian study, where calf mortality following dehorning was reported as 2.1%, but the lack of post-mortem examinations complicated establishing a direct link to the procedure (Bunter *et al.* 2013). It is important to emphasise that the 0–1% mortality rate reported by producers in the survey is not a measured figure, but is an estimate proposed by producers based on their own post-operative observations within the normal context of their operations. The discrepancy between the figures reported here and the figure reported by Bunter *et al.* (2013) suggests that post-operative mortality may be underestimated by producers. These challenges highlight the inherent difficulty of accurately measuring adverse outcomes associated with dehorning in extensive beef systems.

Focus group participants consistently emphasised the importance of breeding genetically polled animals as the long-term solution to dehorning, while acknowledging constraints that may hinder genetic progress. Selective breeding for polled cattle is often complicated in large-scale operations due to several factors, including the complex inheritance of horns in *Bos indicus* breeds, availability and quality of homozygous polled sires, and the prevalence of feral bulls. Although the polled allele is dominant to the horned allele, the presence of the poorly understood scur and African horn genes, which are typically expressed at a greater frequency in *Bos indicus* animals, can cause scur and horn growth in heterozygous polled cattle (Prayaga 2005). Several advancements in genetic testing have accelerated the capacity for producers to genetically test their animals to determine their horn status (Lyons and Randhawa 2020; Randhawa *et al.* 2020); however, complications persist surrounding scurs and the African horn gene (Prayaga 2007; Randhawa *et al.* 2021). Despite the increased costs associated, the use of homozygous polled bulls, mated naturally or through artificial insemination, has been shown to rapidly increase the frequency of polled individuals within Brahman herds compared with using heterozygous sires (Cowley and Ward 2017). Focus group participants described actively seeking polled genetics to ameliorate the need for dehorning, yet highlighted the importance of considering multiple traits when selecting bulls to maintain and enhance the productivity of their herds. This sentiment may not reflect the breeding decisions of the greater northern Australian cattle industry, with only 9% of producers from the Northern Territory prioritising polled status as the most important trait when selecting bulls in the 2010 Pastoral Industry Survey (Cowley *et al.* 2010). However, the 13-year difference between these two reports potentially highlights a shift in paradigm. Further complicating the progress of genetic selection in northern beef herds is the prevalence of horned feral or 'mickey' bulls (Bryan *et al.* 2014). Although genetic selection for polled cattle remains a critical long-term objective for improving welfare, there remains an ongoing need to refine dehorning practices and associated pain and wound management strategies in the interim.

The use of pain relief for dehorning was reported by 75% of our survey respondents from northern Australia and 93% of focus group participants. This exceeds national estimates of 55% (Sloane and Walker 2022; Sloane and Walker 2024) and likely reflects the northern Australian focus of the survey, where dehorning is more prevalent, as well as the recruitment of producers more engaged with industry research and extension. This was noted by multiple focus group participants, who suggested that the prevalence of pain relief usage reported in the survey that was presented to them is likely not representative of the whole northern beef industry. Tri-Solfen was the most commonly used pain relief product reported for dehorning by northern Australian survey respondents and focus group participants, reflecting ease of application, over-the-counter availability and direct application to the wound. Tri-Solfen has been shown to reduce short-term dehorning wound sensitivity (Espinoza *et al.* 2013; Espinoza *et al.* 2016; McCarthy *et al.* 2016), but has been shown to have limited effect on wound healing (Van der Saag *et al.* 2018*a*). The application of Tri-Solfen to amputation dehorning wounds alone has proven troublesome due to poor adherence likely as a result of wound haemorrhage (Sinclair 2012; McCarthy *et al.* 2016; Sheil 2025). The application of Tri-Solfen soaked cotton gauze to dehorning wounds has been shown to improve adherence of Tri-Solfen, but had little effect on pain, haemorrhage or wound healing (Sinclair 2012). Therefore, there remains a need for an effective wound treatment with improved adherence for protecting the wound and supporting healing.

Use of NSAIDs, specifically meloxicam, was less common among northern Australian survey participants, but more frequently discussed in focus groups where producers described

perceived benefits to calf behaviour and recovery. Meloxicam has been shown to reduce wound inflammation following cautery disbudding (Scerri *et al.* 2025), and improve behaviour (Van der Saag *et al.* 2018*b*) and post-operative weight gain (Coetzee *et al.* 2012) following amputation dehorning compared with untreated control calves. However, under commercial conditions in a northern Australian context, meloxicam has been shown to have no effect on tail hair cortisol, liveweight change, behaviour, wound healing or infection over 67 days post-operative (Wooderson 2026). Nationally, the use of analgesics for dehorning has been reported as 18% (injectable) and 8% (oral) in 2024, increasing from 9% (injectable) and 6% (oral) in 2022 (Sloane and Walker 2022; Sloane and Walker 2024).

Multi-modal pain relief is the recommended strategy to maximise welfare during dehorning, enabling the provision of both immediate anaesthesia and longer lasting analgesia (Stock *et al.* 2013; Cattle Council of Australia 2020). The combination of Tri-Solfen® and meloxicam was reported by 15% of northern Australian survey respondents and 43% of focus group participants. Despite positive steps towards the increasing adoption of multimodal pain relief, a single dose of both a local anaesthetic and an NSAID is still unlikely to sufficiently address all the welfare implications of amputation dehorning. Post-operative pain following amputation dehorning has been shown to last up to 20 days, identified by abnormal, pain-associated behaviours (Wooderson 2026), but is likely to extend beyond this period, with chronic pain following cautery disbudding observed until 105 days following the procedure (Casoni *et al.* 2019), while untreated amputation dehorning wounds with exposed sinuses have been observed to take >11 weeks to heal (Fordyce *et al.* 2018). The duration of action of pain relief products has been demonstrated to last 1.5 h (topical anaesthetic; Espinoza *et al.* 2013), 2 h (local anaesthetic; Sylvester *et al.* 2004), 28 h (intravenous meloxicam) and 44 h (oral meloxicam; Coetzee *et al.* 2009). The application of a wound treatment or dressing to amputation dehorning wounds may provide some pain alleviation simply by forming a barrier over the wound, hydrating and protecting exposed nerve endings to reduce environmental exposure and external stimulation (Richardson and Upton 2010; Abdelrahman and Newton 2011), as has been observed in mulesing wounds treated with a placebo wound gel (Lomax *et al.* 2008). Additionally, a wound treatment that provides an optimal healing environment could possibly reduce longer-lasting pain associated with the procedure by accelerating the healing process and minimising wound inflammation, reducing hyperalgesia (Bechert and Abraham 2009; Carr 2022). Effectively addressing the pain associated with dehorning requires a long-term approach that addresses the chronic pain associated with the procedure and may involve protecting the wound to enhance healing.

Although an effect of improved wound healing has not been observed with the administration of currently available pain relief products in the literature, it was the second most important perceived benefit for using pain relief reported by survey respondents. This outcome likely relates to the emotional welfare of staff and cattle owners that is positively influenced by providing pain relief, as discussed by focus group participants. However, producers and stakeholders from the focus groups recognised that currently available pain relief products do not adequately mitigate haemorrhage, infection, flystrike or delayed healing. This aligns with previous research demonstrating that although analgesics reduce acute pain and inflammation, they have limited impact on wound-specific complications following amputation dehorning (Sinclair 2012; Fordyce *et al.* 2014; Van der Saag *et al.* 2018*a*). These findings highlight the need for a holistic approach to dehorning, in which improvements in pain management are accompanied by strategies to minimise wound complications and account for the practical constraints of extensive production conditions.

The application of wound treatments following dehorning has the potential to mitigate haemorrhage, infection and flystrike; however, evidence supporting their effectiveness in extensive beef systems remains limited. Earlier recommendations suggested that wound dressings were unnecessary provided optimal management conditions were met, including early-age dehorning, favourable weather conditions, good technique and sterile equipment (Newman 2007; Rolls 2007). However, this advice was based on wound products adapted from companion animal or intensive livestock systems, which often require repeated application and are difficult to implement at scale (Newman 2007; Rolls 2007). Additionally, under commercial conditions in extensive northern enterprises, ensuring these optimal parameters are met, such as dehorning at a young age, is not always possible. Developing a wound treatment that can address these complications may improve the welfare and wound healing outcomes where calves are being dehorned in less-than-ideal conditions.

Focus group participants reported the use of aluminium-based aerosols and tar-based products as wound treatments, primarily to reduce bleeding or protect wounds from flystrike. There are limited studies reporting the efficacy of aluminium-based aerosols for dehorning wounds, with one study demonstrating the application significantly improved wound healing for cautery disbudding wounds in dairy calves (Huebner *et al.* 2017; Hawkins *et al.* 2025). However these findings are not directly comparable to amputation dehorning, which typically involves excision of greater tissue and exposure of bone or the frontal sinus (Sylvester *et al.* 1998*a*; Stafford and Mellor 2005). Stewart (1939) reported a reduction in flystrike and enhanced wound healing with the incorporation of 25% Stockholm pine-tar in a paraffin wax and viscous oil-based dressing applied over oakum packed into the exposed sinus of amputation dehorning wounds; however, this dressing was slow to apply and did not successfully seal the wound in all cases. Fordyce *et al.* (2018) demonstrated a reduction in haemorrhage and infection and improvement in wound healing with the application of cotton gauze patches to amputation

dehorning wounds with exposed sinuses; however, 50% of the patches dislodged within the first 24 h, with successful results relying on sustained adherence. Rolls (2007) reports that wound dressings for amputation dehorning are seldom required, considering that certain requirements are met, such as performing the procedure when stock are young; using good technique; minimising pre-, peri- and post-operative stress; and ensuring weather conditions are optimal in that it is not wet, humid or dusty. However, as already established, in extensive operations where cattle are mustered only once or twice annually with long or year-round joining periods, it is not always possible to ensure stock are processed at a young age. Furthermore, in cattle that are infrequently handled, minimising perioperative stress is likely not possible. Ensuring optimal weather conditions throughout the post-operative healing period is another factor that may be difficult to control, indicating that the application of a wound dressing to amputation dehorning wounds in northern Australian commercial beef enterprises may enhance post-operative recovery. Of import is the consideration that a wound dressing that requires frequent re-dressing is likely to be less beneficial (Rolls 2007), necessitating a treatment that is applied once at the time of the procedure with no follow up required. The lack of robust evidence for wound treatments specifically designed for amputation dehorning under extensive conditions reinforces the need for novel, fit-for-purpose solutions.

Producers consistently described the ideal wound treatment as an 'all-in-one' solution, capable of reducing pain, controlling haemorrhage, preventing infection, and promoting wound healing while remaining practical and cost effective for use in northern beef systems. Effectiveness was identified as the most important factor (87%) influencing producer decisions to use pain relief and wound management strategies, outweighing considerations such as cost, accessibility and practicality. Focus group discussions indicated that although cost remains relevant, producers are willing to absorb additional expense where clear welfare or performance benefits (i.e. improved average daily gain) are evident. Key attributes included ease and speed of application, durability under variable weather conditions, long shelf life without refrigeration, minimal safety risks to users and a short withholding period. Cost-effectiveness and accessibility were also important, particularly where benefits to animal welfare and production outcomes could be clearly demonstrated. There was strong agreement among focus group participants that data describing the benefits of pain relief and wound treatments were important from a decision-making perspective, and that existing research and extension was not meeting this requirement. Importantly, participants explicitly linked pain and wound management practices to maintaining a 'social license to operate', with the view that reducing pain and wound complications were necessary risk management factors for the industry. Disbudding and dehorning have been identified as areas of potential vulnerability of the sector to public opinion (Hampton *et al.* 2020). These producer-defined criteria provide a practical framework for the development and evaluation of novel and existing wound treatments that suit northern Australian beef production systems, and are not only guided by economic considerations, but also by an increasing awareness of societal expectations of animal welfare standards.

The mixed-methods quantitative survey and qualitative focus groups supported and complimented each other by describing dehorning practices and management decisions and providing the context to these outcomes. Exploring the drivers behind the survey results was central to this project, which aimed to enahnce the understanding of dehorning practices and producer decision-making in northern Australia, to ultimately address gaps in wound management in a practical and commercially feasible way. Although unable to be statistically analysed, the thematic analyses of the focus groups were appropriate for the content of the discussions, where people expressed their experiences, thoughts, emotions and behaviours (Kiger and Varpio 2020). Where the survey was limited by sample size, the context provided by the focus groups provided clarity for the results. The combination of a survey and focus groups was useful for developing a comprehensive understanding of dehorning practices and management considerations in northern Australian beef enterprises, which are variable in nature.

Several limitations should be considered when interpreting the findings of this study. The survey sample size was modest, with uneven and limited representation in some regions of northern Australia. Over 18.5 million head of cattle are reported on holding in Queensland, the Northern Territory and Western Australia, >35 times greater than the cattle numbers reported for northern Australia in the survey (Australian Bureau of Statistics 2026). This large discrepancy highlights potential inaccuracy of qualitative results, specifically related to dehorning prevalence, practices and ages. Additionally, the small sample size limited analysis between regions of northern Australia, as climate and management practices can vary greatly between regions (Bortolussi *et al.* 2005; Cowan *et al.* 2024). However, the main focus of this survey was to understand dehorning practice in the unique context of northern Australia, rather than quantifying dehorning methods and pain relief use. Focus group participants were recruited through RBRC networks, likely over-representing producers who are engaged with research, extension and best-practice initiatives. As a result, reported uptake of pain relief and attitudes toward welfare may not be fully representative of the broader northern Australian beef industry. Survey responses relied on self-report and recall, which may introduce reporting bias (Rosenman *et al.* 2011). Additionally, dissemination of the survey via online platforms that required technological literacy may have limited participation by producers with reduced access to or familiarity with digital technologies (Andrade 2020). Conducting the survey via face-to-face interview (Oxley *et al.* 2004), via telephone-assisted methods or an online survey

with a prize incentive (Sloane and Walker 2024) may have improved the number of responses.

The reliability and interpretability of the survey findings may have been limited by a lack of detail in several survey questions. The type of enterprise and the role of the survey respondent within this enterprise was not asked, omitting details that would have enhanced the understanding of dehorning practices within different production systems. The breed and percentage of polled cattle within the herd are important details that influence the need for dehorning; however, they were not included in the survey. These details additionally provide clarity around whether producers are choosing to not perform dehorning or are actively seeking polled genetics. Tipping, the practice of removing the distal, insensitive portion of the horn (FutureBeef 2011), was also not included in the survey, despite being an important alternative practice to dehorning. Although overlooking these outcomes does not invalidate the information that was gathered, it does limit the understanding of the broader dehorning landscape. The lack of a description around what classifies as dehorning-related mortality and morbidity likely also influenced the accuracy of these results.

The statistical analysis used for the survey was elected due to the small sample size; however, the conservative nature of Fisher's exact test, which uses exact probabilities rather than approximations (Sauro and Lewis 2016), may have limited detection of statistically significant associations where multiple responses were permitted. Qualitative findings from the focus groups were not statistically generalisable; however, they provided important context, and articulated producer-defined priorities that can inform future research into the development of novel wound treatments and testing under commercial conditions. Together, the survey and focus groups were well suited to identifying existing practices, attitudes, and unmet needs related to pain relief and wound management following dehorning in northern Australian beef enterprises.

Conclusion

This study is the first to describe stakeholder attitudes and practices regarding pain and wound management associated with amputation dehorning of cattle in northern Australian beef enterprises. Haemorrhage, infection, myiasis, delayed healing and mortality appear to be risks associated with the procedure that are currently inadequately addressed. The implementation of pain relief is increasing and is effective for acute post-operative pain; however, it does not adequately address wound-specific risks. Systemic and unavoidable management constraints typical of extensive enterprises, such as limited selective breeding for polled animals, performing dehorning at >2 months of age and limited monitoring of calves, demonstrate the necessity for refined dehorning protocols for improved animal welfare. Current dehorning guidelines do not comprehensively consider management constraints typical of very extensive systems. Updated guidelines are needed to support producers in implementing best-practice techniques and procedures that optimise animal welfare and production outcomes following amputation dehorning.

This study is also the first to describe producer-defined priorities for dehorning wound treatments. Producers emphasised the importance of practicality and cost-effectiveness. Future research should include the development and scientific testing of novel wound treatments in comparison with existing potential treatments evaluated under commercial extensive beef production conditions.

References

Abdelrahman T, Newton H (2011) Wound dressings: principles and practice. *Surgery* **29**, 491–495. doi:10.1016/j.mpsur.2011.06.007.

AHDB (2026) How to disbud dairy calves efficiently, easily and painlessly. Agriculture and Horticulture Development Board. Available at https://ahdb.org.uk/how-to-disbud-calves [accessed 20 August 2026]

Aleri JW, Fisher AD, Gogoi-Tiwari J, Waichigo FK, Sodagari HR, Irons PC, Robertson ID (2022) A survey of calf rearing practices in the south-west region of Western Australia. *New Zealand Veterinary Journal* **70**, 211–217. doi:10.1080/00480169.2022.2042413

Algra M, de Keijzer L, Arndt SS, van Eerdenburg FJCM, Goerlich VC (2023) Evaluation of the thermal response of the horns in dairy cattle. *Animals* **13**, 500. doi:10.3390/ani13030500

Anderson N (2010) Dehorning of Calves. The Beef Site. Available at https://www.thebeefsite.com/articles/2261/dehorning-of-calves/ [accessed 12 January 2026]

Andrade C (2020) The limitations of online surveys. *Indian Journal of Psychological Medicine* **42**, 575–576. doi:10.1177/0253717620957496

Animal Health Australia (2014) Australian Animal Welfare Standards and Guidelines for Cattle. Available at https://animalwelfarestandards.net.au/wp-content/uploads/2023/08/Cattle-Standards-and-Guidelines-Endorsed-Jan-2016-061017_.pdf

Australian Bureau of Statistics (2026) Australian Agriculture: Livestock. Available at https://www.abs.gov.au/statistics/industry/agriculture/australian-agriculture-livestock/latest-release#cattle-on-holding-estimates [accessed 24 June 2026]

Bechert K, Abraham SE (2009) Pain management and wound care. *The Journal of the American College of Certified Wound Specialists* **1**, 65–71. doi:10.1016/j.jcws.2008.12.001

Bertram J, Phillips A, Leigo S (2004) Basic Guidelines for a Feedlot Operation. Agnote No. J17. March 2004. Available at https://daf.nt.gov.au/publications/publications-search/publications-database/primary-industry/anim_man/231.pdf [accessed 27 April 2026]

Bortolussi G, Mcivor JG, Hodgkinson JJ, Coffey S, Holmes CR (2005) The northern Australian beef industry, a snapshot. 2. Breeding herd performance and management. *Australian Journal of Experimental Agriculture* **45**, 1075–1091. doi:10.1071/EA03097

Bryan K, Parnell P, Teseling C (2014) 'Management practices of *Bos taurus* bulls in non-temperate Australia.' (Meat and Livestock Australia: Australia)

Bunter KL, Johnston DJ, Wolcott ML, Fordyce G (2013) Factors associated with calf mortality in tropically adapted beef breeds managed in extensive Australian production systems. *Animal Production Science* **54**, 25–36. doi:10.1071/AN12421

Carr NJ (2022) The pathology of healing and repair. *Surgery* **40**, 13–19. doi:10.1016/j.mpsur.2021.11.003

Casoni D, Mirra A, Suter MR, Gutzwiller A, Spadavecchia C (2019) Can disbudding of calves (one versus four weeks of age) induce chronic pain? *Physiology & Behavior* **199**, 47–55. doi:10.1016/j.physbeh.2018.11.010

Cattle Council of Australia (2020) Pain Relief Guide. Cattle Council of Australia. Available at https://futurebeef.com.au/wp-content/uploads/2020/02/201008-CCA-pain-relief-guide.pdf [accessed 27 April 2026]

Coetzee JF, Kukanich B, Mosher R, Allen PS (2009) Pharmacokinetics of intravenous and oral meloxicam in ruminant calves. *Veterinary Therapeutics* **10**, E1–E8.

Coetzee JF, Mosher RA, Kukanich B, Gehring R, Robert B, Reinbold JB, White BJ (2012) Pharmacokinetics and effect of intravenous meloxicam in weaned Holstein calves following scoop dehorning without local anesthesia. *BMC Veterinary Research* **8**, 153. doi:10.1186/1746-6148-8-153

Cowan T, Hinds E, Marshall AG, Wheeler MC, de Burgh-Day C (2024) Observing and forecasting the retreat of northern Australia's rainy season. *Journal of Southern Hemisphere Earth Systems Science* **74**, ES23022. doi:10.1071/ES23022.

Cowley T, Ward J (2017) A practical demonstration of the Polled Gene Marker Test to increase the frequency of polled progeny and use of fixed time artificial insemination in commercial Northern Territory beef herds. Available at https://www.mla.com.au/contentassets/5197c8cfb96547f089d0fffb07dd731a/b.nbp.0630_pdsnt003_final_report.pdf [accessed 27 April 2026]

Cowley T, Oxley T, Macdonald N, Cameron A, Conradie P, Collier C, Norwood D (2010) 2010 Pastoral Industry Survey: Northern Territory Wide. Northern Territory Government.

DairyNZ (n.d.) Disbudding. Available at https://www.dairynz.co.nz/animal/calves/disbudding/ [accessed 20 August 2026]

Department of Agriculture and Water Resources (2017) Export Advisory Notice 2017-15: Live Animal Export. Department of Agriculture and Water Resources.

Department of Agriculture Fisheries and Forestry (2012) Land Transport of Livestock: Standards and Guidelines, Ver. 1.1. Available at https://animalwelfarestandards.net.au/wp-content/uploads/2023/08/Land-transport-of-livestock-Standards-and-Guidelines-Version-1.-1-21-September-2012.pdf [accessed 27 April 2026]

Espinoza C, Lomax S, Windsor P (2013) The effect of a topical anesthetic on the sensitivity of calf dehorning wounds. *Journal of Dairy Science* **96**, 2894–2902. doi:10.3168/jds.2012-5954

Espinoza CA, Mccarthy D, White PJ, Windsor PA, Lomax SH (2016) Evaluating the efficacy of a topical anaesthetic formulation and ketoprofen, alone and in combination, on the pain sensitivity of dehorning wounds in Holstein-Friesian calves. *Animal Production Science* **56**, 1512–1519. doi:10.1071/AN14012

Fordyce G, Mcmillan H, Mcgrath N (2014) Accelerating healing of calf frontal sinuses exposed by dehorning. Report published by Meat & Livestock Australia, North Sydney, NSW, Australia. Available at https://www.mla.com.au/contentassets/a24f7c01ec31432d95c1d4562183ffa0/b.aww.0227_final_report.pdf [accessed 27 April 2026]

Fordyce G, McMillan H, McGrath N (2018) Postoperative healing and behaviour when surgical swabs are applied to calf dehorning wounds. *Australian Veterinary Journal* **96**, 508–515. doi:10.1111/avj.12771

Fordyce G, Mccosker KD, Barnes T, Perkins NR, O'Rourke PK, McGowan M (2022) Reproductive performance of northern Australia beef herds. 6. Risk factors associated with reproductive losses between confirmed pregnancy and weaning. *Animal Production Science* **63**, 365–377. doi:10.1071/AN19441

FutureBeef (2011) Dehorning. Available at https://futurebeef.com.au/resources/dehorning/ [accessed 17 December 2025]

Gunn A (2016) Tighter joinings, how to get there. Meat & Livestock Australia. Available at https://www.mla.com.au/news-and-events/industry-news/archived/2016/tighter-joinings-how-to-get-there/ [accessed 10 September 2026]

Hampton JO, Jones B, Mcgreevy PD (2020) Social license and animal welfare: developments from the past decade in Australia. *Animals* **10**, 2237. doi:10.3390/ani10122237

Hawkins D, Carr A, Barnard J, Renaud P (2025) Cautery disbudding in calves: a comparative assessment of topical wound treatments. *Open Veterinary Journal* **15**(9), 4106–4113. doi:10.5455/OVJ.2025.v15.i9.15

Huebner KL, Kunkel AK, Mcconnel CS, Callan RJ, Dinsmore RP, Caixeta LS (2017) Evaluation of horn bud wound healing following cautery disbudding of preweaned dairy calves treated with aluminum-based aerosol bandage. *Journal of Dairy Science* **100**, 3922–3929. doi:10.3168/jds.2016-12192

Kiger ME, Varpio L (2020) Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Teacher* **42**, 846–854. doi:10.1080/0142159X.2020.1755030

Lomax S, Sheil M, Windsor PA (2008) Impact of topical anaesthesia on pain alleviation and wound healing in lambs after mulesing. *Australian Veterinary Journal* **86**, 159–168. doi:10.1111/j.1751-0813.2008.00285.x

Lyons R, Randhawa IAS (2020) Improving the Australian Poll Gene Marker Test. Meat and Livestock Australia Limited, North Sydney, NSW.

McCarthy D, Windsor PA, Harris C, Lomax S, White PJ (2016) Effect of topically applied anaesthetic formulation on the sensitivity of scoop dehorning wounds in calves. *PLoS ONE* **11**, e0163181. doi:10.1371/journal.pone.0163181

Mclean I, Holmes P, Counsell D (2014) The Northern beef report: 2013 Northern beef situation analysis. Project B.COM.0348. Meat & Livestock Australia Limited, North Sydney, Australia.

Meat and Livestock Australia (2023) Dehorning and disbudding. Available at https://www.mla.com.au/research-and-development/animal-health-welfare-and-biosecurity/husbandry/dehorning-and-disbudding/ [accessed 12 February 2026]

Newman R (2007) 'A guide to best practice husbandry in beef cattle. Branding, castration and dehorning.' ((Ed. Meat and Livestock Australia) (Queensland Department of Primary Industries and Fisheries. Meat and Livestock Australia Limited, Queensland)

Newman R (2023) 'A guide to best practice husbandry in beef cattle: branding, castrating and dehorning.' 2nd edn. (Meat & Livestock Australia)

Oxley T, Leigo S, Hausler P, Bubb A, Macdonald N (2004) Pastoral Industry Survey NT 2004. Northern Territory Government.

O'Rourke P, Winks L, Kelly AM (1992) North Australia beef producer survey 1990. Queensland Department of Primary Industries.

Patinson K, Cosby A, Corbet N, Capern G, Swain D, Trotter M, Bailey D (2019) Automating welfare measurements and interventions for Northern Australia beef cattle. Report published by Meat & Livestock Australia Ltd, North Sydney, NSW, Australia.

Petherick JC (2005) Animal welfare issues associated with extensive livestock production: the northern Australian beef cattle industry. *Applied Animal Behaviour Science* **92**, 211–234. doi:10.1016/j.applanim.2005.05.009

Petrie NJ, Mellor DJ, Stafford KJ, Bruce RA, Ward RN (1996) Cortisol responses of calves to two methods of disbudding used with or without local anaesthetic. *New Zealand Veterinary Journal* **44**, 9–14. doi:10.1080/00480169.1996.35924

Prayaga KC (2005) Genetic options to replace dehorning of beef cattle in Australia. Meat and Livestock Australia.

Prayaga KC (2007) Genetic options to replace dehorning in beef cattle—a review. *Australian Journal of Agricultural Research* **58**, 1–8. doi:10.1071/AR06044

R Core Team (2025) R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing.

Randhawa IAS, Burns BM, Mcgowan MR, Porto-Neto LR, Hayes BJ, Ferretti R, Schutt KM, Lyons RE (2020) Optimized genetic testing for polledness in multiple breeds of cattle. *G3: Genes, Genomes, Genetics* **10**, 539–544. doi:10.1534/g3.119.400866

Randhawa IAS, Mcgowan MR, Lyons RE (2021) Genome-wide analyses of scur genetics in cattle. In 24th Conference of the Association for the Advancement of Animal Breeding and Genetics, Adelaide, Australia, 2–4 November 2021. (Association for the Advancement of Animal Breeding and Genetics)

Richardson C, Upton D (2010) A discussion of the potential mechanisms for wound dressings' apparent analgesic effects. *Journal of Wound Care* **19**, 424–430. doi:10.12968/jowc.2010.19.10.79089

Rolls P (2007) Review of Wound Treatments Available for Routine Husbandry Procedures of Grazing Animals. Meat & Livestock Australia (MLA).

Rosenman R, Tennekoon V, Hill LG (2011) Measuring bias in self-reported data. *International Journal of Behavioural and Healthcare Research* **2**, 320–332. doi:10.1504/IJBHR.2011.043414

Rousseau M (2022) Dehorning. In 'Comparative veterinary anatomy'. (Eds JA Orsini, NS Grenager, A de Lahunta) pp. 1020–1029. (Academic Press, Elsevier)

Sauro J, Lewis JR (2016) Is there a statistical difference between designs? In 'Quantifying the user experience. Practial statistics for user research'. 2nd edn. pp. 61–102. (Morgan Kaufmann)

Scerri T, Lomax S, Thomson P, Kimble B, White P, Govendir M, Clark C, Van der Saag D (2025) Medicated Meloxicam Pellets Reduce Some Indicators of Pain in Disbudded Dairy Calves. *Animals* **15**, 1641. doi:10.3390/ani15111641

Schatz TJ, Hearnden M (2008) Heifer fertility on commercial cattle properties in the Northern Territory. *Australian Journal of Experimental Agriculture* **48**, 940–944. doi:10.1071/EA08057

Sheil ML (2025) Topical anaesthesia for prompt and prolonged wound pain relief: lessons from wide scale use on major open wounds in livestock – an editorial. *Medical Research Archives* **13**, 1–7.

Sinclair S (2012) Understanding and managing the animal welfare impacts of dehorning in *Bos indicus* cattle. PhD thesis, School of Veterinary Science, The University of Queensland.

Sloane B, Walker L (2022) MLA Project Proof Beef. Meat and Livestock Australia, North Sydney, Australia.

Sloane B, Walker L (2024) National Beef Producer Survey of Sustainability Practices. Meat and Livestock Australia.

Stafford KJ, Mellor DJ (2005) Dehorning and disbudding distress and its alleviation in calves. *The Veterinary Journal* **169**, 337–349. doi:10.1016/j.tvjl.2004.02.005

Stafford KJ, Mellor DJ (2011) Addressing the pain associated with disbudding and dehorning in cattle. *Applied Animal Behaviour Science* **135**, 226–231. doi:10.1016/j.applanim.2011.10.018

Stewart MA (1939) A new Prophylaxis for Wound Myiasis in domestic Animals. *Journal of Economic Entomology* **32**, 404–407.

Stock ML, Baldridge SL, Griffin D, Coetzee JF (2013) Bovine dehorning: assessing pain and providing analgesic management. *Veterinary Clinics: Food Animal Practice* **29**, 103–133

Sylvester SP, Mellor DJ, Stafford KJ, Bruce RA, Ward RN (1998*a*) Acute cortisol responses of calves to scoop dehorning using local anaesthesia and/or cautery of the wound. *Australian Veterinary Journal* **76**, 118–122. doi:10.1111/j.1751-0813.1998.tb14542.x

Sylvester SP, Stafford KJ, Mellor DJ, Bruce RA, Ward RN (1998*b*) Acute cortisol responses of calves to four methods of dehorning by amputation. *Australian Veterinary Journal* **76**, 123–126. doi:10.1111/j.1751-0813.1998.tb14544.x

Sylvester SP, Stafford KJ, Mellor DJ, Bruce RA, Ward RN (2004) Behavioural responses of calves to amputation dehorning with and without local anaesthesia. *Australian Veterinary Journal* **82**, 697–700. doi:10.1111/j.1751-0813.2004.tb12162.x

Thakur S, Gupta A, Kumar R, Kumar R (2026) Dehorning in cattle. In 'Clinical diseases, production, and management of cattle'. (Ed. T Rana) pp. 53–58 (Elsevier)

Tyler R, English B, Sullivan M, Jackson D, Jones G, Gynther R, Fletcher J, Holmes B, Macdonald N, Williams M, Holzapfel S, Anderson G, Oxley T, Miller J, Leigo S, Smith P, Bone A, Pritchard J, Poppi D, Quigley S, Mclennan S, Niethe G (2025) 'Weaner management in northern beef herds.' 2nd edn. (Meat & Livestock Australia Limited: North Sydney, Australia)

Van der Saag D, Lomax S, Windsor PA, Taylor C, White PJ (2018*a*) Evaluating treatments with topical anaesthetic and buccal meloxicam for pain and inflammation caused by amputation dehorning of calves. *PLoS ONE* **13**, e0198808. doi:10.1371/journal.pone.0198808

Van der Saag D, White P, Ingram L, Manning J, Windsor P, Thomson P, Lomax S (2018*b*) Effects of topical anaesthetic and buccal meloxicam treatments on concurrent castration and dehorning of beef calves. *Animals* **8**, 35. doi:10.3390/ani8030035

Windsor PA (2021) Progress with livestock welfare in extensive production systems: lessons from Australia. *Frontiers in Veterinary Science* **8**, 674482. doi:10.3389/fvets.2021.674482

Wooderson M (2024) Managing Welfare and Production at Weaning: Final Report (Project code: B.PRS.2001). Meat & Livestock Australia Limited.

Wooderson M (2026) Effect of analgesia and haemostasis on beef calves during dehorning in northern Australia. PhD thesis, Queensland Alliance for Agriculture and Food Innovation, The University of Queensland.

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Data availability. Data used to generate the results in the paper will be available upon reasonable request to the corresponding author.

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