Animal Welfare.
Worldwide.

Shining a light on lamb mortality

Investigating causes of high lamb mortality rates and strategies for reducing it.

Australia is a powerhouse in the global wool market, contributing 80% of the fine merino wool used by the global fashion industry[1]. However, beneath the surface lies the distressing reality that lamb mortality rates are shockingly high and millions of lambs suffer due to mulesing and other animal welfare issues[2].

For years, FOUR PAWS has strongly advocated for an end to the common and controversial practice of mulesing, also known as 'live lamb cutting', calling for an urgent transition to the already available pain-free solutions. There is now greater international understanding of, and opposition to, mulesing[3,4]; however, the high lamb mortality rates in Australia are less commonly known. A study of producer perceptions revealed that nearly half of the surveyed wool producers in Australia underestimate lamb mortality[5] and this has implications for the effective implementation of strategies to combat the problem. Global estimates show that lamb mortality rates generally range from 9-20%[6,7], while very good management can achieve rates below 5%[8]. However, compared to published data in Australia, lamb mortality commonly ranges between 20-30% and, in some cases, reaches more than 70%[5,9]. An estimated 10 million lambs die every year[6], and, in addition to the level of suffering this causes, it also has an estimated economic loss of at least AUD 540 million per year[10].

General Terms

Lamb mortality rate: the number of lambs that died in-utero and prior to weaning (at approximately 14 weeks)[11,12]

Weaning: a process by which the lambs are removed from any source of milk (switching from their ewe's/mother's milk to solid feed)

Ewe: a mature female sheep[13]

Malpresentation: Malpresentation is when the lamb's birthing position differs from the normal position[14].

Figure 1. Merino lamb

Causes of lamb mortality

To effectively protect lambs, it is necessary to better understand causes of lamb mortality and consider possible solutions. The causes can be divided into three stages: during pregnancy; during birth until the first three days of life[6]; and from four days of age to weaning.

1. During pregnancy

Lambs that die in-utero represent 1-3%[15,16] of the proportion of lamb mortality. These deaths are most often caused by infections in the mother that affect the foetus[17,18].

2. During birth and during the first three days of life

Birth and the first few days of life are critical to lamb survival. It is during this period that the highest proportion, over 80%, of lamb mortality rates occur[15,19]. This period also poses many risks for the ewe as she requires heightened levels of nutrition, and is sensitive to sudden changes in diet and environmental conditions. A study conducted in New South Wales, Australia showed a 6% to 22% ewe mortality rate[20]. Further research specific to birthing difficulties, known as dystocia-related

mortality, estimates nearly 300,000 ewes die each year in Australia alone[9].

There are also specific factors that contribute to the high lamb mortality rate during this period. Common causes include dystocia and starvation-mismothering-exposure complex, as explained below[21].

a. Dystocia (birthing difficulties)

Difficult or prolonged births, known as dystocia, are the primary cause of lamb mortality in Australia and globally[22]. There are many reasons for dystocia, including inappropriate ewe (mother) or sire (father) selection, which can result in larger lamb sizes relative to small ewe pelvic sizes[23]; inappropriate feeding; and first-time mothers. With nutritional or breeding-related dystocia, as well as other dystocia conditions like malpresentation, there is a higher risk of lamb starvation and exposure to thermal stress, as explained below[17,19]. Birthweight to ewe size is another significant factor[24], as smaller lambs are less able to survive the crucial period of birth and immediately afterwards.

b. Starvation-mismothering-exposure complex

Starvation, mismothering and exposure are often considered together since they are closely related and intensify each other. Also, environmental conditions and methods of management make it difficult to separate them and therefore the starvation-mismothering-exposure complex is applied to explain these interrelated causes of lamb mortality[25].

To explain this further, in the first few hours after being born, a newborn wet lamb loses body heat rapidly when exposed to cold and wind, and they can easily die due to hypothermia. Consuming enough colostrum (the mother's first milk) and having enough brown fat (fat the lamb is born with) helps the lamb through this critical period. Lambs born with a low body weight can exhaust their reserves within 24 hours or less. Twins and triplets are commonly born smaller in size, making them even more vulnerable. Lambs born in warmer months can also overheat if kept in high stocking densities or not provided with appropriate shade, and this is a commonly cited issue in Australia[19,26,27].

Factors such as selecting rams for ease of lambing, ewe age, breed, metabolic diseases, genetics, nutrition, and management choices all impact the development of the bond between ewes and their lambs[17,19]. Difficult births can be exhausting for her, which leads to heightened nutritional needs for the ewe and affects the bonding of lamb and ewe. If the ewe leaves the birth site too early to look for food, for example, this can lead to difficulties in ewes bonding with lambs and a higher risk of starvation-mismothering-exposure complex of lambs[19]. Lambs born to ewes with low body condition scores, metabolic conditions, or insufficient nutrition, often do not receive an adequate amount and quality of colostrum[28].

Mulesing & Flystrike-Resistance

Lamb marking without mulesing: usually refers to tail docking, castration of male lambs, ear tagging, weighing, vaccinations, and giving antiparasitic drugs[29].

Mulesing: a mutilation practice of generally 2-12-week-old lambs where large skin folds around their buttocks are cut off with shears, commonly without adequate pain relief. Mulesing is usually practiced as part of lamb marking[30].

Flystrike: a condition that occurs when flies lay their eggs in the sheep's skin folds, and maggots then feed on the sheep's skin and flesh. This is particularly prevalent in the Australian wool industry, largely due to the type of sheep generally farmed (wrinkly merino sheep), the climate and the presence of the Australian blowfly (Lucilia cuprina).

Flystrike-resistant breeds: generally plain-bodied sheep without excessive skin wrinkles and with less wool naturally growing around their buttocks. They have been reported to exhibit a healthier body fat at birth and better body weights versus wrinkled sheep. Wrinkly and thick skin is resource-intensive for the sheep to maintain and enhances flystrike risk. Breeding naturally flystrike-resistant sheep alongside adequate animal husbandry helps to reduce both flystrike and therefore mulesing[31].

3. Four days after birth until weaning (at approx. 14 weeks)

The primary causes of lamb mortality between birth and weaning can be further divided into two categories: lamb marking with and without mulesing, and predation.

a. Lamb marking with and without mulesing

Lamb marking, usually practiced on 2-12 week old lambs, includes procedures such as mulesing, tail docking, castration of male lambs, ear tagging, weighing, vaccinations and giving anti-parasite drugs[30]. There is an established link between mulesing and lamb mortality[32]. While lamb marking without mulesing is estimated to contribute up to 2.7%[33] of lamb mortality, mulesing can add an additional 4% to lamb mortality rates according to a study by Evans[34].

Marking, with and without mulesing, increases the potential risk of wound infections including tetanus and can cause profuse bleeding of lambs. The procedures are also highly stressful and can lead to various behavioural changes that can cause mismothering by ewes and consequently, starvation of lambs[35].

The provision of a non-steroidal anti-inflammatory drug (NSAID) during lamb marking and mulesing may reduce the impact of acute pain caused by the procedure; however, studies have shown that the pain caused by mulesing can persist for up to two weeks, long after routine pain medication provided is ceased[36]. Additionally, only approximately 8% of wool producers apply the most effective over-the-counter available combination of local anaesthetic and additional appropriate analgesia (multimodal analgesia) to manage the pain of lambs that are mulesed. The procedure is commonly performed by producers and not by veterinarians[37], with poor techniques and inappropriate facilities, shown to increase lamb losses[35].

b. Predation

Studies from Australia have shown that producers may often overestimate mortality rates related to predation. Australian research based on postmortem examination of lambs showed that mortality due to primary predation (predation as the main cause of death) ranges from as low as 0.25% to 3%. These low rates indicate that predation is typically a secondary factor. In other words, dead or already compromised lambs are more susceptible to being targeted by predators[38,39]. In most cases, the actual cause of death may be linked to issues such as starvation, mismothering, exposure, dystocia, or infection.

Summary – Mortality Causes:

- Lamb mortality can be divided into three stages: during pregnancy, during birth to the first three days of life[6], and from four days old to weaning.
- Birth and the first three days afterwards are the most critical times for lambs and their mothers. Lamb mortality rates are highest during this stage and can make up over 80% of the overall mortality percentage[19]. Common causes of death during this time include dystocia and starvation-mismothering-exposure complex[21].
- If lambs survive the critical period of lambing (birthing), they face the additional risks of lamb marking and mulesing. Lamb marking is reported to contribute 2.7%[33] to lamb mortality and mulesing can add an additional 4%[34] to an already high number of lamb deaths.

Solutions to improve survival

As multiple factors such as birth difficulties (dystocia), starvation-mismothering-exposure complex, lamb marking, mulesing and predation contribute to lamb mortality, different strategies are needed to tackle the problem. While there is no silver bullet, a holistic approach is needed to reduce lamb mortality and to promote the overall health and welfare of these animals. Possible solutions include appropriate breeding, proper husbandry, and improved environments.

1. Appropriate Breeding

Breeding programmes have potential to enable the selection of characteristics or traits which can lead to more resilient animals, including the survivability of lambs and ewes[40]. Direct selection for better lamb survival has been shown to have an overall low heritability, but nevertheless gains in other related genetic areas of ewes are possible over time[24,40,41]. Such has been the case in New Zealand, where genetic data to improve breeding programmes has included lamb survival as a directly selectable trait, and with time, this has improved lamb mortality rates[42].

Aside from direct selection for low lamb mortality, selection of indirect traits can also have the potential to lower lamb mortality rates, such as lamb vigour, ewes' temperament (patience) in cooperating with lamb suckling attempts, and ewe mothering ability[19,43]. In Australia, producers can select sheep genetics that exhibit high Ewe Rearing Ability (ERA), Maternal Behaviour (MH), and high Weaning Rate (WR) amongst others through the use of Australian Sheep Breeding Values (ASBV)[44], to help improve lamb survivability. Furthermore, higher lamb body weight has been shown to be significantly correlated to higher rates of lamb survival. Therefore, traits that positively correlate with increased lamb body weight can improve lamb survival[45]. There is also an association between lower wrinkle scores and increased lamb survival, as shown by Hatcher and colleagues[46]. Importantly, this suggests breeding sheep with lower wrinkle scores has the potential to simultaneously tackle multiple sheep welfare issues, including high lamb mortality and flystrike, which would then negate the need for mulesing.

Figure 1. Visual sheep wrinkle scores (source: Flyboss)

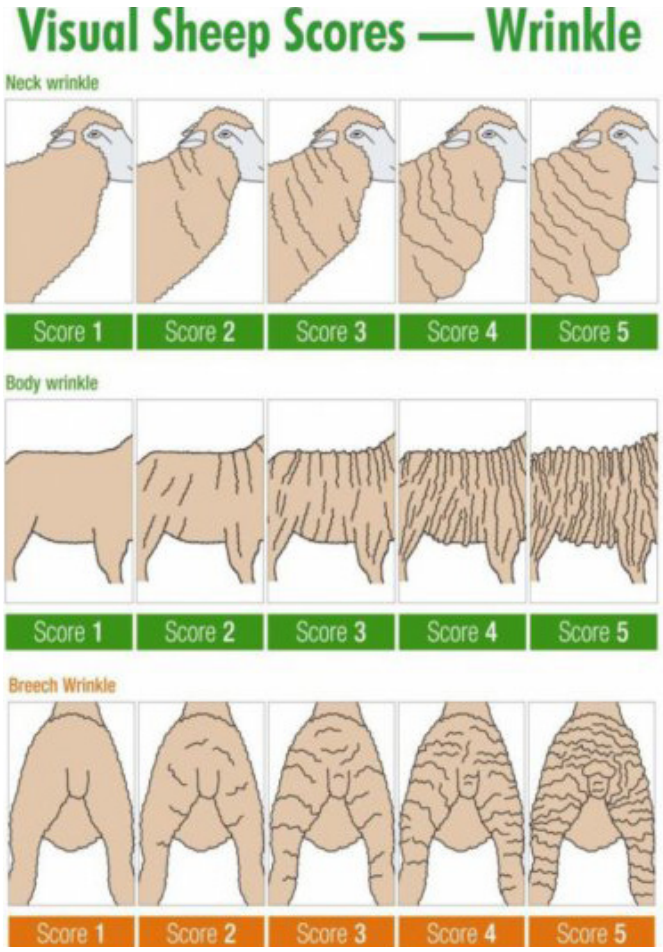

Figure 2. Wrinkly versus plain-bodied sheep (source: Dr Jim Watts)

While there is limited research on the connection between plain-bodied flystrike-resistant sheep and higher lamb survival, there are some very promising indicators. A 2020 survey of nearly 100 wool producers from all climatic and geographical zones in Australia highlighted growers' reports of both lamb survival and growth rates having significantly increased since producers transitioned to plain-bodied and flystrike-resistant sheep[31].

- The Karbullah Merino Stud in Southern Queensland found that, following their transition to plain-bodied, flystrike-resistant sheep, lambing rates increased from 110%-120% to 121%-130% with a lamb survival rate of 90%.

- The Mumblebone Merino Stud in New South Wales saw that a flystrike-resistant approach resulted in reduced weaner mortality (from 5% down to 1-2%); decreased ewe mortality (from 3-4% to 1%) and a rise in successful births (from 70% to 86-89%, surpassing the industry average of up to 60%).

- The Wallaby Run in South Australia transitioned to flystrike-resistant sheep after a large set-back in lamb growth following lamb marking with mulesing and associated lamb deaths. After the transition to plain-bodied sheep, they saw an increase in lamb growth rates post marking without mulesing; lambing percentage increased from 85% to between 91% and 100%.

- The Parkdale Merino Stud in New South Wales reported a 40% increase in lamb survival following their transition to flystrike-resistant, mulesing-free sheep. Stud owner and woolgrower, Don Mudford, identified that sheep with wrinkly skin have thicker skin. The additional weight and increased sweat and wax production associated with wrinkly skin places a physical and nutritional burden on sheep and makes them more susceptible to flystrike.

These are just a few examples of the many producers of plain bodied sheep indicating that a flystrike-resistant breeding approach is a feasible and valuable strategy for more resilient non-mulesed sheep and has strong potential to help improve ewe and lamb survival rates. In these case studies, fleece weight and quality were maintained and benefits such as more efficient feed conversion ratios and reduced environmental impacts were seen. Growers breeding for flystrike resistance generally aim to maintain the right balance of smooth, loose skin and body fat in Merino sheep, which aligns with research highlighting the importance of an adequate body score for successful lambing[6,19].

> **"Since transitioning to plain-bodied sheep types, I've noticed our ewes are having less taxing and more successful births, better able to handle the physical demands of mothering and better at it."**
>
> – Don Mudford, woolgrower

2. Husbandry

a. Ewe nutrition:

Birthweight and lamb size are also critical factors affecting lamb mortality. Lambs that are too small are at a higher risk of being too weak to reach the udder and ingest colostrum, making them less able to regulate their body temperature. Conversely, large lambs present a high risk of dystocia and trauma during birth. This threatens both the ewe's survival and ewe-lamb bonding. Achieving correct lamb birthweight starts with ensuring good ewe body condition score and appropriate nutrition. The ideal condition score for a pregnant ewe is 3 (on a 1-5 scale) and this should be maintained throughout pregnancy. An increase of body score from 2 to 3 can improve lamb survival by about 20% for twins and at least 5% for singles[19,47].

b. Preventative healthcare:

Pregnancy scanning is an important technique for determining if ewes are pregnant, and if they are carrying one or more lambs. Twins and multiple births have a higher mortality rate, so it is important to separate them from single-carrying ewes and manage them separately with appropriate nutrition and management at the time of lambing. Since the majority of lamb mortality events happen around lambing[9,19], more frequent monitoring and appropriate lambing interventions should be carried out during this time. These interventions include separating lambed and

non-lambed ewes daily (drift lambing), assisted 'mothering-up', fostering, artificial rearing or other more hands-on shepherding methods[19]. Additionally, a good vaccination, deworming and welfare (health) management programme is important to prevent lambs and ewes from succumbing to diseases.

c. Stocking density:

Intensive farming and maintaining large groups of animals causes higher mortality in lambs[48,49]. Higher stocking density, or having too many ewes lambing too closely together, can increase the chances for mismothering[50]. Densities at 18 ewes per hectare will start to affect lamb survivability, especially for ewes carrying twins[51]. When twin-bearing ewes are kept at lower flock sizes they can have up to 6.2% higher survival rates in comparison to larger flock sizes[32].

3. Environment

Studies show that good environmental management directly impacts lamb survivability and profitability[52]. For example, planning lambing for spring and autumn, as opposed to summer and winter, can lower mortality rates from 10-20% to as low as 1-2%[53]. Research from Australia has demonstrated that providing shelter can protect lambs from extreme cold exposure, rain, high winds, and can reduce lamb mortality by an average of 17.5% for twins and 7% for single-born lambs[27]. Shelters also help reduce the risk of metabolic disease of ewes, mismothering and possibly even dystocia[27,54]. Shelter can range from natural elements such as trees, shrubs, grass, vegetative crops or hay bales to constructing human-made structures such as hessian fences, corrugated iron or plastic mesh, all of which can have a significant impact[55,56].

Some natural shelters can also provide additional nutrition, although care must be taken to ensure these plants can withstand grazing. Shelters can facilitate bonding between ewes and lambs and reduce the risk of desertion[50]. Good quality pasture within the shelter can also further reduce accidental mismothering when ewes are forced to stray far from their lambs in search of food. Shelters should consider the ability for ewes to maintain visibility of their offspring and should not form a barrier between ewes and lambs.

To help protect ewes and lambs from predation, the condition of the fences surrounding the paddocks should be continuously checked. Good shepherding and close monitoring are also crucial, enabling producers to act swiftly when problems occur.

Figure 3. Natural shelter provision and fences (source: Evergraze)

Summary – Strategies for improving lamb survival

Multiple factors lead to lamb mortality and, therefore, an appropriate mix of welfare-driven strategies must be applied. Breeding (e.g. for flystrike resistance and other lamb survival indicators), adequate husbandry, and the provision of shelter are some of the most promising ways to improve lamb survival.

- **Appropriate breeding:** Researchers and producers have reported the association between higher lamb survival and lower wrinkle scores in flystrike-resistant and mulesing-free sheep. This is an important finding which indicates that breeding sheep with lower wrinkle scores has the potential to simultaneously tackle multiple sheep welfare issues including high lamb mortality and flystrike, therefore reducing the need for mulesing.
- **Husbandry:** Achieving the ideal birthweight of lambs starts with a good ewe body condition score and appropriate nutrition. The ideal condition score for a pregnant ewe is 3 (on a 1-5 scale) and should be maintained throughout the pregnancy. An increase of body condition score from a low 2.0 to an ideal 3.0 can improve lamb survival by about 20% for twins and at least 5% for single lambs[19]. Furthermore, pregnancy scanning, lower stocking densities, improved monitoring and appropriate intervention during the critical times of lambing are crucial to improving lamb and ewe survivability.
- **Environment:** Studies show that lambing in spring or autumn, as opposed to summer and winter, can decrease lamb mortality rates from 10-20% to as low as 1-2%. By providing shelter, whether natural or man-made, lambs are better protected from harsh weather conditions. Shelter can reduce lamb mortality by 17.5% for twin-born and 7% for single-born lambs in Australia, while also minimising the risk of metabolic diseases for ewes. Effective shelter management, that ensures lambs remain visible to their mothers, can help promote bonding between ewe and lamb. Continuous monitoring of paddock fences can help prevent predation.

Conclusion

Despite being the world's leading wool producer for the global fashion market, Australia's lamb mortality rate surpasses the global average by over 10% and results in an estimated 10 million lambs dying annually.

This briefing paper provides an overview of the causes of lamb mortality and offers grower-led solutions. Improving lamb survival involves a multifaceted approach and promising areas of investment are selective breeding for flystrike resistance, improved husbandry, and the provision of shelter.

Breeding for flystrike-resistant, plain-bodied sheep has been reportedly associated with higher lamb survival, offering a possible solution to multiple welfare issues such as flystrike, mulesing and lamb mortality. Industry and academic research, alongside producers' first-hand reports, continue to support the association between low wrinkle scores and higher lamb survival and, despite common misconceptions, the quantity and quality of wool produced remains high.

FOUR PAWS calls for the urgent adoption of breeding and management practices that prioritise lamb and ewe survival. This includes breeding for flystrike-resistant, plain-bodied sheep in addition to other techniques outlined in this report.

Further research is needed to better understand the links between lamb mortality and flystrike risk and, considering the gravity of both issues, we strongly encourage the Australian wool industry to invest in this research.

It is also crucial for producers to be encouraged and supported to roll out these practices. Peak institutions such as producer groups and animal welfare assurance schemes can offer additional training and the brands and retailers who profit from the sale of wool can also play an important role.

What Fashion Brands Can Do:

- **Know your supply chain** right to farm level and discuss lamb mortality with them. Offer to help, for example by paying for shelter installation or by covering the cost of training or engaging a breeding consultant or veterinarian to improve lamb mortality rates.
- **Demonstrate your commitment** to higher sheep welfare by committing to suppliers who are at least certified mulesing-free. These producers are more likely to be farming less wrinkled or plain-bodied sheep[57,58], and by avoiding mulesing, this can also lead to reduced incidents of lamb mortality due to the process.
- **Sign the 'Brand Letter of Intent'** to send a market signal encouraging higher sheep welfare standards, including flystrike-resistant sheep associated with higher lamb survival.
- **Work closely with your supply chain partners** to facilitate the transition towards certified mulesing-free wool. For a comprehensive guide to move away from mulesing, see 'The Wool Guidebook'.
- **Engage with standard owners** to address gaps in existing standards, particularly in terms of breeding and lambing management plans as well as shelter requirements.
- **Advocate for improved industry standards.** Your voice can play a crucial role in shaping industry practices and mitigating issues such as lamb mortality and mulesing.

What Standard Owners Should Consider:

Include criteria in your standards that encourage lower lamb mortality. For example:

- Implementing written breeding plans with effective genetic management
- Providing adequate and sufficient shelter and fencing
- Managing animal health and preventative plans, including mortality and ill-health record-keeping with thresholds for intervention
- Increasing overall monitoring, especially during high-risk times such as lambing
- Reducing stocking densities, particularly for first-time mothers
- Ensuring good ewe nutrition (3.0 condition score) and colostrum provision for newborn lambs
- Time lambing to avoid extreme heat, cold or other climatic stress in lambs and ewes
- Facilitate learning between certified producers to improve lamb survival rates.
- Include requirements to disclose lamb mortality rates and making overall results publicly available to brands and consumers.


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Disclaimer:

The information presented herein should be viewed as a catalyst for future research endeavors aimed at improving the overall welfare of sheep and fostering sustainable practices in the industry. It is important to note that while efforts have been made to ensure accuracy, this document does not constitute a comprehensive scientific study. Rather, it serves as a valuable compilation of current research and observations. We strongly encourage the Australian wool and sheep industry to invest in further research, addressing the effect of flystrike-resistant sheep breeding and management on lamb and ewe mortality.

About FOUR PAWS

FOUR PAWS is the global animal welfare organisation for animals under direct human influence, which reveals suffering, rescues animals in need and protects them. Founded in 1988 in Vienna by Heli Dungler and friends, the organisation advocates for a world where humans treat animals with respect, empathy and understanding. The sustainable campaigns and projects of FOUR PAWS focus on companion animals including stray dogs and cats, farm animals and wild animals – such as bears, big cats and orangutans – kept in inappropriate conditions as well as in disaster and conflict zones. With offices in Australia, Austria, Belgium, Bulgaria, France, Germany, Kosovo, the Netherlands, Switzerland, South Africa, Thailand, Ukraine, the UK, the USA and Vietnam as well as sanctuaries for rescued animals in eleven countries, FOUR PAWS provides rapid help and long-term solutions.

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