Potential Benefits of Internal Pelvimetry in Merino Ewes

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Abstract
The sheep industry loses $540M revenue per annum due to perinatal lamb mortality. Industry extension and adoption strategies aim to reduce perinatal lambing losses to environmental factors such as starvation/mismothering, difficult birth exposure and predation through programs to improve ewe body condition and feed availability. However, in well managed flocks, lamb mortality remains around 20% with 48% of these losses explained by difficult or prolonged birth. To combat this, a method to identify breeders most at risk of dystocia needs to be developed. One proposed method to achieve this is through internal measurement of the pelvic inlet area. Ewes will undergo pelvic measurement with callipers at the Cowra Agricultural Research Station during 2017 with this being the first time such evaluation has occurred in Australia. Over 450 ewe hoggets will be measured for frame size, weight, condition, pelvic dimensions and lambing ease, while their lambs will be measured for birth weight and physical dimensions of the face and shoulders. The long-term view we hold is that if the pelvis can be successfully measured, then tools for sheep and seedstock producers can be developed in the form of genetic selection and ewe management to reduce perinatal mortality in Australian breeding flocks.

Key words: dystocia, lamb survival

Introduction
In NSW studies involving Merino and crossbred ewes, average lamb losses are 16.5% for singles and 31.5% for twins (Fowler, 2007). Dystocia explains 17.7% (Luff, 1980) to 48% (Refshauge et al. 2016) of pre-weaning lamb losses. When the cost of ewe mortality due to dystocia is included in the net cost of perinatal mortality, the loss to industry is $540M (Lane et al., 2015).
Currently, the available tools to minimise the risk of dystocia include strategic management of ewe nutrition and sire Australian Sheep Breeding Values (ASBVs) for the genetic traits of lambing ease and birth weight. Producers manage ewe nutrition to avoid overfat single-bearing ewes and/or skinny twin-bearing ewes, but only those that adopt real-time ultrasound pregnancy scanning and who direct their contractor to scan for twins are in a position to utilise such a strategy. About 30% of producers are using ultrasound pregnancy scanning, and perhaps some 60% of these identify twin lambs (Refshauge and Shands, 2013).
There is a common belief within the industry that a larger frame size in ewes reduces the likelihood of difficult parturition. However, to collect the data necessary for calculation of lambing ease and birth weight ASBVs, ram breeders must be in the lambing paddocks making observations and collecting newborn lambs and not all studs collect such information.
In cattle it has been found that there is a significant relationship between pelvic inlet area and calving ease (Holm et al., 2014) and genetic relationships between frame size, birth weight and pelvic area. These relationships are positive in association; therefore an increase in one leads to an increase in the others (Benyshek and Little, 1982; Morrison et al. 1986; Glaze et al., 1994; Koots et al., 1994; Upton and Bunter, 1995). However, increasing frame size leads to larger birth weights, negating the potential benefits of a larger pelvis. Clearly more needs to be understood for sheep, a species that has larger litters and considerably higher neonatal mortality than cattle.

Dystocia
Dystocia is defined as a "difficult birth" by George (1975). The frequency of dystocia in Australian flocks is between 3 and 53.6% dependent upon breed of sheep and environmental factors (Hinch and Brien, 2014). All causes of dystocia are identified in Table 1, which identifies feto-pelvic

disproportion as the leading cause that also has the potential to be selected against. Feto-pelvic disproportion is the mismatch between fetal size and the size of the pelvic inlet.
Meat and Livestock Australia (2015) found that dystocia was the third most costly health condition influencing sheep performance, costing the sheep industry $142M per annum (Lane et al., 2015). Dystocia has been linked to 40% of perinatal lamb losses, mostly arising from difficult and delayed birth (Holst, 2004). The most recent neonatal lamb autopsy study shows that the inclusion of brain injury assessment during the autopsy increased the number of lambs categorised in the broad class of dystocia, to 48% (Refshauge et al., 2016). This broad class of dystocia includes those lambs physically stuck in the birth canal, as well as lambs that die very soon after birth or up to 5 days after birth. The commonality between these lambs is lesions of the brain and blood vessels of the central nervous system (brain, spinal cord and spinal column). While dystocia causes significant financial challenges to the sheep industry it is important to remember that there are also significant ethical and welfare issues associated with the management, prevention and treatment of dystocia. These welfare and ethical concerns include prolonged postpartum periods resulting in higher stress levels associated with pain and loss, uterine infections and/or cervical stenosis and reduced reproductive performance (van Rooyen et al., 2012).

Table 1. Causes of dystocia and their relative occurrence (%) in ewes (Thorne and Jackson, 2000).

Cause	Relative Occurrence
Fetal maldisposition	50%
Obstruction of the birth canal	35%
Fetal-pelvic disproportion	5%
Fetal monsters/ abnormalities	3%
Others	7%

Pelvimetry

Pelvimetry is the measure of the dimensions of the pelvic inlet. The area of the pelvic inlet can be calculated through a radiographic technique (Haughey and Gray, 1982 and Cloete et al., 1998) or via a pelvic meter (Rice and Wiltbank, 1970). The pelvic meter has been widely used in cattle and has successfully resulted in a higher proportion of unassisted births as shown in Table 2 (Holm et al., 2014). A South African study using Dorper ewe lambs examined the use of internal pelvic callipers to measure pelvic dimensions and to determine the correlation between body parameters and pelvic inlet area (van Rooyen et al., 2012). It was found that pelvic area can be successfully measured using internal callipers, however, there were only weak correlations between those measures and external body parameters (Table 3), leading to the imperative to measure internal pelvic dimensions in Australian sheep.

Table 2. Effects of the use of internal pelvimetry for selection in heifers on calving fate, after adjusting for lean body weight (Holmet al., 2014).

Fate	Dystocia	Unassisted Birth	Calf birth weight
Culled	58 %	19%	29.0 kg
Retained	28%	41%	29.5 kg

Methodology

Modified sheep callipers will be used to internally measure the pelvic dimensions (height and width) of ewes, as shown in Figure 1. To achieve accurate measurements on live animals the assessor will calibrate the modified sheep callipers based on their technique. The calibration occurs through the comparison of live measurements to the same measurements collected post-slaughter. In van Rooyen, Fourie, & Schwalbach (2012), a correlation of 80% between live and slaughtered animals is considered adequate. Following initial training calibration tests in abattoirs, the pelvic dimensions of maiden Merino hogget ewes will be undertaken at the Cowra Agricultural Research Station. These ewes will be assessed for pelvic height and width along with other body height and weight parameters. The hoggets will progress normally through their pregnancy. During lambing, ewes will be measured for parturition performance, such as lambing ease, while lambs will have birth weight, litter size, sex, meconium score, thorax and cephaly recorded. This data will then be analysed to determine the association between pelvic dimensions, body parameters and dystocia. The collection of data for all these traits will allow for the analysis of pelvic dimensions and its association with dystocia and lamb mortality.

Table 3. Correlation of pelvic measurements with the body parameters; body weight, shoulder height, chest depth, shoulder width, hindquarter width, rump length, chest projection and rump slope from a South African study (van Rooyen et al., 2012).

	Body Weight	Shoulder Height	Chest Depth	Shoulder Width	Hind-quarter Width	Rump Length	Rump Slope
Pelvic Width	0.26***	0.12*	0.24***	0.11^{NS}	0.30***	0.04^{NS}	0.20***
Pelvic Height	0.24***	0.09^{NS}	0.24***	0.10^{NS}	0.24***	0.03^{NS}	0.27***
Pelvic Area	0.24***	0.10^{NS}	0.26***	0.12^{NS}	0.25***	0.05^{NS}	0.26***

Level of significance: * = P < 0.05, ** = P < 0.01, *** = P < 0.001 and NS = not significant

Discussion

Dystocia results in significant lost revenue for producers and lower welfare for affected ewes and lambs. Since there is no method available to completely prevent the occurrence, producers devote their time to the treatment of ewes experiencing dystocia or to restricting nutrition to minimise prevalence. Strategies used in cattle present opportunities to develop methods for the measurement of pelvic dimensions in sheep. This research aims to develop a technique that is suitable for industry adoption, and thereby substantially reduce the financial and welfare impacts of dystocia on the Australian sheep industry.

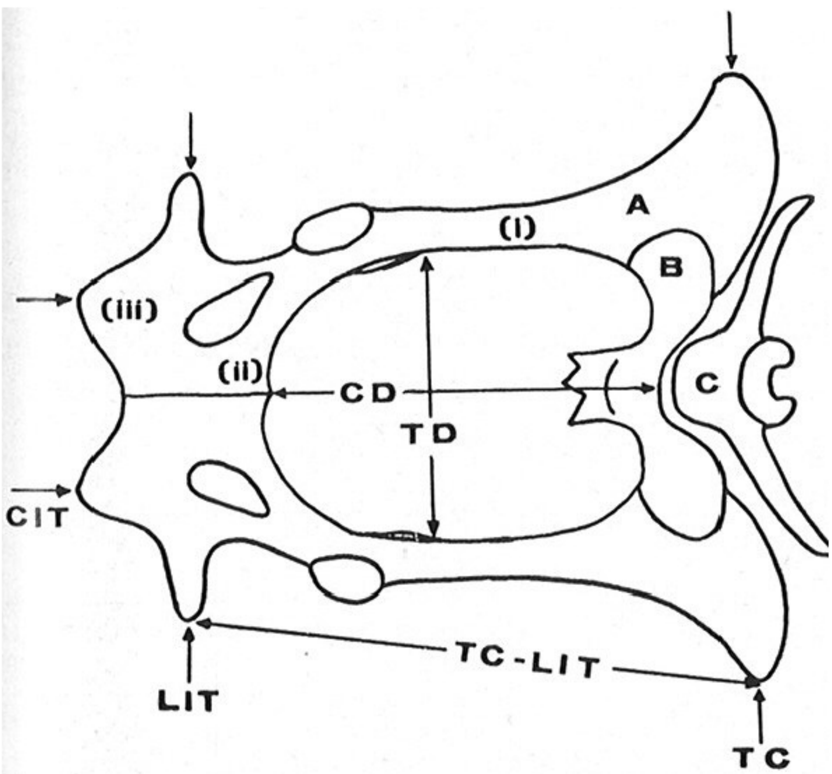

Figure 1. Sheep pelvis, ventral view. A, Ossa coxarum, (i) Ilium, (ii) Pubis, (iii) Ischium; B, Sacrum; C, Last lumbar vertebra; CIT, Caudal tuber of the tuber ischia; LIT, Lateral tuber of the tuber ischia; TC, Tuber coxae; CD, Conjugate diameter; TD, Transverse diameter (Fogarty and Thompson, 1974).

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