Sheep CRC Practical Wisdom Notes

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Bone growth and selection for muscling

Key points

- Selection for eye muscle growth (PEMD) decreases the length of the leg bones and specific sire selection for muscling may shorten the legs.
- Single trait selection for muscling may have the consequence of shrinking the skeletal frame and this underpins the need to use a multi trait selection approach.

Introduction

Recent work jointly funded by the Australian Sheep Industry Cooperative Research Centre (Sheep CRC) and Meat and Livestock Australia has highlighted the possible unintended consequences of single trait selection for muscling.

As a sheep grows from a lamb to an adult, its bones lengthen at special cartilage growth regions called growth plates. When these close and become converted to bone, growth virtually ceases and the animal is skeletally mature. Though this final fusion might not occur until the sheep is over three years old, length¬wise bone growth has slowed to a trickle long before then. A sheep will reach 95% of its final mature leg length at around 1 to 1.5 years of age.

However, lamb growth involves more than just a simple increase in size. Different bones grow at different rates, resulting in changing leg proportions as the sheep matures from a gangly, long-legged lamb to a well-proportioned adult. This 'skeletal' maturation occurs in tandem with 'physiological' maturation, invisible changes such as altered enzyme and hormone levels that affect meat quality and carcase composition. The relationship between these two processes is not fully understood.The relationship between these two processes is not fully understood. Muscle growth sits somewhere in between the two, partly a physical process (longer bones mean longer, larger muscles) and partly a physiological process affected by the timing and relative development of muscle groups. The relative timing of bone, muscle and fat development is important because it creates what is loosely termed the 'animal maturity type' and is linked to carcase composition at slaughter age.

What does the research tell us?

Limb bone growth was compared in commercially relevant genotypes; Merino x Merino, Border Leicester sire x Merino, Poll Dorset sire x Merino; and second cross (Poll Dorset sire x Border Leicester/Merino ewe), from 4 to 22 months of age. Poll Dorset sires were selected for high Australian Sheep Breeding Values (ASBVs) for either growth (post weaning weight—PWWT) or muscling (eye muscle depth— PEMD). Figure 1. Note the striking difference in the size of the cannon bones of two sucker lambs of the same age, but different genotypes.

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The results showed often striking differences in bone growth between the genotypes, although these differences were more modest when compared allometrically, that is, the length or weight of individual bones relative to the whole of the leg. This confirms that the differences in bone growth between the genotypes were mostly secondary to a more generalised difference in the timing and rate of growth.

The results also showed:

- The leg bones of ewes were distinctly shorter than wethers by around 2 to 3% at 8 months and 8 to 9% as adults. In fact, this difference was much greater than the differences between any of the five genotypes. This is because hormones, principally oestrogen, cause the growth plates of ewes to close earlier.
- There were clear differences in bone size of Poll Dorset cross lambs from sires selected for muscling (PEMD) or growth (PWWT).
- Merinos had comparable adult leg length to terminal sire crosses, but with quite different proportions—longer lower leg (cannon and shank) and shorter upper leg. The lower muscle to bone ratio of Merinos is partly due to their 'leggy' proportions.
- Of all the leg bones, the cannon bone (metacarpal or metatarsal) is the most variable and least 'controlled' in its growth pattern. This means the use of the USDA 'break joint' specification as a maturity indicator is unreliable.

What were the differences in maturity type?

Comparing the bone length of growing animals to predicted adult lengths allowed estimation of skeletal maturity. This showed that in wethers, high muscling Poll Dorset and Border Leicester x Merino crosses matured faster than growth-selected Poll Dorset crosses and Merinos. Genotype differences at maturity were less for the earlier-maturing ewe lambs.

These patterns of skeletal maturity did not necessarily match with other observations of maturity such as permanent incisor eruption (two tooth eruption occurred earlier in Border Leicester crosses) or indicators of physiological maturity such as bone mineral and muscle enzyme profiles (which indicate muscling-selected Poll Dorset crosses were in fact less mature physiologically).

What are the implications of selecting for high muscling?

One possible unintended consequence of using sires identified as genetically superior for eye muscle growth (PEMD) to increase carcase muscling is highlighted. The leg bones of lambs from Poll Dorset sires with high ASBVs for PEMD were distinctly shorter than those from sires with high growth ASBVs, despite similar body weights. While this difference was greatest in the lower leg (cannon and shank), heavily-muscled bones such as the femur (thigh) and humerus (upper foreleg) were also 2 to 3% shorter.

Other production data showed that the carcases of high muscling lambs were also shorter along the spine, and had lower carcase bone percentage, suggesting this limb shortness may be indicative of generalised skeletal stunting in animals bred for high eye muscle depth. This parallels a similar phenomenon seen in double-muscled cattle. In trying to increase production through increased relative muscling, we must take care that we are not unintentionally shrinking the bony frame rather than increasing muscle. Selection for a single trait such as eye muscle depth can have unintended side effects, and underpins the need to use a multi-trait selection approach.

Take home messages

- Use a balanced multi-trait selection approach (such as with a Carcase Plus index) with emphasis on both muscling (EMD) and growth (WWT) to gain improvemenets in carcase size. This approach also has the benefit of maintaining good eating quality as carcse size increases.
- Single trait selection alone for high muscling without a balance with high growth can result in decreased length of the leg bones and may have the unintended consequence of shrinking the skeletal frame.
- The use of the USDA 'break joint' specification as a maturity indicator is unreliable and not recommended, because the cannon bone is the least 'controlled' bone in its growth pattern.

Further information

For further information visit www.sheepcrc.org.au

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