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Clones help develop ewe feeding strategy

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Rob Kelly (Manager of Wool Program) and Peter England (ex-member of zone advisory committee International Wool Secretariat (IWS)) holding cloned identical twins.

Cloned sheep are not a new animal to the researchers of Agriculture WA, but the method that produced Dolly is.

Cloned sheep have been produced at the Great Southern Research Institute as early as the mid 1980s. Myra Yelland, Rob Kelly, John Davies and Johan Greeff outline how clones are used in experimental studies on wool production.

One of the most important uses of clones to date has been to better understand the long-term consequences of poor ewe nutrition during pregnancy. Measurements on wool follicle development and wool quality are particularly time consuming so clones were used to reduce the number of animals and samples that needed to be measured.

A pair of identical twins replaces the need for about 20 normally bred animals. However, there is also a down side — the length of time and high cost of producing identical twins makes it only practical in a few circumstances.

What affects wool production and quality?
The wool production unit on a Merino sheep is the 60 to 80 million follicles found in the skin. If we laid all the fibres a sheep produces end to end, then this wool factory produces about 20 kilometres of wool each day! Research work as far back as the 1940s has shown that these follicles are important determinants of the amount and quality of wool produced by a sheep — the other major factor being how we feed the sheep.

It is therefore logical to expect that how these follicles are established, the number that is established, and how they vary across the body of the Merino sheep, would be important to the quality of the fleece produced by a sheep.

Some of the information on wool production was sorted out in research work in the 1950s and 1960s. For example, we know that
help develop ewe feeding strategy

Stained transverse section of skin showing secondary:primary ratio of approximately 22:1.

wool follicles are formed during foetal life. Primary follicles are produced between day 60 and day 90 of foetal life, while secondary follicles are produced between day 80 of foetal life and birth (day 150).

About 75 per cent of the follicles are producing wool by the time the lamb is four weeks old. Primary follicles are associated with a sweat gland, which distinguishes them from secondary follicles.

The number of fibre producing primary and secondary follicles are counted from skin sections taken under local anaesthetic.

Adult medium wool Merino sheep normally have a secondary to primary ratio of 20:24:1, meaning there are 20-24 secondary follicles for every primary. Sheep with higher S/P ratios tend to produce finer wool.

The challenge to growing wool in WA
Farmers in Western Australia have long been faced with the problems and expense of hand feeding pregnant ewes, as paddock feed deteriorates in quality and quantity over summer and autumn. During the last third of pregnancy the ewe needs 50 per cent more energy and protein than a dry ewe, and this more than doubles in lactation.

It is not surprising then that pregnant ewes in summer/autumn in WA will lose weight if not fed grain supplements. Weight loss leads to a marked reduction in wool production from the ewe together with lower lamb survival and growth to six months of age. For example, a flock of autumn lambing ewes that loses 5 kilograms will produce 0.4 kilograms less clean wool per ewe which is 1 micron finer and 12 N/kilogram weaker than ewes that maintained weight.

Production losses are smaller for winter/spring lambing ewes with better paddock feed conditions.

That’s the ewe, but what about her progeny? Does undernutrition of the ewe during pregnancy and lactation affect the establishment of the wool follicle in her lamb, and does it affect the lifetime performance of this animal?

This is an important but complicated question, demanding the use of cloned sheep to produce genetically identical progeny.
**How we did it?**

The first sets of genetically identical twin lambs for this research were produced at Katanning in 1988. Embryos from donor ewes were collected, split into two identical halves and transferred into recipient ewes.

*Splitting a fertilised egg into two identical halves.*

*Artificially inseminating a donor ewe.*
kilograms and one condition score at lambing. In Experiment 2 the treatments continued to weaning at 12 weeks of age with the underfed ewes losing 2 condition scores (Figure 1).

If the nutrition of the pregnant and lactating ewe affects the formation and maturation of follicles in the developing lamb, it will show up as changes in the S.P ratio.

**What happened?**

**Progeny growth**

Growth rate of lambs from birth to hogget shearing is influenced by nutrition of the pregnant and lactating ewe. When breeding ewes were only underfed during pregnancy (Experiment 1), and lost one condition score, the lambs were 0.5 kilogram lighter at birth than lambs born to ewes fed to maintain weight and condition score (Figure 2). This led to a liveweight difference of about 2 kilograms at lamb shearing which continued through to hogget shearing.

In the second experiment, ewes were underfed during both pregnancy and lactation, and lost 2 condition scores in comparison to their maintenance fed counterparts. The progeny of these underfed ewes were about 10 kilograms lighter at weaning and lamb shearing than the progeny of ewes fed to maintenance. By hogget shearing the difference had been reduced to 3 kilograms.
Figure 3. Effect of underfeeding the ewe during pregnancy on progeny S:P ratios from birth to 2.5 years of age.

Figure 4. Effect of underfeeding the ewe during pregnancy and lactation on progeny S:P ratios from birth to 2.5 years of age.

Table 1. Clean fleece weights in progeny resulting from underfeeding the ewe during pregnancy and during pregnancy plus lactation.

<table>
<thead>
<tr>
<th>Age at shearing (years)</th>
<th>Feeding over Pregnancy</th>
<th>Feeding over Pregnancy &amp; Lactation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maintenance</td>
<td>Underfed</td>
</tr>
<tr>
<td>0.5</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>1.5</td>
<td>4.3</td>
<td>4.2</td>
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<td>4.7</td>
</tr>
<tr>
<td>4.5</td>
<td>5.2</td>
<td>5.1</td>
</tr>
</tbody>
</table>

nya = not yet available
Effect on progeny wool production

In our work, S:P ratios were less at birth, lamb, hogget and adult shearing for the animals born to ewes underfed during pregnancy and during pregnancy and lactation (Figures 3 and 4).

Progeny from the ewes underfed in pregnancy only grew 0.1 to 0.2 kilogram less clean wool per year than their maintenance counterparts to 4.5 years of age (Table 1).

For the progeny from ewes underfed in both pregnancy and lactation, the penalties were about twice that experienced by the progeny that were underfed in only pregnancy (Table 1).

Differences in raw wool characteristics such as yield, mean fibre diameter, staple length and strength were small, and would have little effect on wool price.

Likewise, while there is considerable variation across the sheep in follicles, wool production and wool quality, this variation was not affected by the nutrition of the breeding ewe.

Message for wool producers

Ewe

It is important to feed ewes to maintain liveweight over pregnancy – to increase weight, staple strength, mothering and milking ability. The best way to make decisions on when to adjust feeding rates, either of supplements or paddock feed, is to condition score a random sample of the flock. This information will result in ewes in good condition and liveweight during pregnancy and lactation.

Progeny

These detailed studies showed that undernutrition of the foetus from day 50 of pregnancy, and lamb undernutrition to 12 weeks of age, will reduce the initiation and development of secondary follicles leading to lower fleece weights (up to 0.4 kg), but has little effect on any other fleece characteristic. Birthweight, lamb survival and growth rate to hogget shearing are also reduced.

Clearly all of these effects need to be considered when evaluating the feeding strategy for the pregnant ewe.

The value of these changes will depend on the costs of maintaining the pregnant and lactating ewe, the number of progeny and the time they spend on the farm before sale. For example, if ewes are maintained during pregnancy in condition score 3-3.5 in comparison with 2-2.5, then it is expected that each ewe will:

- produce about 0.5 kilogram more clean wool that is sounder and broader
- produce between 10 and 20 per cent more lambs at lamb marking, and that
- their progeny will produce 0.2 kilogram more clean wool at each annual shearing

The feeding requirements of the breeding ewe are best met by green feed, rather than supplements of grains. Winter and spring lambing can dramatically reduce the need for supplementary feeding – it is a lot cheaper and easier to maintain the liveweight and condition score of a breeding ewe on green than dry feed.

Further reading

see Farmnotes 12/92 Feeding pregnant and lactating ewes Agdex 433/50 and 46/97 Consequences of underfeeding the pregnant ewe Agdex 433/53.

Acknowledgements

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