



Making every mating count



Revised and edited by:

Dr Ken Geenty
Former Research & Development Manager
NZ Meat and Wool Producer Boards

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SUMMARY



CHAPTER 1: AN OVERVIEW OF LAMBING PERFORMANCE ON FARMS

Improved lambing percentage makes the biggest contribution to higher profits on sheep farms. This chapter covers changes in the sheep industry, lambing performance on farms and changes needed to the farm system with improved lambing percentage.

CHANGES OVER TIME

Sheep industry trends during the 1990s and early 2000s demonstrated reduced ewe numbers, improved lambing %, increased lamb carcass weights, a greater proportion of income from sheep meat and increased ewe hogget lambing.

Changes in ewe breed composition during the early 2000s towards composites has contributed to improved lambing performance.

Improved lambing percentages during the early 2000s has meant greater focus on management and survival of multiple births.

WHAT HAPPENS TO POTENTIAL LAMBS?

In a South Island farm survey the average number of eggs shed per 100 ewes mated was 161, average scanning was 134% and average tailing 121%.

Of the total 40 'eggs' lost 25 were between mating and scanning due to barren ewes and embryonic failures, a further two 'eggs' were accounted for by late pregnancy ewe deaths and 13 'eggs' perished as lambing deaths.

There was large variation in potential lambing percentage between individual survey farms.

FARM SCANNING SURVEYS

Lamb losses between scanning and tailing averaged 20% for Crossbreds at scanning levels between 130% and 170% while average lamb losses for Merinos were 26% at scanning levels between 90% and 130%.

Dystocia and starvation/exposure cause up to 75% of total lamb losses in high performance flocks.

FARM SYSTEM CHANGES

At higher lambing percentages planning and management needs to be more finely tuned to closely match feed supply and animal demand.

Changes to the farm system could include less ewes wintered, later lambing, and earlier draft of lambs.

Key aspects to monitor are pasture cover, ewe weight and condition score, pregnancy scanning, lamb growth rates and animal health.

There is no set recipe for the best farm system.

CHAPTER 2: WEANING TO MATING

The period from weaning to mating is important for preparation of ewes and rams for good reproductive performance.

EWES WEIGHT AND CONDITION FOR MATING

A good lambing percentage is largely achieved by early preparation between weaning and the next mating.

Ewes need to be in good body weight and condition (CS3) for high ovulation rates at mating.

Ewes should not lose weight between weaning and mating as it will result in reduced feed conversion efficiency and penalise wool production.

Ewes need to eat 1.0 to 1.3kg of medium to good quality dry matter per day to hold condition score 3.0 to 3.5 during summer.

Progress can be monitored by measuring live weight and/or body condition score (CS).

Preferentially feed light ewes in the flock to achieve good liveweight and condition score at mating.

RAM HEALTH AND PREPARATION

Ram preparation is important for good mating performance and sperm production which begins eight weeks before mating.

Seek veterinary advice for treatment of genital problems or foot abscess.

Avoid shearing within eight weeks of mating.

Rams should be checked 8-10 weeks before mating for general soundness, genital problems such as epididymitis, scrotal mange or pizzle rot, and feet problems.

Purchasing from brucellosis accredited ram breeding flocks is advised.

SPERM PRODUCTION

Good testicle size, or scrotal circumference of 30cm or greater, is important for high quality sperm and semen production.

Testes must remain cool for best sperm production and survival and this is important eight weeks prior to mating as well as during the mating period.

For ram breeders semen quality can be tested using electro-ejaculation or an artificial vagina followed by inspection for sperm density and motility.

Serving capacity or libido of rams can be tested in pens with ewes in oestrus.

VASECTOMISED RAMS

Vasectomies should be done by a veterinarian.

Uses of vasectomised rams include; stimulation of hoggets or ewes to cycle earlier, identifying ewes in oestrus for AI and identifying non pregnant ewes after mating.

CHAPTER 3: MATING & EARLY PREGNANCY

The mating and early pregnancy period includes the 5-6 weeks rams are with the ewes plus a week or two. During this period lambing percentage is determined by ewe and ram fertility, ewe ovulation and conception rates and successful embryo establishment.

ewe oestrus

Oestrus is the period, averaging 24 hours, when ewes will accept ram service.

The average interval between oestrus cycles is 17 days.

Shearing may stop ewes cycling and should be avoided from two weeks before until two weeks after mating.

Ewe hoggets which show oestrus have a higher lifetime reproductive performance than those which don't.

ewe ovulation rate

A high ovulation rate (OR) is the first step in achieving a high lambing percentage.

High ewe live weight and live weight gain during mating causes high OR - for each extra kg of ewe weight there will be 1-2% higher lambing percentage.

A 10% increase in OR causes 6.9% more lambs born and 5.7% more lambs tailed.

Increases in lambing percentage above 170% are mainly due to more triplets and less singles.

Underfeeding just before and during mating will reduce OR.

Major genes affecting OR include the Booroola and Inverdale and ewes with these genes have higher OR by 1-3 eggs (homozygous Inverdale ewes are infertile).

There is breed variation in average OR with Merinos at the lower end of the scale, crossbreds in the middle and composites highest with potential lambing over 200%.

There is large variation in OR within breeds.

Crossbreeding can be used to introduce high fertility genes and will give up to 20% increase in OR in addition to the breed genetic gain.

Vaccines which immunise ewes against some of their own hormones can increase OR by up to 59% but are not widely used.

Ewe breeding season is normally from early February to late May autumn and usually starts with a 'silent' cycle (ovulation without oestrus).

Each successive ewe oestrus during the breeding season has about 0.15 more eggs shed.

Breeds such as Dorsets and Merinos have a longer breeding season than crossbreds.

SYNCHRONISATION

Synchronisation can be used to get ewes ovulating simultaneously by using hormones or rams.

Rams introduced early in the breeding season, either vasectomised or entire, will stimulate ewes to be more receptive to rams 18-21 days later.

Vasectomised rams should be put out with the ewes 17 days ahead of the planned start of mating for at least 10 days.

Use of hormones involves CIDRs or sponges with progestagens inserted into the vagina so ewes will ovulate after withdrawal.

Synchronisation for out of season breeding usually requires PMSG also to stimulate ovulation.

INTERNAL PARASITES AND TRACE ELEMENTS

Worms are not normally a problem with ewes at mating time but checking faecal egg counts prior to mating, particularly with young ewes, may be warranted.

Selenium should be routinely administered pre mating in deficient areas.

Iodine deficiency can suppress lambing percentage so levels should be checked.

TOXINS

Facial eczema (FE) caused by a pasture fungus can suppress lambing percentage through increased barrenness and fewer multiples.

Effects of FE can be minimised by preventive grazing management, zinc dosing or breeding for resistance.

The toxin zearalenone from a pasture fungus can reduce ewe fertility and fecundity.

Tests for zearalenone levels are best done using ewe urine samples.

Phyto-oestrogens produced by plants such as red clover, subterranean clover and lucerne can decrease ovulation rate by up to 30%.

Pure stands of oestrogenic plants should be avoided at mating time.

High ryegrass endophyte pastures can suppress lambing percentage so should not be used around mating time.

THE RAM

Ram harnesses can be used to identify the timing of ewes mated and expected spread of lambing.

High protein feed supplements can be used for preparation of rams for mating if high quality pasture is limited.

Depending on terrain and adequate paddock sub-division, ewe:ram ratios of 150+:1 can be used for mixed aged ewes and rams in good body condition.

Ewe:ram ratios should be 100:1 for two tooth ewes and ewe hoggets or less for younger rams. or less for younger ewes and/or rams.

ARTIFICIAL INSEMINATION

Originally artificial insemination was used mainly in ram breeding flocks and more recently in commercial flocks for introduction of new breeds.

Conception rates of 65-70% are regarded as good and are higher for intra-uterine (laparoscopic) than cervical inseminations.

Either fresh or frozen semen can be used successfully by a skilled operator.

CONCEPTION FAILURE

Failure to mate can include up to 3% of ewes and can be minimised by high ewe live weight and condition, good ram preparation appropriate ewe:ram ratios.

Fertilisation failure can be due to poor ram preparation and/or stresses during mating such as excessive yarding, shearing or flystrike.

EMBRYONIC AND PLACENTAL DEVELOPMENT

Embryonic losses in early pregnancy commonly reach 20-30% of fertilised eggs and most losses are in multiple ovulations.

Causes of embryonic loss include genetic abnormality, diseases such as Toxoplasmosis, Campylobacteriosis, Hairy Shaker, mineral deficiencies or hormonal imbalances.

Little can be done by farmers to significantly reduce embryonic losses apart from minimising stress around mating.

Placental development between days 30 and 90 of pregnancy is linked to lamb birth weight.

Loss of 5kg or more ewe live weight during early-mid pregnancy will reduce placental development and lamb birth weight causing poorer survival of multiples.

Ewes need 1.0-1.3kg of average to good quality pasture dry matter per day to hold body weight and condition during mating and early pregnancy.

CHAPTER 4: MID & LATE PREGNANCY

During the mid and late pregnancy period it is important to minimise ewe health problems and prepare for good lamb survival and ewe lactation.

PREGNANCY SCANNING

Pregnancy scanning information, obtained between days 60 and 90 of pregnancy, allows farmers to identify empty ewes and those with single or multiple pregnancies.

Scanning results give farmers a measure of their potential lambing percentage and losses between scanning and tailing.

An additional benefit from scanning can be separation of ewes into early (first 10 days), mid (second 10 days) and late (all remaining) lambing groups.

An important benefit from scanning is separation of ewes with multiples from those with singles for preferential feeding and lambing management.

At pregnancy scanning review live weight and condition score targets for the remainder of pregnancy.

EWES FEEDING AND LAMB SURVIVAL

Feeding in mid pregnancy to maintain good body weight and condition can promote good placental growth and satisfactory lamb birth weights and survival with multiples.

In both heavy and light ewes with twins a low level of feeding during mid pregnancy can decrease foetal weight, the effect being greatest in light ewes with reduced lamb survival.

Severe underfeeding in mid pregnancy can reduce the number of lambs born. Ideally ewes should not graze below 800kg DM/ha or 3cm sward height in mid pregnancy, especially multiples. At grazing levels below this there is greater risk of negative consequences for the ewe and her lambs.

Shearing ewes in mid pregnancy (between days 50-100) increases birth weight of multiples by up to 0.7kg.

During late pregnancy (days 100-150) foetal and udder growth is rapid with increased ewe energy requirements.

Foetal growth during late pregnancy is resilient to varying feeding levels except for severe underfeeding.

Underfeeding of ewes during late pregnancy will cause loss of ewe body condition and possibly metabolic disorders and if severe will reduce lamb birth weight.

Increased ewe feed requirements above maintenance during the final 8 weeks of pregnancy are 0.1-0.5kg DM per day for singles and 0.2-0.9kg DM for multiples. To achieve these target intakes in the last 2 – 3 weeks of pregnancy ewes should not graze below 1200kg DM/ha or 4cm sward height.

Underfeeding during late pregnancy may cause ewe health disorders and/or restrict udder growth and subsequent colostrum and milk production.

Lambs from ewes underfed during mid-late pregnancy will have lower body fat reserves when they are born with less chance of survival.

Ewes supplemented with protein or concentrates in late pregnancy may produce more colostrum with improved lamb survival.

Under feeding in mid-late pregnancy restricts udder development and subsequent milk production.

Ewe lambs born to ewes well fed during pregnancy have better lifetime reproductive performance than those from ewes poorly fed.

Autumn lambing requires a different feed profile which suits summer dry areas with good winter pasture growth like Northland.

Shearing of ewes in mid pregnancy is more likely to increase lamb birth weight than pre lamb shearing.

Pre lamb shearing of ewes can encourage them to seek out shelter with better lamb survival, particularly for multiples.

Pre-lamb shearing with a winter comb minimises ewe losses in bad weather.

ABORTION

The most common causes of abortion in sheep are toxoplasmosis and campylobacter (also known as vibrio).

Lamb losses due to abortion are generally greatest in younger ewes with less immunity.

Lamb deaths due to toxoplasmosis can be at any stage during pregnancy or soon after lambing.

A single vaccination for toxoplasmosis gives lifetime immunity and is highly effective.

Infection and lamb deaths with campylobacter is in the last 6-8 weeks of pregnancy.

Vaccination for campylobacter is effective with a sensitiser and booster required in ewes prior to mating.

EWES HEALTH DISORDERS AND DEATHS

The cost of 1% of ewes lost in a 2,000 ewe flock is equivalent to 40 ewes wintered and 50 lambs tailed.

Milk fever due to calcium deficiency can occur in late pregnancy, usually in ewes with multiples, due to sudden changes in feeding or disruptions such as shearing, crutching or vaccinating.

Treatment for milk fever is by injection with calcium borogluconate.

Pregnancy toxemia or “sleepy sickness” can occur in late pregnancy, usually in ewes carrying multiples, and is due to underfeeding or stress such as prolonged bad weather.

Pregnancy toxemia can be treated orally with a sugary solution or “ketol”.

Vaginal prolapse, or “bearings” can occur in late pregnancy and are most prevalent in ewes with multiples.

Bearings are caused by high intra-abdominal pressure and there is no scientific evidence on ways of avoiding the condition.

Retention of bearings followed by successful lambing can be achieved with early detection and careful treatment (see recommendations page 46).

Underfeeding of ewes in late pregnancy is *not* recommended for prevention of bearings.

PRE-LAMB HEALTH CHECKS

Ewe vaccination with “5-in-1” in late pregnancy protects the ewe over lambing and the lambs against deaths between lambing and weaning caused by clostridial diseases.

Ewes should have adequate levels of selenium and vitamin E at lambing to avoid lamb deaths due to white muscle disease.

Iodine deficiency in ewes can hinder lamb development during pregnancy and cause lamb deaths soon after birth due to goitre. Treat with Flexidine injection or potassium iodide orally.

CHAPTER 5: LAMBING

Lambing is the time when all the work done up to mating and during pregnancy is rewarded with a good lambing percentage. The aim is to give all lambs ‘on board’ the best possible chance of surviving and thriving.

CHOOSING LAMBING PADDOCKS

Lamb survival is improved on flat or gently sloping paddocks than on steep hills.

Effective shelter will help lamb survival and should be used preferably for multiples.

Types of shelter include hills or slopes, trees or shelter belts, bushy plants and lamb covers.

LAMB SURVIVAL

Average lamb deaths range from 5-26% between farms and are higher for multiples than singles.

Major causes of lamb death are dystocia in singles and starvation/exposure mostly in multiples. Combined, these account for about 60% of all lamb deaths.

Some 70% of lamb deaths can be prevented by better nutrition and preventive measures.

Optimum lamb birth weight for best survival is 4.2-7.4kg for singles and multiples. Below this range increases the risk of starvation/exposure (mainly multiples) and above dystocia (mainly singles).

Good nutrition throughout pregnancy is essential for optimum birth weights of multiple lambs.

Lambs born in autumn or winter have lower birth weights than in spring.

Lamb survival is often higher with crossbreeding due to positive heterosis for lamb birth weight and ewe milk production.

Lamb survival is generally lower in hoggets or young ewes than older ewes.

Significant differences in lamb survival have been shown between progeny of different sires.

Selection for improved lamb survival can include components such as; ease of lambing, mothering ability, lamb vigour and cold resistance of lambs.

SHEPHERDING & INTERVENTION

Separating early and late lambers assists with differential feeding and allows more effective shepherding.

Shepherding intensity varies and can decrease lamb losses by assisting difficult births, attending to cast ewes, treating bearings and fostering mis-mothered lambs.

It is important not to disturb ewes from their lambing site to ensure effective bonding can occur.

“Shedding off” of lambed ewes should not include lambs under 24 hr old.

Lamb swapping and stealing often occurs with ewes crowded around the same site and is not a big problem with commercial farms but causes inaccuracies for pedigree recording in ram breeding flocks.

MAIN CAUSES OF LAMB DEATHS

Dystocia is mainly caused by difficulty of passing large single lambs through the birth canal but can also occur with smaller weak lambs and poor ewe uterine contractions.

Since dystocia is repeatable, ewes assisted during lambing and their lambs should be identified for culling.

Starvation/exposure can be caused by small weak lambs with little or no body fat reserves, severe cold weather, mis-mothering or lack of colostrum or ewe milk.

The chilling effects of wind and rain combined are more likely to cause lamb deaths from exposure than low temperature alone.

Lambs vary in their ability to maintain body temperature in cold conditions but this is very difficult to select for.

Poor ewe nutrition in late pregnancy delays onset of milk secretion and increases the risk of lamb starvation.

Ewes vary in mothering ability which is repeatable and can be assessed in terms of their reaction to human presence.

EWE NUTRITION

Good ewe nutrition in late pregnancy and early lactation improves lamb survival and early growth.

Pasture cover at lambing should be 1200kg DM/ha or 3-4cm long.

During early lactation pasture cover should be 1400-1600kg DM/ha or 5-6cm length.

EWE MILK PRODUCTION

Ewe milk production peaks 2-4 weeks after lambing then gradually declines.

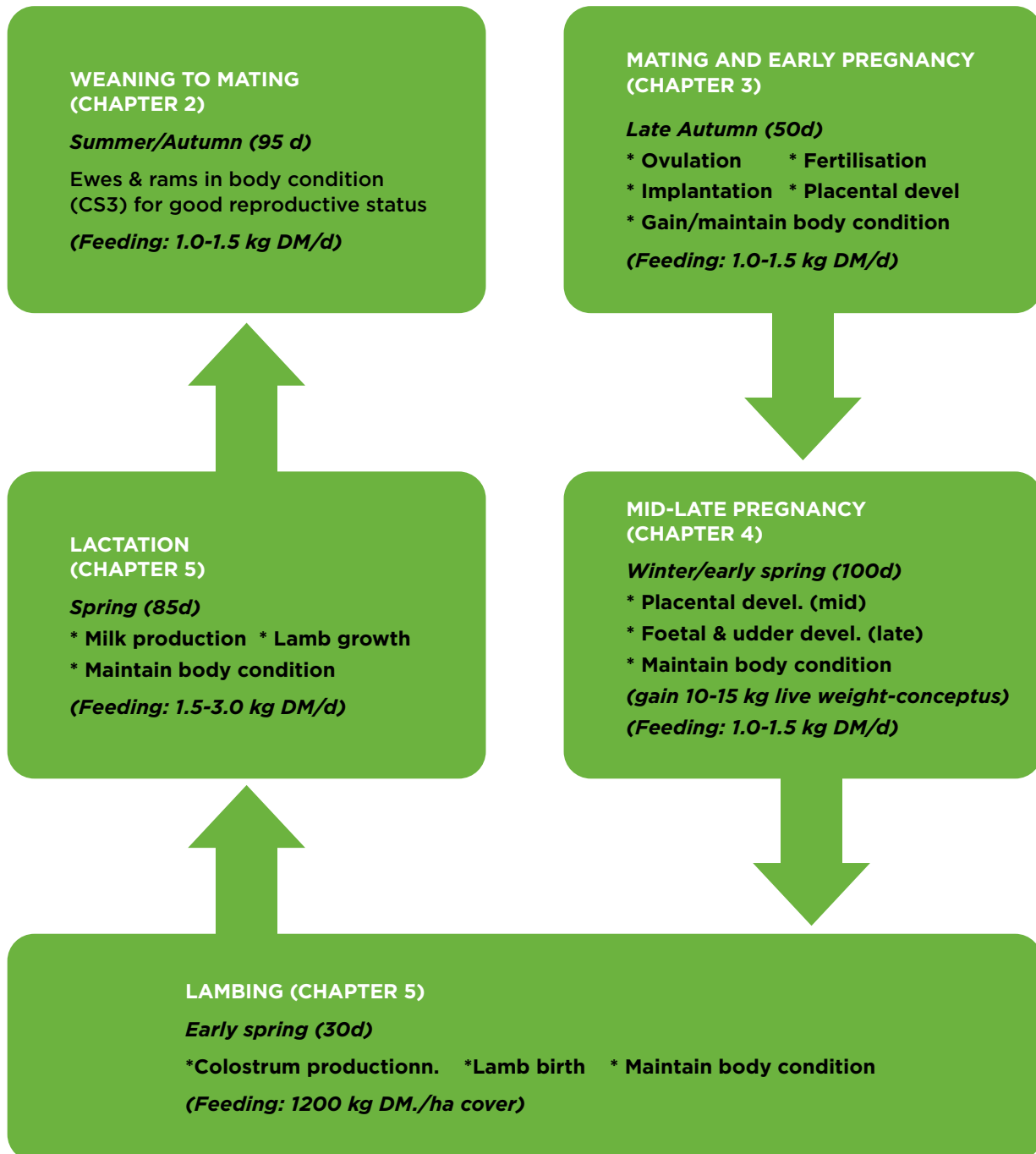
Ewes with twins or triplets produce 30-50% more milk than those with singles.

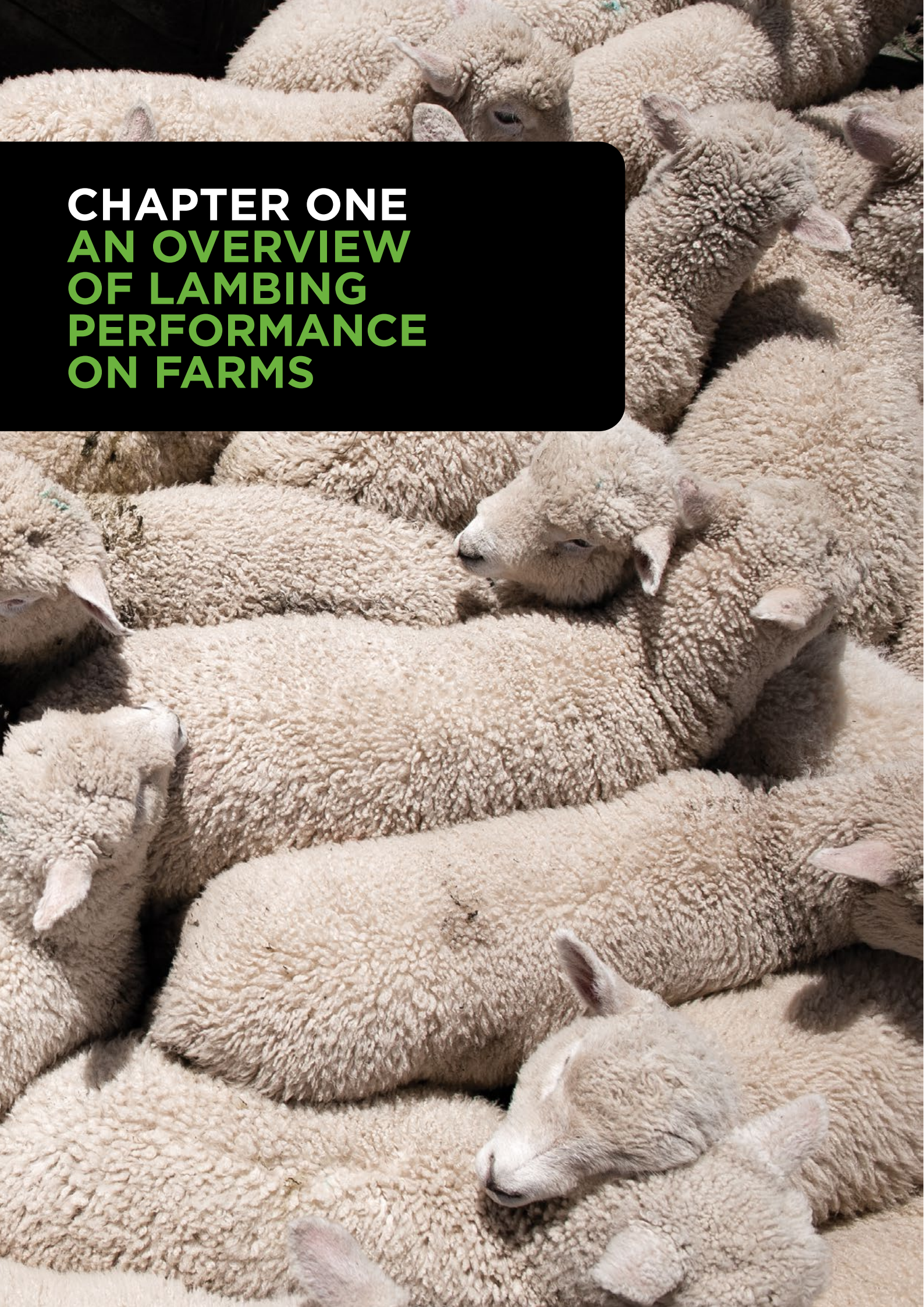
There is large variation in ewe milk production levels within flocks but this is hard to select for as lambs substitute good quality pasture for milk.

DEFINITIONS

Abortion	The premature loss of a pregnancy, usually where the dead foetus is expelled, from 60 days of pregnancy on.
Difference	Scanning percentage minus tailing percentage (number of lambs lost per 100 ewes scanned).
Egg	The female reproduction cell produced by the ovary.
Embryo	The stage of pregnancy between 11 and 34 days after fertilisation. After this time the organs and body systems develop and the body shape forms.
Fecundity/prolificacy	Ability of ewes to produce multiples.
Fertilisation	The process by which the sperm unites with the egg to form a fertilised ovum. This occurs in a tube (the oviduct or fallopian tube) that links the uterus with the ovary.
Fertility	Proportion of ewes that get in lamb or rams that fertilise eggs.
Foetus	Stage of pregnancy from day 34 until full term. Over this time the organs and systems mature.
Lambing percentage	$\frac{\text{Number of lambs tailed}}{\text{Number of ewes mated}} \times 100$
Mummified foetus	A foetus that has died but has neither been reabsorbed nor expelled. Fluids are absorbed from the dead foetus leaving the dried up structures inside the uterus. This may be expelled at any time but very often is delivered at term when another surviving foetus may be born normally.
Ovary	The sex gland of the female that produces eggs. There are two in each female. The process of releasing the eggs is called ovulation. More than one egg can ovulate from one ovary at the same time. Eggs can ovulate from both ovaries at the same time.
Ovum	The unfertilised or fertilised egg up until 11 days after fertilisation. It is a cell mass that has no organs, major tissues or systems developed.
Percent lambs lost	$\frac{\text{difference}}{\text{scanning percentage}} \times 100$
Placenta	An organ of pregnancy inside the uterus that links the dam with the foetus. It provides nutrients to the foetus and removes wastes.
Reabsorption	The process that occurs when an ovum, embryo or young foetus dies and is absorbed back into the ewe. This usually occurs in the first 60 days of pregnancy.
Scanning percentage	Number of lambs counted per 100 ewes scanned.
Semen	Fluid produced by the male containing sperm and nutrients. It comes from the testes and the accessory sex glands.
Sperm (or spermatozoon)	The male reproductive cell produced by the testes. It takes over 50 days for a sperm to form and mature inside the testes. The sperm fertilises the egg in the oviduct at the end of the uterus in the ewe.
Tailing percentage	Number of lambs tailed per 100 ewes scanned.
Testes	The sex gland of the male that produces sperm. There are two testes in each male. Attached to the testes is the epididymis which stores sperm.
Uterus	The organ in the female in which the fertilised ovum embeds and in which the embryo and foetus develop.

SHEEP REPRODUCTIVE CYCLE





CHAPTER ONE **AN OVERVIEW** **OF LAMBING** **PERFORMANCE** **ON FARMS**

RECOMMENDATIONS

- Improved lambing percentage means higher profits.
- With increased lambing percentages there should be greater focus on ewe management and survival of multiple births.
- Most scope for minimising lamb losses is around lambing when 18-25% of lambs present at pregnancy scanning are lost.
- Feed supply and animal needs should be closely matched for the most profitable system.
- Changes to the farm system with increased lambing percentage could include later lambing, regular lamb drafting and fewer ewes wintered.
- Monitoring animals and feed conditions provides quality information for quality decisions.
- There is no set recipe for the best farm system.

CHANGES OVER TIME

Lambing performance in New Zealand languished at around 100% for several decades until the early-mid 1990s when there was a marked trend towards 120%. (Fig. 1.1). This improved lambing performance over the 1990s and early 2000 decades coincided with: (see Figs. 1.2 & 1.3)

- 50% reduced breeding ewe numbers
- Total weight of NZ lamb carcass production almost maintained – 6.7% reduction only
- Average lamb carcass weight increased by 30% to 18.6kg
- Total NZ wool production dropped 46%
- Wool income declined from 43% of sheep farm income to 10%
- Lamb and mutton farm income increased from 57% to 90%
- Ewe hoggets lambing increased from 13.6% to 30.5% annually producing 1.1 million lambs.

Source: Beef + Lamb New Zealand Economic Service.

The improved lambing percentage as ewe numbers declined, particularly during the late 1990s, is likely due in part to better feeding and management with fewer ewes. In addition, widespread uptake of pregnancy scanning during the early 1990s provided farmers with another management tool for preferential treatment of ewes with multiple lambs. A result of better feeding and management as ewe numbers declined has been increased lamb carcass weights and almost maintaining total lamb carcass weight. Sheep farming systems have changed to focus on efficiency and putting a greater proportion of feed into lamb growth than into ewes.

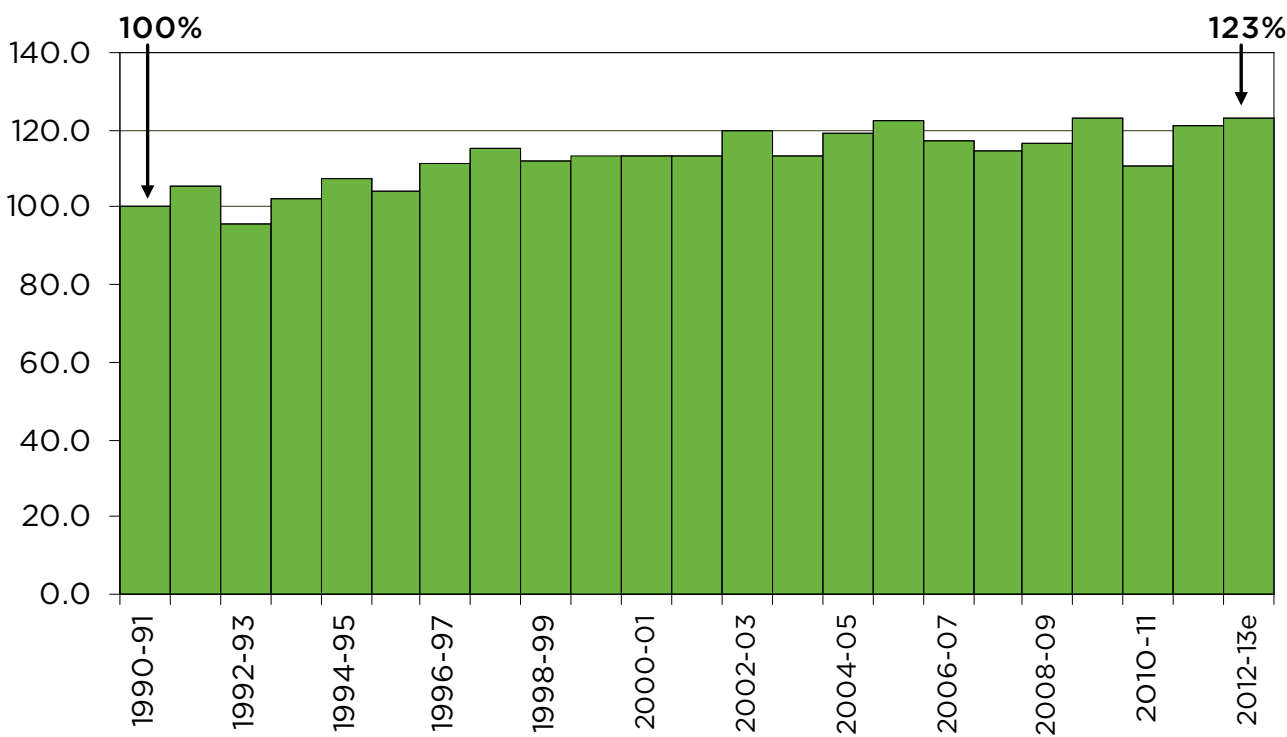
Increased lambing of ewe hoggets to 30% has also made a very significant contribution to improved productivity from the national flock despite the reductions in breeding ewe numbers.

Another significant change in the sheep industry over the two decades has been the rather spectacular change in proportions of income from wool and meat with the industry now predominantly a sheep meat based industry with only 10% of farmer income from wool.

Sheep industry trends during the 1990s and early 2000s demonstrated reduced ewe numbers, improved lambing %, increased lamb carcass weights, a greater proportion of income from sheep meat and increased ewe hogget lambing.

BREEDING EWE LAMB PERCENTAGE TREND

Figure 1.1. Trends in national lambing percentage over the 1990s and early 2000 decades.
Source: Beef + Lamab New Zealand Economic service.



During the early 2000s changes in % ewe breed composition of the national flock has been recorded as follows (table 1.1).
Increased proportions of composites, bred from higher prolificacy breeds such as Finns, East Friesians and Texels has undoubtedly contributed to increased national lambing percentage. This increase in high performing composites has been at the expense of fine wool breeds Coopworths, halfbreds and corriedales.

Table 1.1. Changes in ewe breed composition of the national flock.

Source: Beef + Lamb New Zealand Economic Service.

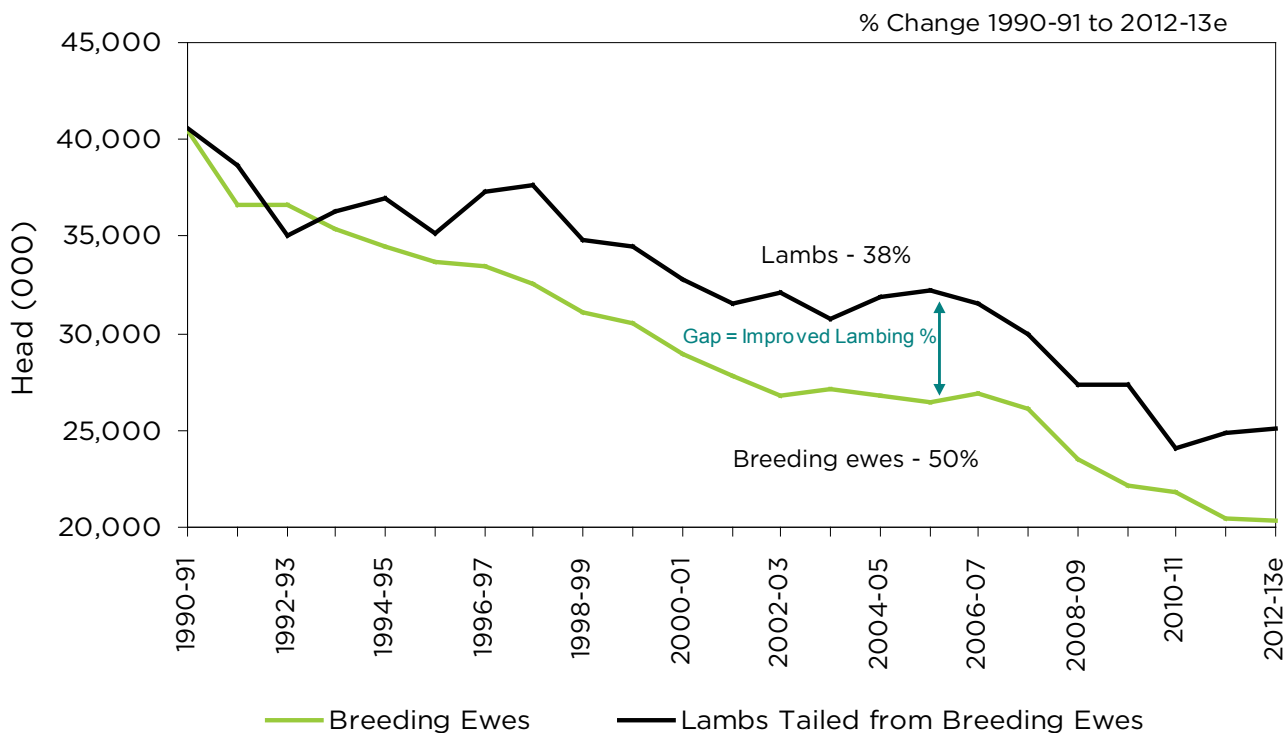
Breed	% in 2000	% in 2011
Coopworth	16.6	9.3
Corriedale	8.9	3.3
Merino	5.9	3.9
Romney	48.2	46.0
Composite	(no est.)	11.5
Perendale	6.1	12.0

Changes in ewe breed composition during the early 2000s towards composites has contributed to improved lambing performance.

BREEDING EWE AND LAMB CROP TREND

Figure 1.2. National breeding ewe and lamb numbers over the 1990s and early 2000 decades.

Source: Beef + Lamb New Zealand Economic Service.



BREEDING EWE PRODUCTIVITY

Figure 1.3. Trends in breeding ewe numbers and weight of lamb carcass production over the 1990s and early 2000 decades.

Source: Beef + Lamb New Zealand Economic Service.

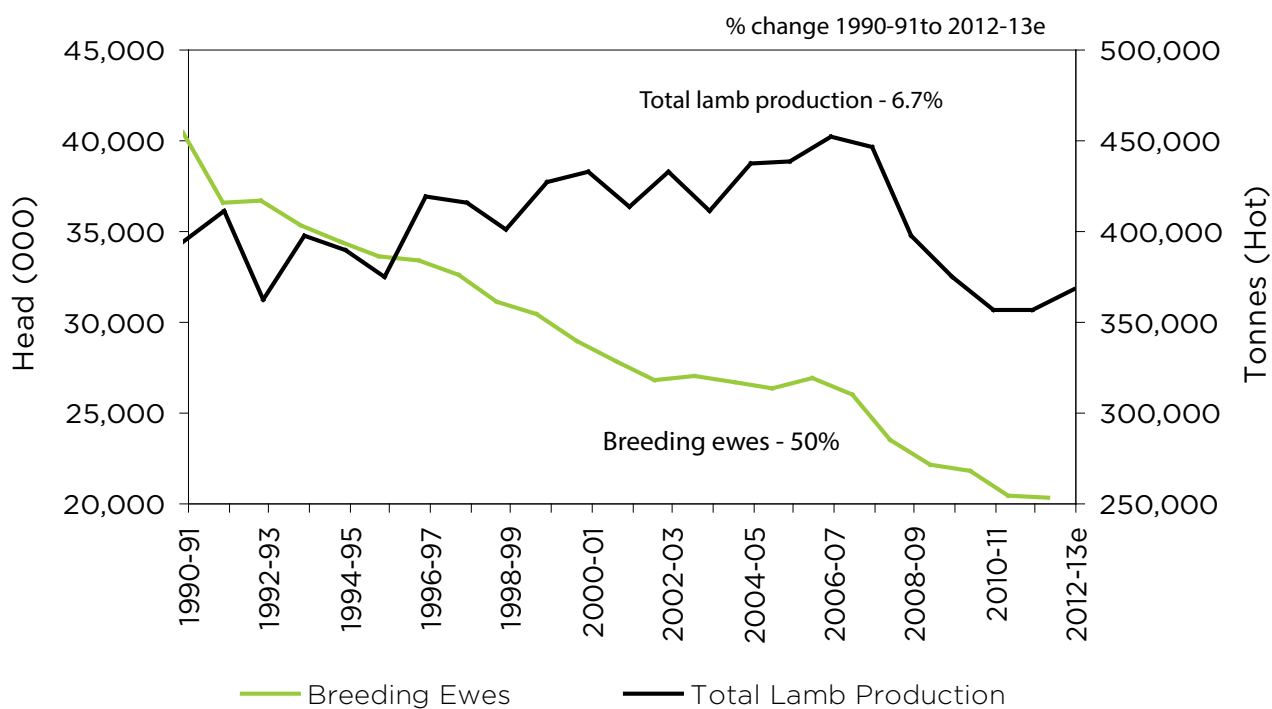
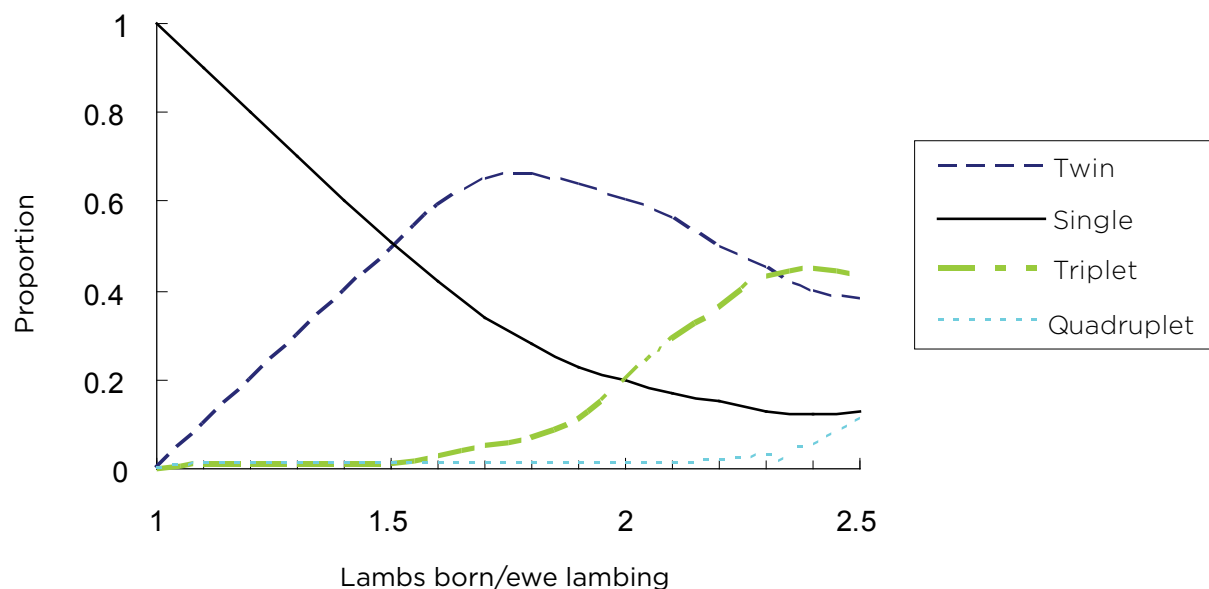


Figure 1.4. Proportions of single (red line), twin (blue broken line), triplet (green broken line) and quadruplet (light blue dotted line) at different levels of average lamb drop.

Adapted from Amer et al. 1999.



The structural and performance changes in the industry have meant greater proportions of twins and triplets in many flocks and hence more focus on management and survival of multiple births (refer to Fig. 1.3).

The relative predicted proportions of single, twin, and triplet lambs at different levels of lamb drop are shown in Fig. 1.4 above.

Generally, proportions of triplets born increase after 150% lambing, reaching 20% at just under 200% lambing when there is also about 60% of twins. Numbers of quadruplets born only start to increase at about 220% lambing.

Improved lambing percentages during the early 2000s has meant greater focus on management and survival of multiple births.

In a South Island farm survey the average number of eggs shed per 100 ewes mated was 161, average scanning was 134% and average tailing 121%.

WHERE ARE THE “POTENTIAL LAMBS” LOST?

Currently, improved lambing percentage is the most important factor for higher profits on sheep farms. This improvement can be achieved by better ovulation rates and minimised lamb losses between pregnancy, scanning, and tailing.

Information from farm surveys indicates the wide variation in potential and achieved lambing results between farms. Generally reproductive wastage (ewe and lamb deaths) increases with ovulation rate and in one South Island survey at an ovulation rate of 1.61 averaged about 40 eggs per 100 ewes mated.

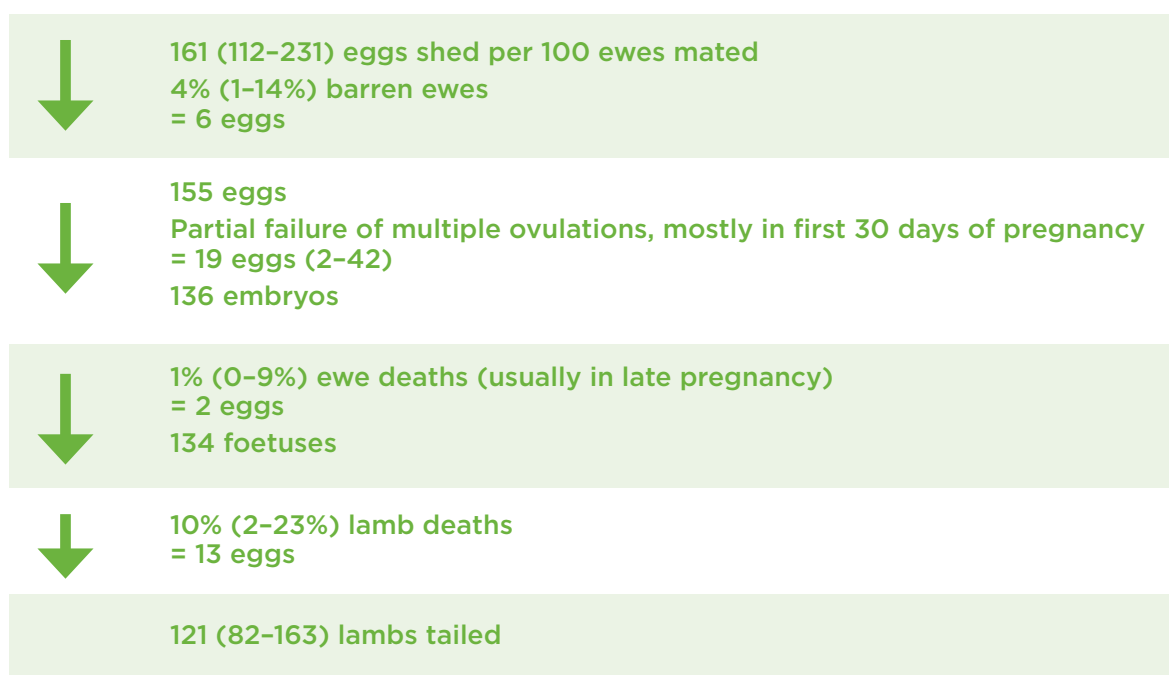
Some 15% of viable eggs were lost as embryos and ewe deaths in the first 30 days of pregnancy. Another 11% died between pregnancy scanning (day 60–90 of pregnancy) and tailing at four to five weeks after lambing.

Note that while 40 potential lambs were lost for every 100 ewes mated, some farms' performance was outstanding while others had huge losses.

Of the total 40 'eggs' lost 25 were between mating and scanning due to barren ewes and embryonic failures, a further two 'eggs' were accounted for by late pregnancy ewe deaths and 13 'eggs' perished as lambing deaths.

The diagram below shows where the losses occurred with the numbers in brackets indicating the wide range of results from individual survey farms.

Adapted from Kelly, 1980.



The average difference in the above survey between embryos which would have shown up as scanned (136%) and lambs tailed (121%) indicates a very low lamb loss of 11% during late pregnancy and lambing.

There was large variation in potential lambing percentage between individual survey farms.

Table 1.2. Farm pregnancy scanning monitoring schemes.

Source: Geenty 1997.

Breed	Scanning%	Tailing%	Difference	Lamb Loss%
Crossbred	170	138	32	19
	150	122	28	19
	130	106	24	18
Merino	130	92	38	29
	110	81	29	26
	90	69	21	23

SHEEP FARM SCANNING SURVEYS.

The widespread use of pregnancy scanning by ultrasound in New Zealand sheep flocks has provided a lot of information on lambing potential and lamb losses between scanning and tailing 4-5 weeks after lambing.

Information from some of these monitoring schemes in New Zealand is summarised in table 1.2 above.

Generally scanning levels were lower and lamb losses higher for Merinos, averaging about 26%. In the Romney and crossbred flocks lamb losses averaged around 18%.

Lamb losses between scanning and tailing averaged 18% for Crossbreds at pregnancy scanning levels between 130% and 170% while average lamb losses for Merinos were 26% at scanning levels between 90% and 130%

A survey of 20 high performance flocks in New Zealand in 2003, including several composites and pregnancy scanning levels between 174% and 226%, showed predominant causes of death were dystocia and starvation/exposure accounting for around 75% of all lamb deaths within three days of lambing. Although there was big variation between flocks average proportions of lambs lost were 14% for singles, 16% for twins and 29% for triplets.

Dystocia and starvation/exposure cause up to 75% of total lamb losses in high performance flocks

THE FARM SYSTEM

It is inevitable that with improvement in lambing percentage, which will mean proportionately more lambs, there will be changes needed to the farm system. For example very different management and production practises are required farming at 150% lambing compared with 110%.

The main aspects of management and production which will need reviewing with higher lambing percentage include:

- planning and prioritising activities
- mating and lambing date
- number of ewes carried through the winter
- lamb selling and breeding replacement policies
- sheep to cattle ratio
- feed planning
- breeding policy
- pasture production and fertiliser needs.

Increased lambing percentage may require small changes or 'fine tuning' such as decreasing breeding ewe numbers or sheep:cattle ratio or reducing stocking rate through the winter to ensure better matching of pasture feed supply and animal needs.

At higher lambing percentages planning and management needs to be more finely tuned to closely match so feed supply and animal demand

For example with 30% more ewes carrying twins, good ewe body condition and adequate feed at lambing become more important otherwise lamb mortality will increase markedly and total lambs weaned will not be proportionally increased. This may require that some 15% fewer ewes be carried through the winter (i.e. fewer ewes producing the same number or more lambs than previously) and a slightly later lambing date. Also with a greater proportion of lambs during the spring-summer period, lamb selling and drafting may need to be earlier than previously to ensure enough feed for good ewe weights at the next mating and adequate growth for replacement ewe lambs.

Changes to the farm system could include less ewes wintered, later lambing, and earlier drafting of lambs

In addition to stock policy decisions like those above, other components of the system will need consideration to support a higher lambing percentage. Included will be factors like fertiliser application and pasture varieties for better feed production, provision of stock shelter, adequate sub-division for effective feed planning and allocation and reviewing lambing date.

Monitoring

A critical part of effective planning and management for higher lambing percentage is monitoring which provides 'quality information for quality decisions'. For example a significant improvement in lambing percentage may simply come from vaccinating against contagious abortion (toxoplasmosis or campylobacter) if it is known this is a spasmodic or regular problem.

Key aspects to monitor are pasture cover, ewe weight and condition score, pregnancy scanning, lamb growth rates and animal health

Key aspects which need to be monitored include the following:

- pasture cover for sheep feeding levels
- ewe mating and weaning weight and condition score
- pregnancy scanning for preferential management
- growth rates of lambs for drafting and replacements
- genetic merit of rams
- animal health status and health plan.

Monitoring should not be perceived as a cost but rather as a productive investment.

There is no set recipe for the best farm system

In conclusion it should be noted that there is no set recipe for the best farm system. Factors such as the knowledge, attitudes and skills of the farmer, production and profit goals and many other aspects of each individual farm will need to be considered in developing the best system for that farm.

The realisation of lambing potential on farms requires consideration of the many events and activities throughout the farming year from lamb weaning right through until the following lambing. The next four chapters progressively run through the weaning to mating, mating and early pregnancy, mid to late pregnancy and lambing periods.

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CHAPTER TWO

WEANING TO MATING



RECOMMENDATIONS

- High ewe liveweight and condition score (minimise ewes with CS less than 3) are required at mating for good ovulation rate and potential lambing percentage.
- It is more efficient and productive to hold good ewe liveweight and condition score over summer than to lose and regain.
- Ewes need 1.0 to 1.3 kg of average to good quality dry matter per day to hold body condition score at 3 over summer.
- Preferentially feed light ewes in the flock for improved liveweight and condition score at mating; responses will be greatest in small framed ewes.
- Rams should be checked before ram buying time, and again 8-10 weeks before mating. Good feeding and exercise should commence.
- Buy rams from brucellosis accredited flocks and check all rams for testicle abnormalities and mange at least 8 weeks before mating.
- Sperm production and semen quality are best in rams with larger testicles and when scrotal temperature is lower than body temperature.
- Use lower ewe:ram ratios with younger ewes and/or rams.

The period between weaning and next mating is important for good reproductive efficiency in the coming season and for good wool production. Performance will be penalised if ewes are “screwed down” or worked hard to maintain summer pasture quality, to the extent that the ewes lose condition. Ewes which are light at weaning must be well fed to regain weight by mating.

Good lambing percentages are largely achieved by early preparation between weaning, and the next mating

THE EWE

RECOVERY OF WEIGHT FOR THE NEXT MATING SEASON

The main determinant of the coming season's lambing percentage is ovulation rate at mating. Ewes must reach good mating weight and condition which may be difficult if they lost a considerable amount of weight during winter and have not made this up by weaning. Condition score (“CS”, see Appendix six) should be a minimum of 3 at mating. Ewes need to gain about 5kg live weight to improve by one condition score.

The late spring/summer period tends to be the time when feed is most plentiful. If ewes cannot reach a suitable pre-mating weight over summer, flushing with high feeding levels for periods up to six weeks before mating becomes extremely important for good ovulation rates and a high lambing percentage next season. Controlling feed quality over summer with breeding ewes may restrict their ability to regain weight before mating.

Although responses to flushing are greater in thin, than fat ewes, deliberately restricting ewe weights over summer before flushing is not recommended. Ewes in good condition during pre-flushing and/or at mating have lower barrenness than those in poor condition.

It is much more efficient to hold ewe liveweight and condition score between weaning and mating as it takes a lot of extra feed to regain weight. For example, eachkg of ewe liveweight lost is equivalent to 17 MJ ME while it takes 65 MJ ME to gain one kg of liveweight (see “A Guide to Feed Planning”).

Ewes need to be in good body weight and condition (CS3) for high ovulation rates at mating

Experiments at Templeton Research Station showed that ewes ate less feed if liveweight was held between weaning and mating and also had similar ovulation rates to ewes which had lost then regained to the same liveweight. In addition, ewes well fed over summer in these experiments produced 11% more wool than those underfed.

Results from the Templeton experiments are summarised in Table 2.1.

Ewes should not lose weight between weaning and mating as it will result in reduce feed conversion efficiency and penalise wool production.

Table 2.1. Average ewe weight (kg) at weaning and subsequent mating in relation to different summer feeding levels and average ovulation rate (OR).

Adapted from Thompson et al., 1990.

Ewe weight at weaning (kg)	Summer feeding level	Average ewe mating weight (kg)	Average ovulation rate
54.8	low	low	1.52
54.8	low-high	low-high	1.73
54.8	medium	medium	1.93
45.0	low	low	1.28
45.0	low-high	low-high	1.51
45.0	medium	medium	1.53
45.0	high	high	2.17

FEEDING LEVEL OVER SUMMER

Ewe feed demand over summer is determined by the amount needed to maintain or gain weight for condition score of 3 or greater at mating. Table 2.2 shows the feed requirements of mature ewes maintaining or gaining liveweight. Use these to calculate the feed demand for ewes to reach their desired pre-mating weight. Pasture length guidelines can be obtained from Appendix 4.2.

Ewes need to eat 1.0 to 1.3 kg of medium to good quality dry matter per day to hold condition score at 3.0 to 3.5 during summer.

FEEDING RECOMMENDATIONS

- Extra feed required for liveweight gain, assuming average quality feed (10 MJ ME/kg DM):
- 50 g/day gain: Add approximately 30% to the maintenance amount above
 - 100 g/day gain: Add approximately 60% to the maintenance amount above
 - 150 g/day gain: Add approximately 100% to the maintenance amount above.

Table 2.2. Maintenance feed requirements of grazing adult sheep (kg of dry matter per day).

Adapted from Geenty and Rattray, 1987.

Liveweight (kg)	Feed Quality		
	Poor (25+% dead material) 8 MJ ME/kg DM	Average (green-leafy) 10 MJ ME/kg DM	Good (legume dominant) 12 MJ ME/kg DM
50	1.31	1.00	0.79
60	1.50	1.15	0.92
70	1.69	1.30	1.00
80	1.90	1.46	1.12

(see pasture length guidelines – Appendix Table 4.2)

CONDITION SCORING

Weighing is a good tool for assessing summer ewe weight gain requirements from weaning and to monitor progress up to mating. Condition scoring can be useful for frequent checks on progress over summer and is quicker than yarding and weighing. Condition scoring a number of random ewes in the corner of a paddock, or when they are in the yards for some other job can be sufficient to gauge the condition score of the flock.

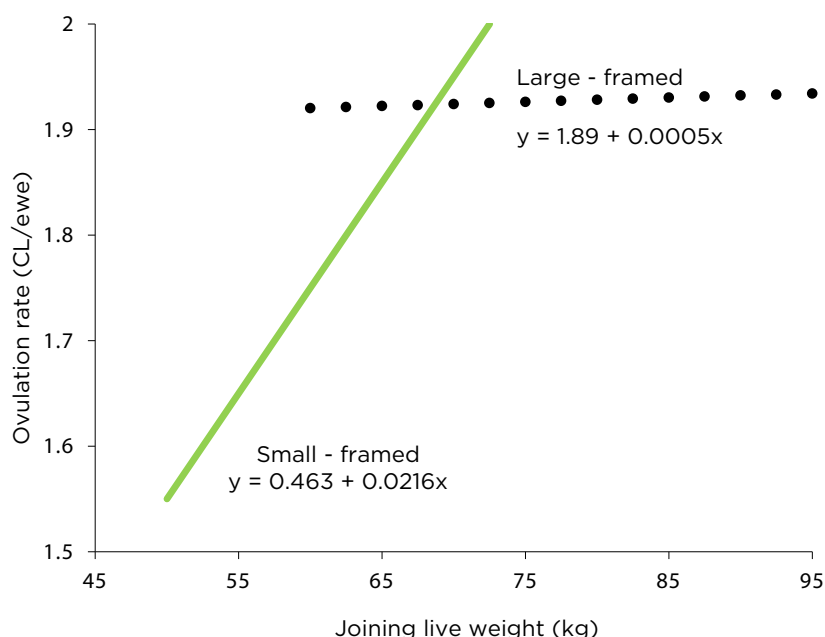
For more detail about condition scoring, see Appendix six.

Generally high liveweight and condition score at mating results in good lamb birth weight and weaning weight, particularly for twin lambs. In addition there is a positive ovulation rate response to increased mating liveweight which translates more to lambs born. However there is a limit to this response which diminishes in larger framed ewes at around 65kg liveweight as shown in the following Fig. 2.1.

Progress can be monitored by measuring ewe live weight and/or body condition score (CS).

Figure 2.1: Response of ovulation rate to liveweight at mating in small and large framed ewes.

Adapted from Rutherford et al. 2003.



It appears that the 'modern improved Romney' has very good conception and ovulation rates even at relatively lighter liveweights as illustrated in Table 2.3 below which represents some 2,000 ewes.

Ovulation rates in the table below correspond well with those in Fig. 2.1 with ovulation rates at 1.90 or greater at liveweights above 65kg.

Preferentially feed light ewes in the flock to achieve good liveweight and condition score at mating.

Table 2.3. The effect of mixed age Romney ewe CS and weight range on the percentage of ewes pregnant and number of foetuses diagnosed per ewe bred.

Source: Corner et al. unpublished.

	Ewes diagnosed pregnant	Number of foetuses per ewe bred
Condition score		
2	92.1%	1.63
2.5	97.9%	1.84
3	98.8%	1.89
3.5	98.6%	1.90
4	97.8%	1.89
4.5	97.5%	1.93
Live weight range		
<55	95.4%	1.57
55 – 59.9	97.4%	1.77
60 – 64.9	98.6%	1.84
65 – 69.9	98.8%	1.91
70 – 74.9	97.6%	1.93
75 – 79.9	99.3%	2.02
>80	98.9%	1.97

THE RAM

HEALTH INSPECTIONS

Active healthy rams are essential for good fertilisation rates, especially for high ewe:ram ratios (100+:1). Inspect your present rams before ram buying to check the number of replacements needed and again eight weeks before mating. A quick examination the day before putting the rams out leaves no time to cure health problems or find replacements.

Ram preparation is important for good mating performance and sperm production which begins eight weeks before mating.

RAM PREPARATION

Eight weeks before mating, check for:

- wounds and flystrike
- genital health problems such as epididymitis, scrotal mange, pizzle rot and penis abnormalities. Isolate any rams with genital problems immediately to reduce the risk of infecting healthy rams. Get your veterinarian to inspect and blood test these rams
- foot problems. Footrot and other lameness may reduce feed intake and hence sperm production, as well as reducing ram mobility during mating. Foot abscess will elevate body temperature and cause infertility for up to two months.

Seek veterinary advice for treatment of genital problems or foot abscess.

Sperm development takes eight weeks, so all sperm present at mating has developed prior to the mating period. Begin good feeding and exercise at least eight weeks pre-mating.

Avoid shearing within eight weeks of mating.

BRUCELLOSIS

Brucellosis is caused by *Brucella ovis* and may be seen as epididymitis in rams. Often undetected, brucellosis reduces ram fertility and hence lambing percentage if enough rams are affected. Brucellosis is mainly considered a ram problem but occasionally causes abortion or small weak lambs if ewes are infected.

Rams should be checked 8-10 weeks before mating for general soundness, genital problems such as epididymitis, scrotal mange or pizzle rot, and feet problems.

Brucellosis is spread through sexual activity between rams and by ewes acting as passive carriers at mating, passing it on when mated by more than one ram.

Vaccination is no longer practised. Buy rams from accredited brucellosis-free flocks and beware of infection introduced by males other than breeding rams — e.g. a neighbour's cryptorchid lambs run with the rams while waiting to be collected. Isolate rams with epididymitis or testicular abnormalities (e.g. hardness or odd sizes) and blood test as soon as possible.

Purchasing rams from brucellosis accredited flocks is advised.

SCROTAL MANGE

Scrotal (chorioptic) mange is a disease which may render rams infertile by raising testicle temperatures. Mange is associated with infestation by the *Chorioptes bovis* mite. Dried exudate appears on the skin, revealing damaged weeping skin when scraped from an active lesion. Many rams carry mites but have no lesions and there is no correlation between mite numbers and the extent of lesions on individual rams.

Rams with small inactive lesions may produce normal semen but rams with extensive lesions have poor quality semen. Check rams carefully and reject any with active or extensive lesions—consider them temporarily unsound, treat and re-examine. Rams with severe active or inactive lesions may be permanently unsound and should be replaced.

The mite may be carried by other animals (e.g. horses, cattle and goats). Consult your veterinarian about a treatment programme if rams have problems with scrotal mange.

SPERM PRODUCTION

TESTICLE SIZE

Sperm production is proportional to the amount of testicular tissue — i.e. rams with larger testes generally produce more sperm. Large testes and high sperm production allow sperm numbers to remain high when rams serve many ewes per day. Testicle size may thus indicate a ram's potential ability to serve large numbers of ewes although sperm quality, ram mobility and libido are also important. This recommendation is for ram breeders only.

Simple practical measurements such as scrotal circumference can be used to estimate testicle weight and hence sperm production to compare rams for likely serving capacity. Generally a scrotal circumference of 30cm or greater is adequate.

Good testicle size, or scrotal circumference of 30cm or greater, is important for high quality sperm and semen production.

SCROTAL TEMPERATURE

The testes must remain cool for best sperm production and survival. This is especially important in the last eight weeks before mating, as fever or stress from any cause may reduce sperm quality and/or quantity. If rams are in full wool it is advisable to shear the scrotum and crutch and in hot areas shade should be available for rams.

Testes must remain cool for best sperm production and survival and this is important eight weeks prior to mating as well as during the mating period.

1. Scrotum
2. Testis
3. Head of epididymis
4. Body of epididymus
5. Tail of epididymus
6. Vas deferens
7. Pampiniform plexus
8. Tunica dartos muscle
9. Cremaster muscle
10. Bladder
11. Ampulla
12. Seminal vesicle
13. Prostate gland
14. Bulbo-urethral gland
15. Urethra
16. Retractor penis muscle
17. Sigmoid flexure
18. Penis
19. Glans penis
20. Urethral process
21. Prepuce
22. Anus
23. Pubis bone

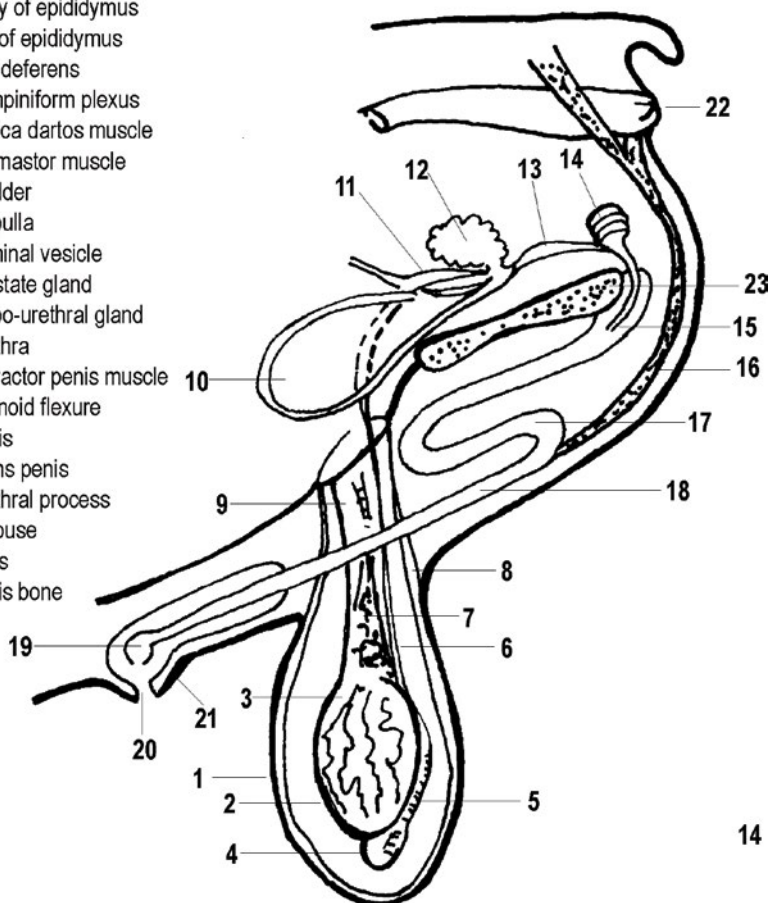


Figure 2.2. Reproductive system of the ram. Sperm are produced by the testes and acquire fertilising capacity in the body of the epididymus after which they reside in the tail of the epididymis. For effective sperm production (spermatogenesis) the testes must be two to three degrees C lower than body temperature.

SEASONALITY

Decreases in semen volume, sperm density and motility have been noted during late spring and early summer (i.e. when seasonal sheep breeds are sexually inactive) with peak values during autumn. In practice these changes are not usually important.

SEMEN QUALITY

Semen quality tests are not warranted with commercial rams. Quality is most likely to be checked with expensive rams used by ram breeders in single sire group mating. Semen collected using electro-ejaculation is suitable for checking sperm motility and morphology but sperm numbers are variable and this is not a good check for density. Samples collected with an artificial vagina are generally more consistent and sperm density tends to be higher.

For ram breeders semen quality can be tested using electro-ejaculation or an artificial vagina followed by inspection for sperm density and motility.

Two or three tests at five day intervals are a better predictor of fertility than a single test. If any factor is unsatisfactory at the first test, repeat testing before rejecting the ram. Sperm volume and density also decline after frequent ejaculation so testing after high levels of sexual activity may give misleading results.

HIGH SERVING CAPACITY RAMS

Identification of high serving capacity rams is best done with a serving capacity test which measures the number of successful services within a given period of time (e.g. two or more ejaculations when confined in a pen with four oestrus ewes for 20 minutes. Testicle size, as mentioned above, indicates likely sperm production and possible serving capacity.

Serving capacity or libido of rams can be tested in pens with ewes in oestrus.

Rams born to prolific ewes, and preferably born as twins or triplets themselves, are more likely to have a high serving capacity than rams born to low fecundity ewes. Rams born as co-twin to another ram are more likely to have a high serving capacity than rams born as co-twin to a ewe lamb.

BEHAVIOUR AND SEXUAL EXPERIENCE

Ram libido and sexual activity vary considerably. Across a range of studies, 27% of the rams used were found to be inactive when first exposed to ewes in oestrus. While most rams improved with further exposure to ewes, some still showed poor performance — e.g. low libido and low ejaculation rates.

Older, experienced rams usually seek out ewes in oestrus whereas inexperienced rams, especially lambs, may not be as efficient at detecting ewes in oestrus and may have lower fertility. Use ram lambs at reduced ratios (e.g. 50 ewes per ram lamb) and mate to older ewes which will look for the ram. Harnesses are useful to show ram lamb activity especially for single-sire mating.

With high ewe:ram ratios of 150+:1 use experienced rams if possible and avoid large paddocks. Ram libido may outlast sperm production so rams may appear to continue mating but prove infertile.

VASECTOMISED RAMS

Vasectomies should be done by a veterinarian.

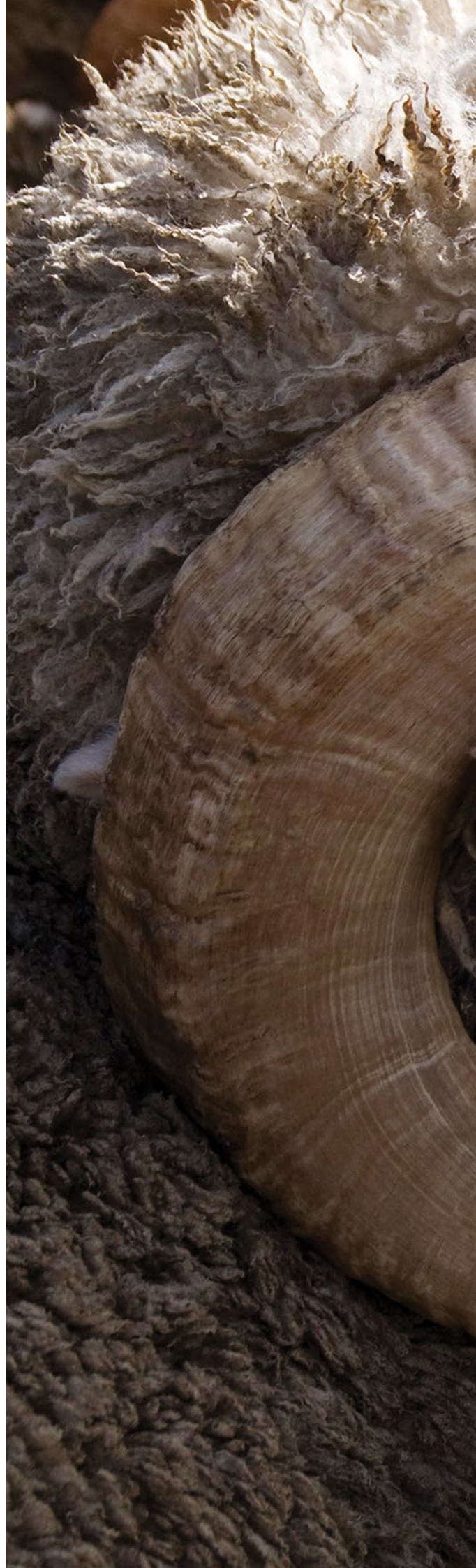
Vasectomies must be done by a veterinarian at least six weeks before use. Vasectomised rams can be used to:

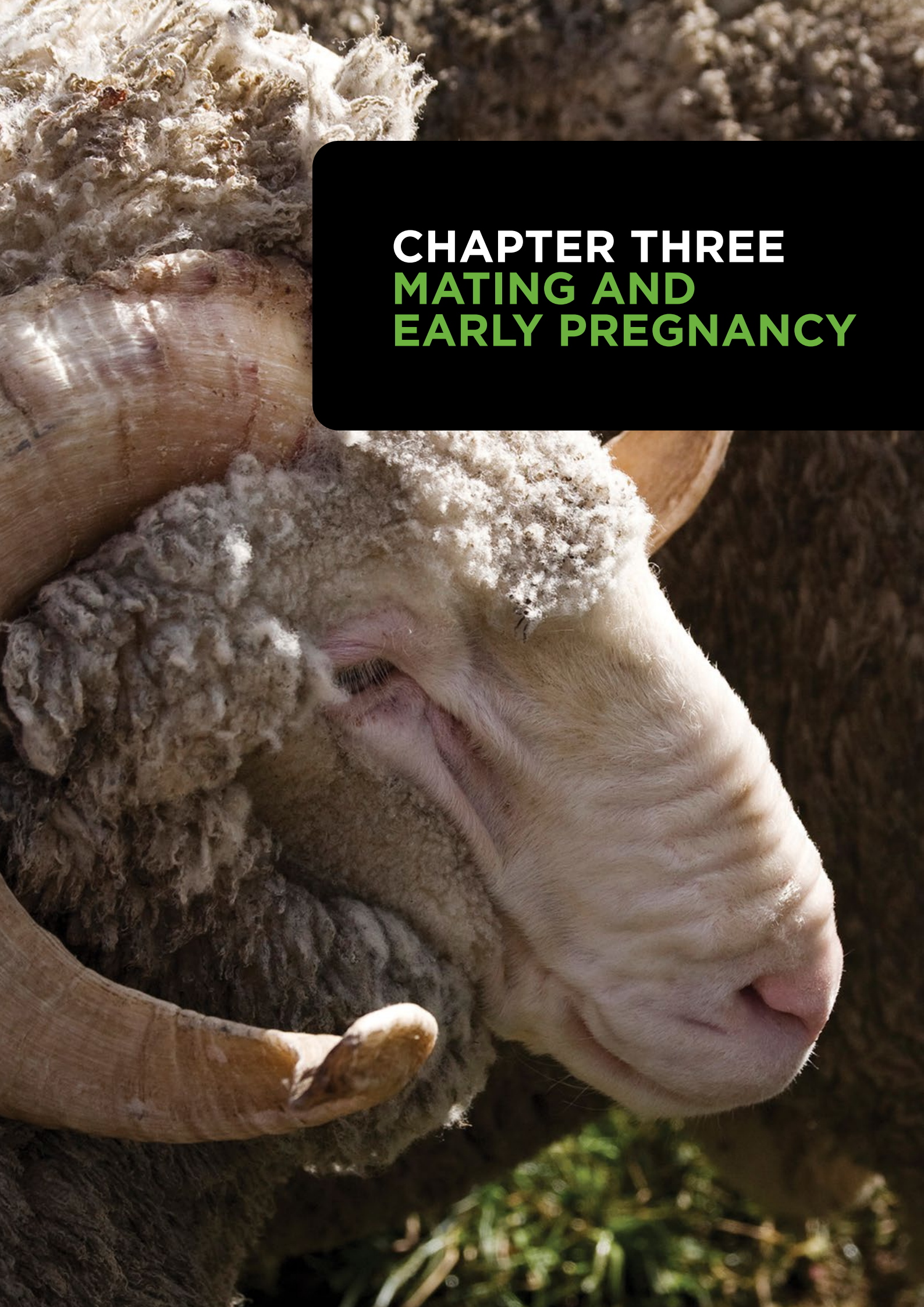
- stimulate ewes to cycle earlier (see “Ram effect” page 35)
- identify ewes in oestrus for AI (see page 30)
- identify non-pregnant ewes after mating, using harnessed vasectomised rams (e.g. 500 ewes to one ram) after breeding rams are removed. This method identifies non-pregnant ewes for early sale well ahead of pregnancy scanning
- stimulate hoggets to cycle earlier
- introduce non-breeding hoggets to the vasectomised ram and get them accustomed to ram behaviour.

Uses of vasectomised rams include stimulation of hoggets or ewes to cycle earlier, identifying ewes in oestrus for AI and identifying non pregnant ewes after mating.

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CHAPTER THREE **MATING AND** **EARLY PREGNANCY**

RECOMMENDATIONS

- Continued high ewe liveweight and condition score during mating means good ovulation rate and potential lambing percentage.
- It is important that ewes not only reach good weight at mating but that they are increasing in live weight during the mating period.
- Minimise stress such as yarding, shearing, sudden feed changes etc. during mating- early pregnancy to avoid upsetting oestrus and to maximise embryo survival.
- Avoid shearing from two weeks before until two weeks after mating.
- Good feeding in early pregnancy is important for early placental development, which in turn boosts lamb birth weight and hence survival, especially of multiples.
- Ewes need 1.0 to 1.3kg of average to good quality dry matter per day to hold body condition score during mating and early pregnancy.
- Hoggets to be mated must be well grown and close to 40kg live weight at mating, which should be one cycle later than the ewe flock.
- Ewes must be removed from pastures containing toxins like zearalenone or phyto-oestrogens well before mating, particularly if diagnosed levels have been high.
- Ewe:ram ratios can be 150+:1 for well prepared ewes and rams but the ratio should be less than 100:1 for ewe and/or ram hoggets.

This chapter covers mating and early pregnancy management to the end of the first third or day 50 of pregnancy. This will include the 35-42 days the rams are with the ewes plus a week or two following mating. Priorities include maximising the number of lambs conceived, minimising embryo mortality and development of the placenta for good lamb birth weight and survival.

Potential lambing percentage is determined during the mating-early pregnancy period by:

- ewe and ram fertility
- ewe ovulation rates
- ewe conception rates
- successful establishment of the embryo.

If potential is low (e.g. due to poor ovulation rate) then good management from mating to tailing cannot rescue the situation but will help lamb survival. If the potential is high, management to maximise lamb survival becomes critical. The implantation period of 12-14 days after fertilisation, when the embryo becomes established in the uterus, is also critical.

THE EWES

Good ewe health and body condition score of at least CS3 at mating is critical in achieving a high pregnancy rate and establishing a pregnancy that is likely to result in healthy lambs at docking.

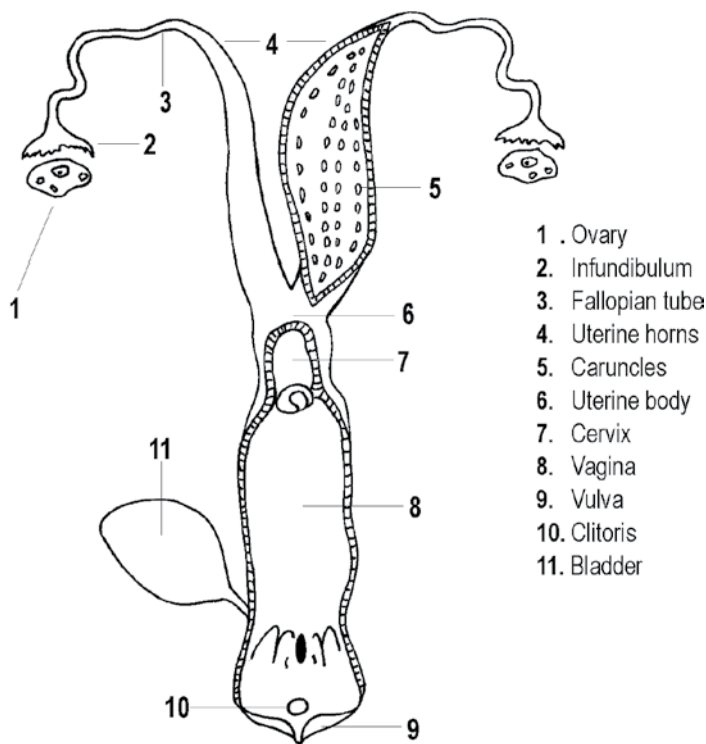
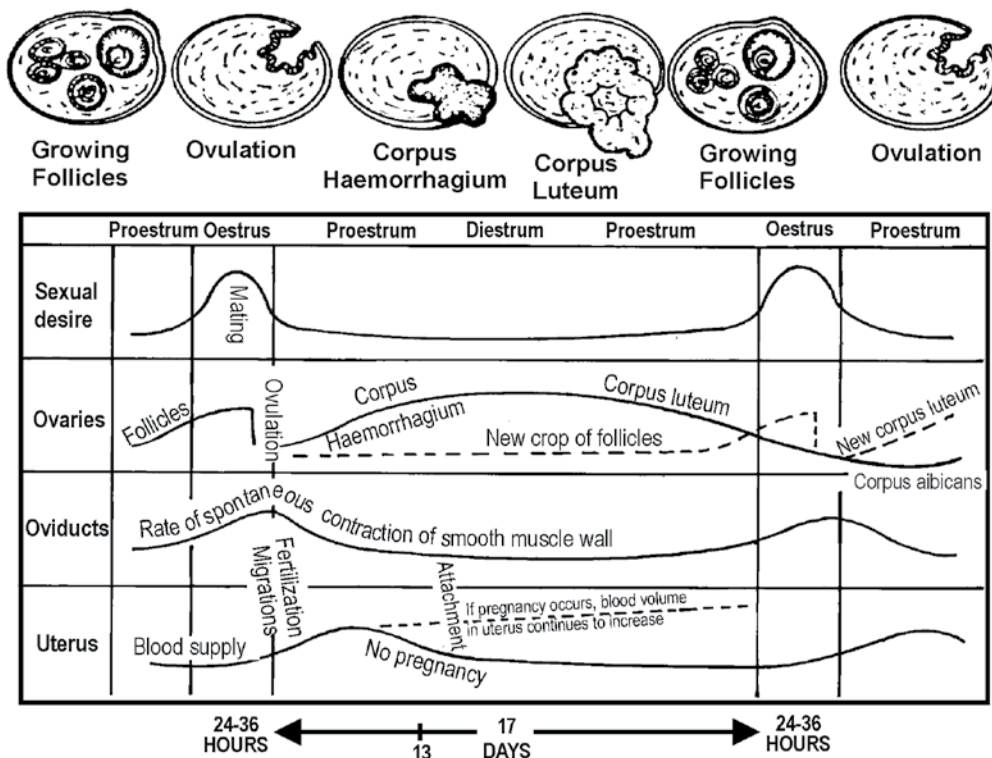


Figure 3.1. Reproductive tract of the ewe showing the ovaries connected to the two uterine horns by the fallopian tubes or oviducts. Eggs from the ovaries are fertilised by ram sperm in the fallopian tube and 12-14 days later implant into the wall of the uterus where as embryos they connect via the placenta to caruncles for transfer of nutrients from the ewe.

Figure 3.2. Physiological and hormonal changes during the oestrus cycle in ewes. Oestrus is brought about by oestrogen from developing follicles on the ovary and progesterone from the corpus luteum. Progesterone priming is essential and the reason for a silent heat at first oestrus is because there is no corpus luteum to produce progesterone. Eggs are released into the funnel of the fallopian tube infundibulum near the end of the oestrus period where they are fertilised and progesterone from the corpus luteum prepares the uterus for implantation. Then oestrus cycling ends and gestation begins.

Physiological Changes of Reproduction in the Ewe



OESTRUS

Oestrus is the period, averaging 24 hours, when ewes will accept ram service.

Oestrus is the period when the ewe will accept service by the ram. Oestrus usually lasts about 24 hours but varies from 4-72 hours depending on ewe age, breed and degree of contact with the ram. The oestrus cycle averages 17 days with a range of 15-18 days. There are no obvious behaviour changes such as those shown by cattle and rams detect ewes in oestrus mainly by odour from pheromones or external hormones. Ewes in oestrus, especially experienced breeders, often seek out the ram and compete for attention.

The average interval between oestrus cycles is 17 days.

EFFECTS OF SHEARING AND COLD STRESS

Shearing often coincides with mating with second shear policies. If ewes are shorn just prior to putting the rams out they may stop cycling for about three weeks. Although ewes still ovulate they may fail to show oestrus behaviour and, therefore will not be mated. This shows as a “gap” in activity at lambing.

Shearing may stop ewes cycling and should be avoided from two weeks before until two weeks after mating.

Avoid shearing from two weeks before mating until two weeks after the end of mating, to prevent suppression of oestrus or lack of embryo implantation.

AGE OF THE EWE

Young ewes such as hoggets and maiden two tooth ewes have shorter oestrus and weaker libido and thus less time in which to mate. They may fail to compete if mated in the same mob as older ewes so should be mated separately.

HOGGET OESTRUS AND HOGGET LAMBING

Puberty is more closely related to hogget weight than age. Hoggets grown rapidly are likely to show first oestrus earlier. Age and liveweight at puberty vary both between and within breeds. Ewes of the more fecund breeds such as Finn crosses tend to reach puberty earlier and at lighter liveweights than less fecund Romney-based breeds. Ewes born and reared as twins may also reach puberty at a similar age to single lambs but up to 3kg lighter.

Ewes which reach puberty early and lamb as hoggets tend to show higher reproductive performance over their lifetime. They have more lambs as two tooth ewes if live weight is maintained than those that did not show hogget oestrus.

Ewe hoggets which show oestrus and/or conceive have a higher lifetime reproductive performance than those which don't.

Ewes which showed hogget oestrus and/or conceived have more lambs and less barrenness in successive years. These effects may result in an additional 7.7 lambs born per 100 ewes mated and accrue to 23 additional lambs per 100 ewes over three lambings.

Hogget lambing is highly effective if they are well grown to reach puberty and well fed throughout pregnancy and lactation to reach acceptable two tooth mating weights. As a general rule hoggets should be close to 40kg live weight at mating and joined with the ram at least one cycle later than ewe mating.

For more detail see the Beef + Lamb New Zealand booklet “Hogget Performance, unlocking the potential”.

EW E OVULATION RATE

High ovulation rate is the obvious first step in achieving high lambing percentages. Table 3.1 demonstrates the expected litter size according to ovulation rate.

A high ovulation rate (OR) is the first step in achieving a high lambing percentage.

Table 3.1. Ovulation rate, resulting litter size and percentage of singles and multiples.

Adapted from Hanrahan, 1982.

Ovulation rate	Litter size of those that lamb	Percentage			
		Singles	Twins	Triplets	Quads
1	1	100			
2	1.7	30	70		
3	2.3	16	44	41	
4	2.7	11	31	39	19

A 10% increase in ovulation rate typically causes:

- 6.9% more lambs born per ewe lambing
- 5.7% more lambs docked per ewe mated.

A 10% increase in OR causes 6.9% more lambs born and 5.7% more lambs tailed.

A 170% lambing percentage would have about 3% of ewes with triplets but increases in lambing above this are mostly due to more triplets and fewer singles. The proportion of triplet and quadruplet litters is likely to exceed 15% when lambing percentage reaches 190%. A lamb drop of 200% may comprise 20% singles, 60% twins and 20% triplets (see Fig 1.4, page 14).

Increases in lambing percentage above 170% are mainly due to more triplets and less singles.

EFFECT OF EWE LIVEWEIGHT

Liveweight has both static and dynamic effects as follows:

The static liveweight effect

Heavy ewes have higher ovulation rates and more lambs than light ewes. Twinning or percentage of twin births to total births increases by about 6% per 4.5kg increase in ewe liveweight—i.e. 1.33% perkg increase. This effect operates up to around 65kg liveweight and there is some evidence of a decline at the top end of this range. Barrenness increases markedly under average weight of 40–45kg for Romney-based breeds and 35–40kg in Merinos.

High ewe live weight and live weight gain during mating causes high OR - for each extra kg of ewe weight there will be 1-2% higher lambing percentage.

Comparisons of poorly-reared and well-reared ewes show that while the poorly reared ewes have fewer multiple ovulations, this is probably a function of their lower adult liveweight.

The dynamic liveweight gain or “flushing” effect

Some trials have shown ewes gaining weight quickly (flushing), e.g. 0.5–1.0kg per week, in the period 3 to 6 weeks before mating had higher ovulation rates than ewes of similar weight with low or no weight gain. However the results outlined in Chapter 2 showed that ovulation rate was more dependent on ewe live weight at oestrus than on changes between weaning and mating.

The response to live weight gain in terms of ovulation rate is greater in lighter ewes than heavier ewes. Therefore if additional feed is limited farmers can choose ewes which are likely to be most responsive.

Underfeeding

Underfeeding just before or during mating reduces ovulation rates due to losing live weight. Moderate under nutrition does not appear to affect other reproductive factors such as incidence of oestrus, mating behaviour or fertilisation rate.

Underfeeding just before and during mating will reduce OR.

EFFECT OF EWE AGE

Ovulation rate generally increases from puberty to peak at about four years old. This level is maintained for several years then declines in old age. Useful breeding life in terms of ovulation rate and overall lambing percentage may last to at least eight or nine years old. Table 3.2 shows that lambing performance

of old ewes is eventually offset by high ewe deaths. Note that “lambing percentage” refers to lambs docked divided by ewes mated, so deaths of the old ewes are accounted for in the lambing percentage figures.

Table 3.2. Mortality and breeding performance of different aged ewes

Adapted from Hickey, 1960.

Ewe age (years)	Cumulative Death rate (%)	Lambing percentage (%)
1.5	3.0	78.2
2.5	4.4	94.4
3.5	6.0	96.8
4.5	8.6	109.2
5.5	12.8	108.6
6.5	18.0	100.4
7.5	25.5	93.6
8.5	37.2	91.8
9.5	52.5	86.6
10.5	75.3	84.2

MAJOR GENES AFFECTING OVULATION RATE

There have been major “fecundity genes” identified in New Zealand such as the Booroola gene (Fec^B) and the Inverdale gene (FecX^I). These are not widely used in commercial flocks.

Booroola gene

The Booroola gene was discovered in prolific Merinos. Each copy of the gene has an additive effect on ovulation rate — e.g., if ewes with no Booroola gene shed 1 egg per ovulation then ewes with one copy (heterozygous) will shed about 2.5 eggs and ewes with two copies of the gene (homozygous) will shed about 4.0 eggs. The extra 1.5 eggs from heterozygous ewes results in an increase in litter size of 1.0.

Major genes affecting OR include the *Booroola* and *Inverdale* and ewes with these genes have higher OR by 1-3 eggs (homozygous Inverdale ewes are infertile).

Inverdale gene

The Inverdale gene was discovered in an Invermay flock selected for prolificacy. It is found on the X-chromosome, so a ram carrying FecX^I passes the gene on to all of his daughters and none of his sons. A ewe with one copy of the gene passes it on to half of her offspring of either sex.

A single copy increases ovulation rate by about 1.0 egg per ovulation and litter size by about 0.6. There appear to be no direct effects on rate of barrenness, embryonic mortality or lamb mortality although both of the latter increase in line with higher litter sizes, as normal.

Homozygous ewes (FecX^I/ FecX^I) are infertile and have small non-functional streak ovaries. Thus careful management practises are required to ensure no ewe lambs are born with two copies. These can be seen with a laparoscope at two months of age. Ram lambs can therefore be progeny tested for the FecX^I gene by mating them to known FecX^I ewes—if they have the gene, half of their daughters will show streak ovaries. The Inverdale gene has potential where ewes are mated to terminal sires.

Since the Booroola and Inverdale were first discovered further reproductive genes have been identified. However these also are not widely utilised in New Zealand.

BREED EFFECTS

Many farmers believe inherently low fecundity in the Merino accounts for low performance on high country. Merino ovulation rates are only slightly lower than for similar size ewes of Romney-based breeds but lambing percentage improves dramatically when Merino ewes are well fed (see variation in pregnancy scanning results for Merinos in Chapter 1).

There is breed variation in average OR with Merinos at the lower end of the scale, crossbreds in the middle and composites highest with potential lambing over 200%.

There has been a proliferation of composite breeds during the late 1990s-early 2000s and they now comprise just under 12% of the ewe flock (see Table 1.1 in Chapter 1). These composites include high fecundity breeds such as the Finn and East Friesian and along with high performing Romneys and Coopworths commonly have pregnancy scanning levels in excess of 200%.

Genetic increases in litter sizes appear to be predominantly due to higher ovulation rates. There is no evidence that selection for increased litter size has increased “uterine efficiency”—i.e. efficiency of producing lambs from the number of eggs shed—either within or between breeds. With most sheep breeds there is greater variation in ovulation rate within breeds than between breeds.

There is large variation in OR within breeds.

Since ovulation rate and reproductive performance are moderately heritable, steady genetic progress can be made. In selected Romney strains up to 2% per year improvement in lambing percentage over long periods has occurred. Selection for increased lambing percentage on commercial farms is usually done by selecting ewe replacements predominantly from twin ewe lambs.

Crossbreeding can be used to introduce high fecundity or fertility genes and will give up to 20% increase in OR in addition to the breed genetic gain.

Crossbreeding can be used to introduce more fecund breeds such as the Finn and East Friesian, introduce special genes such as the Booroola or to increase heterosis (hybrid vigour). Heterosis is extra performance achieved above the expected average of the parent breeds. Heterosis is usually most pronounced in traits that are relatively slow to respond to selection, including several reproductive performance traits, as shown below.

Table 3.3. General estimates of heterosis for reproductive traits.

Adapted from Dalton, 1980.

Trait	Heterosis (percentage response)
Barrenness (hybrids less barren)	18
Lambs born per ewe lambing	19-20
Lambs weaned per ewe joined	60
Lamb survival	10-15
Lamb birth weight	6

LATITUDE EFFECTS

In practice, farmers in the south generally expect about 5–10 more lambs per 100 ewes mated than ewes of similar genetic background and mating liveweight would achieve in the north. These results appear to be related to latitude and there are no practical steps North Island farmers can use to make up the difference. Cooler temperatures in southern regions are thought to help, causing lower plant and animal pest levels and correspondingly better feed quality and animal health.

IMMUNISATION AGAINST HORMONES FOR HIGHER OVULATION RATE

Vaccinating ewes to produce antibodies against some of their own hormones can increase ovulation rates. Commercial products variously available for this have included Androvax™ and Ovastim.

Even though these products have shown increases in ovulation rate of up to 59 eggs per 100 ewes treated and 24% (range 11–56%) increase in lambing percentage, they are not widely used as improvements in feeding and genetics have been favoured. However they can have a role in certain specific circumstances such as well grown ewes with low fertility.

Vaccines which immunise ewes against some of their own hormones can increase OR by up to 59% but are not widely used

Treatment must be given each year and can be combined with other vaccinations. In the first year, two doses are given at eight and four weeks before mating. *If mating is within 2–3 weeks of the second treatment increases in barrenness occur, so timing is very important.* In subsequent years, ewes need only one booster dose four weeks before mating.

Farmers considering use of these vaccines must assess their ability to suddenly rear about 20% more lambs. Most increases in lambing percentage happen more gradually and farmers can adjust management accordingly over several years. These products are not a treatment for low ovulation rates caused by poor ewe feeding. Preferential feeding of the multiple-bearing ewes during pregnancy is still very important in achieving good lamb survival.

Treatments with these vaccines may be useful in improving reproductive performance from ewes lambing out of season. Ovulation rates are usually lower for hormonally induced, out of season breeding but immunisation may lift performance back to more normal levels.

SEASONALITY OF OVULATION AND OVULATION RATE

Most sheep breeds are seasonal breeders and fewer eggs are shed in the first cycles of the breeding season in early autumn. The first cycle of each season usually features a “silent heat”—i.e. ewes ovulate but do not show oestrus. Highest lambing percentage coincides with mating mid-season—i.e. about April, depending on location. Higher numbers of abnormal eggs may be shed near the beginning and end of the breeding season.

Ewe breeding season is normally from early February to late May and usually starts with a ‘silent’ cycle (ovulation without oestrus).

Ewes normally have about 0.15 more eggs shed at each progressive oestrus during successive cycles to the third cycle. Ewes should therefore be mated at their second or third oestrus for maximum lamb numbers.

Each successive ewe oestrus during the breeding season has about 0.15 more eggs shed.

BREED EFFECTS ON SEASONALITY

Breed effects are important in seasonality. For example Dorsets, Dorsers and Merinos are much less seasonal than Romney-based breeds and many are successfully lambed in autumn without hormonal treatment. Selection to develop a flock capable of lambing naturally in autumn using only the “ram effect” can be done by culling those that fail to breed out of season and keeping autumn-born ewe lambs as replacements.

Breeds such as Dorsets and Merinos have longer breeding season than crossbreds.

The Merino has an extended breeding season and in Australia is routinely mated from about October to December. The New Zealand Merino has a slightly longer breeding season than Romney-based breeds.

SYNCHRONISATION

Synchronisation may be used to get ewes ovulating simultaneously, often to facilitate timing of artificial insemination and/or to induce ewes to cycle out of season. The two ways to achieve this are by using rams or by hormonal treatment.

USE OF RAMS (“RAM EFFECT”)

The introduction of rams early in the breeding season stimulates ewes to ovulate within 3–6 days, without showing oestrus if this is the first ovulation of the breeding season. The ewes will naturally show oestrus about 17 days later. Ewe flocks stimulated by the ram effect are thus likely to be synchronised. Rams introduced several weeks before normal onset of oestrus may have no effect and late introduction will only stimulate those few ewes which have not begun cycling.

Synchronisation can be used to get ewes ovulating simultaneously by using hormones or rams.

Rams used for synchronisation may be entire or vasectomised. Some poor results with rams vasectomised for one year or longer have been reported and this may be due to reduced libido in these rams. High libido vasectomised rams are most effective and should be introduced up to a week before normal if using teasers to stimulate ovulation and oestrus.

Rams introduced early in the breeding season, either vasectomised or entire, will stimulate ewes to be more receptive to rams 18–21 days later.

Some breeds are more effective, with Dorset rams usually superior to Romneys.

HORMONAL SYNCHRONISATION

Hormonal synchronisation can be used to:

- stimulate first oestrus (e.g. first oestrus in hoggets or an early first oestrus for older ewes)
- synchronise ewes to show oestrus at the same time (e.g. to condense lambing or for artificial insemination) during the normal breeding season.

Use of hormones involves CIDRs or sponges with progestagens inserted into the vagina so ewes will ovulate after withdrawal.

“Controlled internal drug releasers” (CIDRs) or sponges containing progestagens (synthetic analogues of progesterone) are most commonly used. Results are more heavily influenced by operator skill and timing of insemination than product type. The CIDR or sponge is inserted in the vagina and withdrawn after several days (11–14 days). The ewe typically shows oestrus within two to three days after withdrawal when CIDRs are used within the normal breeding season. This time varies depending on dose level of progestagen, type of device or sponge used and whether pregnant mare’s serum gonadotropin (PMSG) is also used to assist with synchronisation and/or to stimulate greater ovulation rate. Ewes not fertilised at this oestrus will return to oestrus about 16–17 days later and remain generally synchronised. This is useful when planning a return visit for an AI technician.

Synchronisation for out of season breeding usually requires PMSG and this can also stimulate ovulation rate.

Prostaglandin injections can also be used for synchronisation but are not common.

Ask your vet about synchronisation or hormonally induced oestrus if you are planning to use it for the first time.

OUT OF SEASON MATING

Slightly earlier breeding can be achieved using the “ram effect” but farmers lambing ewes out of season generally use CIDRs and PMSG. Melatonin implants have been successful in stimulating lambing performance out of season. Good management is essential to ensure ewes are in oestrus with high ovulation rates and thus good potential lambing percentage. Even then ewes lambing out of season do not usually achieve lambing percentages comparable to those during their normal breeding season.

INTERNAL PARASITES

Internal parasites or worms are not usually a problem in ewes at mating and drenching is not generally recommended. However, it is important to establish that internal parasites are not limiting ewe weight gains pre mating, particularly in young ewes. Check worm burdens by faecal egg counting at least four weeks before mating in consultation with your veterinarian or consultant.

Worms are not normally a problem with ewes at mating time but checking faecal egg counts prior to mating, particularly with young ewes, may be warranted.

TRACE ELEMENTS

Various trace elements may cause problems during mating in different regions. Check with your veterinarian or consultant for a guide to likely local deficiencies and suitable products for overcoming these. Selenium and iodine are presented here as examples.

SELENIUM

Selenium-responsive infertility is likely in areas where congenital white muscle disease occurs. Conception rates may be normal but high embryonic loss to approximately day 30 of pregnancy occurs if ewe blood selenium level is below 10 mg/ml. These losses will manifest as dry ewes at pregnancy scanning. Such embryonic losses are prevented by treating ewes with selenium before mating.

Check with your veterinarian or consultant before supplementing with selenium. Supplementation has no benefits if levels are adequate and excessive selenium is toxic.

Selenium should be routinely administered pre mating in deficient areas.

IODINE

Iodine deficiency of ewes, especially at sub-clinical levels, has been suggested as a widespread reason for reduced reproductive performance mainly due to poorer lamb survival. Table 3.4 shows lambing percentage responses to a single injection of Lipiodol® (now known as Flexidine) at least six weeks before mating or in mid pregnancy.

Responses to iodine varied. Wairarapa ewes treated three weeks pre-mating showed elevated thyroxine levels but no advantage over the control flock for lambing performance, lamb growth rate or ewe fleece production. Iodine may not have been limiting in the Wairarapa ewes.

Iodine deficiency can suppress lambing percentage so levels should be checked.

These results demonstrate the need to establish the existence of a deficiency before expecting treatment to show benefits. Blood testing is generally reliable for important trace elements such as selenium but elevated lamb thyroid gland weights are the best indicator of iodine deficiency. A lamb thyroid gland weight to lamb weight ratio of 0.40 or greater indicates iodine deficiency.

Table 3.4. Changes in lambing performance for ewes treated with Lipiodol®.

McGowan, 1983.

Locality	Treatment timing	No. ewes treated	Improvement in % of lambs	
			born	docked/weaned
Sth Auckland	pre-mate	278	not recorded	9
Wairarapa	pre-mate	100	18	8
Sth Canterbury	pre-mate	159	10	10
Manawatu	mid pregnancy	115	5	4
Sth Canty Yr 1	mid pregnancy	213	0	not recorded
Yr 2		149	17	21
Yr 3		69	20	23

TOXINS

FACIAL ECZEMA

Facial eczema (FE) disease is caused by ingesting the fungus *Pithomyces chartarum*. Spores of *P. chartarum* contain a toxic compound, sporidesmin, which causes liver damage, sensitivity to sunlight and decreased animal performance. FE commonly occurs in late summer/autumn in warm humid regions of the North Island. The incidence generally drops further south and FE is virtually unknown in most parts of the South Island.

Ewes exposed to high pasture spore counts at Whatawhata Research Station showed 2–3% more barrenness and 5–7% fewer multiple births for every 100 i.u. increase in serum GGT levels. (GGT is an enzyme which indicates liver damage, as caused by facial eczema.) Up to 17% of the flock either died from clinical FE, were barren or were culled.

Facial eczema (FE) caused by a pasture fungus can suppress lambing percentage through increased barrenness and fewer multiples.

Early exposure to FE may penalise lifetime performance due to permanent liver damage. Hoggets with high GGT levels (>350 i.u./l) subsequently showed lower fertility (i.e. number of ewes lambing/number of ewes mated) at all matings over the next four seasons compared with hoggets with lower GGT levels but the effect was only statistically significant at hogget and two tooth mating.

Management options to reduce FE effects include:

- spore counting to identify safer parts of the farm. Spore counts may be lower on southerly facing slopes and on some pasture types
- lax grazing if ewes must graze pastures with high spore counts
- planning grazing management to allow crops and safer parts of the farm available to ewes around mating
- zinc dosing if pasture spore counts are high on grazed pasture
- fungicide spraying of pastures on easy country
- long term breeding for resistance to FE and use of FE tested rams on commercial farms.

Effects of FE can be minimised by preventive grazing management, zinc dosing or breeding for resistance.

Breeding for FE resistance

Some stud breeders who supply rams to FE-affected areas are breeding for resistance. Ram lambs are dosed with sporidesmin and blood GGT levels are measured to indicate severity of liver damage and thus resistance or susceptibility to FE. Resistance is quite highly heritable so progress can be rapid with selection. Some stud breeders resist testing ram lambs because liveweight gain can be affected and susceptible ram lambs may be unsaleable.

ZEARALENONE

Zearalenone is a toxin produced by a range of *Fusarium* fungi in pasture. Its effects are similar to oestrogen, reducing ewe fertility and fecundity. Rams appear not to be affected. *Fusaria* and the zearalenone toxin occur throughout New Zealand.

Fusaria generally grow on dead material in pasture rather than on green leaf. Growth is greatest in late summer and autumn, with spore formation under warm dry conditions. Zearalenone level does not always follow the pattern of spore production in the pasture so spore counting as done for FE is not helpful. High zearalenone levels occur under a wide range of weather conditions and “problem times” are hard to predict.

The toxin zearalenone from a pasture fungus can reduce ewe fertility and fecundity.

Intake of zearalenone before mating affects oestrus behaviour through decreased cycle length, increased oestrus duration, and decreases ovulation and fertilisation rates. The number of barren ewes increases and fewer ewes have multiples. Zearalenone exposure after mating does not appear to affect pregnancy rate or embryonic loss.

Ovulation rate (and lambing percentage) falls by about 5% for every mg of zearalenone ingested per day for short term exposures and about twice this rate if exposure is prolonged. Thus the minimum toxic dose for short exposure (10–15 days) is very low at about 1 mg per day and even lower for exposure over 20 days.

Suspect zearalenone effects if lambing performance appears inconsistent with ewe mating weights and no other obvious problems such as ram infertility, abortion etc. can be found. Pasture zearalenone levels can be measured and related to reproductive performance, as can metabolites in ewe blood and urine.

Tests for zearalenone levels, which can suppress lambing %, are best done using ewe urine samples.

Pasture tests can indicate zearalenone presence but sheep urine testing provides the best indicator as urine zearalenol (a metabolite of zearalenone) increases with zearalenone intake. Urine samples should be collected from 12–15 ewes and bulked together with an equal quantity from each ewe (0.5 to 1 ml) for a single test. Blood zearalenol levels are poorly related to zearalenone intake and are not helpful.

Testing is done by AgResearch at Ruakura and should be in conjunction with a veterinarian or consultant for instructions.

There is no treatment or vaccination against zearalenone effects and resistance to FE does not confer resistance to zearalenone. If there are some ewes that perform well in spite of exposure to zearalenone, there may be scope to select for genetic resistance to zearalenone.

PHYTO-OESTROGENS

Some pasture legumes such as red clover, subterranean clover and lucerne contain compounds that mimic natural oestrogen. Levels of these compounds rise if plants are damaged by insect pests. A few plants in mixed pastures do not cause problems but grazing pure stands can decrease ovulation rate. Ewes flushed on oestrogenic lucerne have shown a decline in ovulation rate of up to 30% compared with similar weight ewes on grass dominant pasture. New non-oestrogenic red clovers are available.

Phyto-oestrogens produced by plants such as red clover, subterranean clover and lucerne can decrease ovulation rate by up to 30%.

Conservation as hay reduces the oestrogenic effect but does not remove it entirely. Lucerne silage may be more potent than the plants from which it was made.

The effects of short term exposure are temporary and can be overcome by grazing ewes on non-oestrogenic pastures for 14 days before mating. Effects of four weeks grazing of oestrogenic red clover may be overcome within as little as one week on non-oestrogenic pasture. Temporary effects of lucerne grazing can be overcome by a short period of 7–14 days grass feeding before mating.

However, long term exposure to high concentrations of oestrogenic pastures can lead to permanent infertility. Compared with ewes grazing ryegrass-white clover swards, those grazing pasture with 60+% red clover for 6 months before mating showed:

- small non significant depressions in ovulation rate although the ewes on red clover were 3–6kg heavier
- similar proportions of ewes marked by rams in the first cycle

- 30% more returns to service
- more barren ewes (up to 62% barren, typically 34–48%). Ewes on 30% red clover also showed higher barrenness (7–17% barren) than those on ryegrass-white clover (5–9%)
- 0.5 fewer lambs born per ewe mated
- more vaginal prolapse (bearings)
- 82% more deaths over the six year study.

Ewes still ovulate and show oestrus but do not conceive. This is thought to be caused by changes in cervical mucus impeding sperm passage and preventing fertilisation. Ewes exposed to red clover long-term also show vaginal abnormalities.

Pure stands of oestrogenic plants should be avoided at mating time.

There is no treatment or vaccine to prevent the effects of phyto-oestrogenic compounds so, although they are high quality feeds, red clover and lucerne may be unsuitable around mating. Given the risks of permanent infertility, it is best to avoid oestrogenic pastures for breeding females, including ewe lambs and hoggets, as much as possible.

ENDOPHYTE

Ryegrass endophyte is a seed-borne fungus found in some perennial ryegrass cultivars. While endophyte confers plant resistance to Argentine stem weevil, high levels can lead to ryegrass staggers in stock. There is now variation in the level and type of endophyte in ryegrass cultivars. Thus farmers have some scope to control the level of exposure their ewes get to this toxin through the choice of ryegrass seed purchased.

High ryegrass endophyte pastures can suppress lambing percentage so should not be used around mating time.

Staggers may disrupt mating activity and hence reduce conception rates. High endophyte ryegrass pastures should be avoided and alternative pasture species or supplements used at mating. If high endophyte pasture cannot be avoided they should be grazed lightly.

Farmers in areas with minimal Argentine stem weevil should not include high endophyte ryegrass in pasture seed mixes.

THE RAM

USING HARNESSSES

Ram harnesses are useful to:

- prove ram activity (especially in single-sire mating)
- identify ewes returning to service
- indicate expected lambing dates and spread of lambing
- Help with prioritising feeding requirements in late pregnancy.

Frequency of crayon colour change depends on the reason for using harnesses but changes every 7–10 days are most useful to indicate lambing dates. Introducing harnesses after 17 days of mating avoids marking the ewes that conceive in the first cycle, reducing the amount of wool marked by crayon.

Ram harnesses can be used to identify the timing of ewes mated and expected spread of lambing.

Well-fitted harnesses do not interfere with ability to mate or reduce ram effectiveness. Check harnessed rams daily, especially in rougher scrubby paddocks.

FEED SUPPLEMENTS

Rams often lose considerable weight over mating, especially at high ewe:ram ratios and if feed is limited. Rams may also lose up to 20% of their testicular volume during mating. Since sperm output per unit weight of testis is relatively constant, it tends to decline over mating. Changes in testicular volume occur faster than changes in liveweight and body condition.

High protein feed supplements can be used for preparation of rams for mating if high quality pasture is limited.

High quality feed supplements for rams before mating can improve testicular volume. Peas, lupins or other high quality and high protein supplements are suitable. Supplementary feeding of rams is uncommon in New Zealand but may be worthwhile with high ewe:ram ratios.

EWES:RAM RATIOS

Most farmers mate at least 100 ewes per ram to make maximum use of the genetic gain from each ram. As the number of ewes per ram increases, the total number of mounts and services per ram increases but

the number of services per ewe declines. However, even at ratios of 210 ewes per ram, the proportion of ewes mated in each cycle is unchanged, so long as the rams are in good body condition with good testis size.

Ram fighting increases considerably at less than 30 ewes per ram. At more than 100 ewes per ram, ewes may compete for rams with jostling and pushing which disrupts services. Rams have been observed to mate more than 300 ewes in a cycle when mated at ratios of 210 ewes per ram.

Ewe to ram ratios of 150+:1 can be used with mixed age ewes and rams in good condition.

However, as the number of services and mounts per ewe falls, flock fertility may decline. Losses of fertilised eggs appear to be higher in ewes served once compared with those served twice or more.

These effects are unlikely to be important in typical flocks mated at 100–150:1 but could become limiting with very high ewe ratios (e.g. 400:1). However, high ratios (e.g. 200–300:1), for at least one cycle of mating, remain an efficient way of using rams and of getting good value from expensive rams without artificial insemination.

Choose appropriate ratios according to ewe and ram age—e.g., 100:1 for ewe hoggets, 150:1 for older ewes. Higher ratios are not as big a problem where teams of rams are used. Using smaller mating paddocks enhances ewe-ram contact. Do not mate ewe hoggets in the same mob as older ewes.

Ewe to ram ratios should be 100:1 or less with ewe or ram hoggets.

ARTIFICIAL INSEMINATION

The use of artificial insemination (AI) in sheep has gradually increased. Initially AI was used in ram breeding flocks to introduce high value rams and for sire referencing, but now it has spread to commercial flocks. AI is now used to introduce new breeds before rams are widely available.

Originally artificial insemination was used mainly in ram breeding flocks and more recently in commercial flocks for introduction of new breeds.

Conception rates are usually lower than for natural mating with 65–70% regarded as a reasonable commercial result and over 75% excellent.

Conception rates of 65-70% are regarded as good and are higher for intra-uterine (laparoscopic) than cervical inseminations.

Success is influenced by factors such as:

- **identification of ovulating ewes**
Failure to correctly identify ewes in oestrus for good timing of insemination reduces conception rate. Cycling ewes can be identified using harnessed vasectomised rams.
- **cervical insemination versus intra-uterine insemination**
Intra-uterine insemination with thawed frozen semen gives conception rates about 10 percentage points higher than for cervical with fresh semen—e.g. operators might guarantee non-return rates or conception rates of 60% and 50% for intra-uterine and cervical insemination respectively. Cervical insemination needs to be well timed in relation to ovulation whereas intra-uterine is more flexible. Farmers can be trained for cervical insemination, but only a veterinarian can carry out intra-uterine insemination.
- **frozen versus fresh semen**
Fresh semen must be used within 24 hours and frozen semen is preferable if this cannot be guaranteed. Freezing is common and the technology is well developed, but it is only suitable for intra-uterine insemination.
- **technician skill**
There is no substitute for skill and cost-cutting may lead to poor results. Skilled operators are becoming more common and farmers using AI for the first time should ask their veterinarian to recommend a technician.

Either fresh or frozen semen can be used successfully by a skilled operator.

CONCEPTION FAILURE

Conception failures are seen as “dry-dry” ewes. Such ewes should generally be culled although dry-dry hoggets and sometimes two toothies are kept.

FAILURE TO MATE

The number of commercial ewes which fail to mate is generally low. Over three cycles of mating, typically 0-3% of ewes fail to mate and this is higher if ewes are synchronised or mated out of season. Most failures are overcome by being mated at the next cycle.

Failure to mate can include up to 3% of ewes and can be minimised by high ewe live weight and condition, good ram preparation and appropriate ewe:ram ratios.

Important factors in minimising failures to mate are:

- adequate ewe liveweights
- healthy active rams
- ewes not isolated from rams by paddock topography or size, bush or scrub, ridges, deep gullies, partially removed fencelines
- good availability of feed—when feed is scarce the flock disperses to search for feed, decreasing the number of ewe:ram contacts
- lower ewe:ram ratios with young ewes
- enough rams to cope with synchronised ewes if necessary.

Heavy rain can interrupt mating behaviour for one to two days but there is little farmers can do about this.

FERTILISATION FAILURE

Failure of fertilisation measured by returns to service has been around 0-15% in individual experimental flocks and a maximum of 5-20%. When ewes shed two or more eggs, usually all or none are fertilised rather than a proportion.

Most fertilisation failures are overcome by returns to service as most ewes have a second or even third opportunity to conceive in any mating period. However, this may not occur in flocks mated late in the season where many ewes may not be first mated until their last cycle for the season.

Fertilisation failure can be due to poor ram preparation and/or stresses during mating such as excessive yarding, shearing or flystrike.

Fertilisation failures are higher for single-sire mating, artificial insemination, when ewes are synchronised and when mating out of season. Ram harnesses are useful to indicate returns to service in single-sire mated flocks where fertilisation failures may lead to low or nil lambing percentages. A ram with high returns can be replaced before it is too late.

Failures should not be a problem if:

- rams are healthy, in good condition and brucellosis free
- several rams are used in each flock so ewes are mated by two or more rams
- Stresses such as yarding, shearing or flystrike are minimised.

EMBRYONIC AND PLACENTAL DEVELOPMENT

In early pregnancy the embryo implants into the lining of the uterus and the placenta begins to develop. During implantation, 12-14 days after fertilisation, embryos are vulnerable and some or all of multiple conceptions may be lost.

Development of the placenta is very important as it affects lamb birth weight. Small lambs are especially susceptible to starvation/exposure soon after birth while very large lambs may cause dystocia. See chapter 5 for more discussion about the importance of lamb birth weight and implications for lamb survival.

EMBRYONIC LOSS

Embryo death in early pregnancy is a major contributor to reproductive wastage with typically 20-30% of fertilised eggs lost. Most concern is on “partial failure of multiple ovulations” or the loss of one or more embryos from several fertilised eggs. Multiples are more likely to be lost and birth weights of surviving lambs are often lower when sibling embryos have been lost. Embryonic loss is higher in hoggets than two toothed or older ewes, although it may also be high in ewes over 8 years old.

Embryonic losses in early pregnancy commonly reach 20-30% of fertilised eggs and most losses are in multiple ovulations.

Suggested causes of embryonic loss include:

- Chromosomal abnormality. The death of lambs with severe chromosomal abnormalities is desirable in many cases, as such lambs carried to term would die at birth or soon after.
- Selenium deficiency
- Severe underfeeding of ewes
- Stress such as shearing in bad weather. It appears that stress must be frequent or severe to have large effects but minor stresses such as yarding and handling should still be kept to a minimum.
- There is good evidence from pregnancy scanning studies that vaccinating for Campylobacter & Toxoplasmosis can reduce embryonic or early pregnancy losses from these diseases. Serological studies have found that Toxoplasma has been present on 100% of farms surveyed and Campylobacter about 85%.
- Disease such as Hairy Shaker disease increases embryonic and later foetal loss but is probably under-diagnosed. Other unidentified disease agents may have similar effects. There are no treatments for these
- Extreme high temperatures which are unlikely to be a problem in New Zealand.

Causes of embryonic loss include genetic abnormality, diseases such as Hairy Shaker, mineral deficiencies or hormonal imbalances.

There is very little farmers can do to reduce embryonic losses apart from feeding ewes well and minimising handling and stress during mating-early pregnancy, plus ensuring ewes are vaccinated against Toxoplasma & Campylobacter infections..

Little can be done by farmers to significantly reduce embryonic losses apart from minimising stress around mating.

ewe NUTRITION AND PLACENTAL DEVELOPMENT

Placental development is strongly linked to lamb birth weight. Underfeeding can reduce cotyledon numbers and development, thus reducing the transfer of nutrients from the ewe to the lamb and causing lower lamb birth weights.

Placental development between days 30 and 90 of pregnancy is linked to lamb birth weight.

The major factors affecting foetal growth are ewe nutrition and the size of the placenta. Ewes should be fed to maintain good mating body condition in early pregnancy to ensure adequate early placental development.

These effects extend into mid pregnancy (see Chapter 4). If ewes lose about 5kg in the first 90 days of pregnancy placental development and multiple lamb birth weights will be reduced. Ewes losing more than 12% of their mating liveweight up to day 90 of pregnancy may have up to 10% lower lamb birth weights, regardless of late pregnancy nutrition.

Loss of 5kg or more of ewe live weight during early-mid pregnancy will reduce placental development and lamb birth weight causing poorer survival of multiples.

Work from Massey University showed placental weight increased in a near linear way with improved nutrition to day 100 of pregnancy. After feeding ewes at either 0.5 X maintenance (0.5M), 1.0M or 1.5M, placental weight at day 100 was 670g, 718g and 861g, respectively.

UNDERNUTRITION

Very poor nutrition in early pregnancy has been shown to reduce the number of ewes lambing by the Merino breed, which is likely caused by embryonic loss. Serious losses may appear when liveweights at mid pregnancy are 15% lower than mating weight. Moderately poor nutrition may not effect the number of lambs born.

There is evidence that where low lamb numbers are conceived but most ewes are pregnant (i.e. the flock is fertile but almost all ewes have singles), moderately restricted feeding in early pregnancy does not greatly affect survival and lambing percentage. The losses of single embryos probably do not occur and any restriction in placental development still results in a sufficiently large lamb.

Ewes need 1.0-1.3kg of average to good quality dry matter per day to hold body condition during mating and early pregnancy.

Poor ewe nutrition in early pregnancy may, however, reduce lamb growth from birth to weaning. This effect disappears by about 18 weeks of age but may be important for farmers wishing to grow lambs quickly for slaughter at weaning. Poor nutrition in later pregnancy will further reduce early lamb growth due to restricted udder development and lower milk supply.

Feeding to maintain ewe weight and condition from mating through mid pregnancy encourages good placental development and ensures viable pregnancies become well established, as described earlier. Avoid abrupt changes in feeding level.

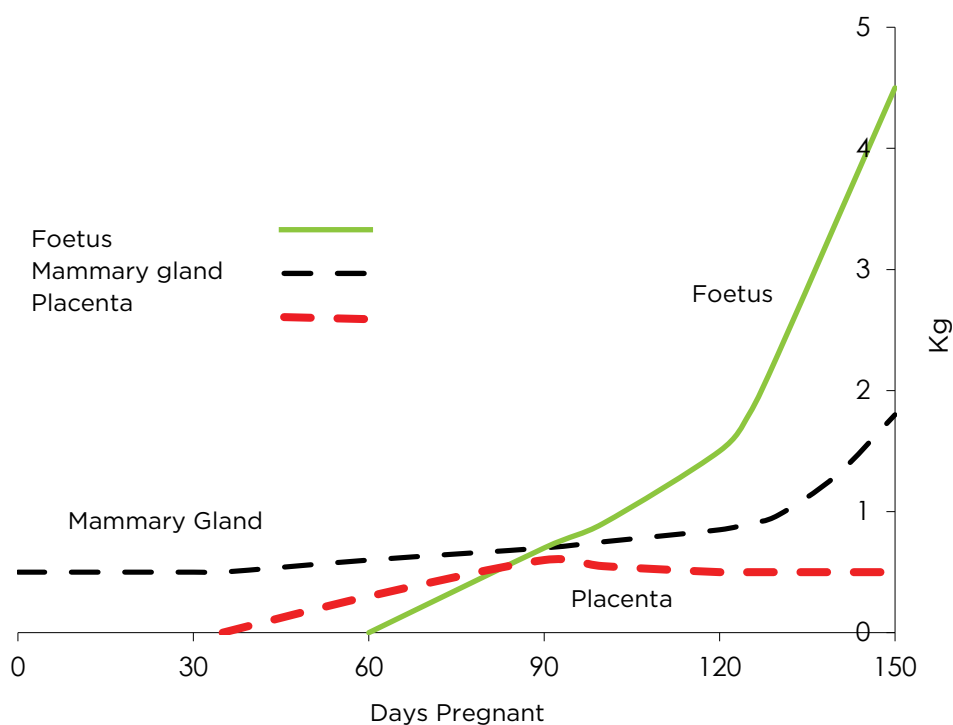
STRESS

Environmental stresses and cold weather can reduce embryo survival. Repeated stress, such as yarding and handling increases embryonic loss through partial or complete loss of embryos. Stressed ewes may lose up to about 30% of potential embryos compared with 17% for non-stressed ewes.

Commercial farmers usually handle ewes infrequently over this period and may expect smaller losses. However, it is worth keeping stress to a minimum by avoiding shearing and excessive handling in the first month of pregnancy.

Figure 3.3: Schematic diagram showing the increase in weight of the foetus, placenta and mammary gland during regnancy.

Source: D. Revell.



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CHAPTER FOUR

MID TO LATE PREGNANCY



RECOMMENDATIONS

- Feed ewes well in mid pregnancy to ensure good lamb birth weight for multiples.
- Separate single- and multiple-bearing ewes as soon as possible after pregnancy scanning and preferentially feed multiples to hold ewe condition throughout pregnancy. (Note: If the residual pasture mass after grazing is more than 800kg DM/ha, there is no benefit in grazing multiple-bearing ewes separately in mid-pregnancy.)
- It is important to feed ewes, especially multiple bearing, well during the last six weeks of pregnancy to minimise ewe body condition loss. This minimises the risk of ewe metabolic disorders and helps with good colostrum and subsequent milk production.
- Ewes in light to average body condition at mating should be fed to maintain condition through mid pregnancy. Very fat ewes may benefit from a slight restriction in feeding in mid pregnancy but few commercial ewes are likely to be in such condition.
- Avoid under feeding in late pregnancy which restricts udder development and subsequent milk production.
- Vaccinate ewes at least two weeks pre-lambing to avoid clostridial diseases.
- Treat trace element deficiencies as directed by a consultant or veterinarian to ensure adequate levels in newborn lambs.

Management during the second and third 50 days of pregnancy, from day 51 to lambing, is important to minimise ewe health problems in pregnancy and prepare for good lamb survival and ewe milk production.

By mid-pregnancy the foetal lamb is well established. Lamb birth weight can still be influenced by mid-pregnancy under nutrition and maintaining ewe condition is a priority for late pregnancy, particularly in ewes with multiples. Good feeding throughout pregnancy feeding also encourages good udder development and onset of colostrum production at lambing and high potential levels of milk subsequently.

PREGNANCY SCANNING

Ultrasound scanning is the only practical and reliable method of determining the number of fetuses carried by ewes. It is increasingly common and is practised on all New Zealand breeds (see farm scanning survey in Chapter Two). Scanning information allows farmers to:

- identify non-pregnant ewes and cull these if not already identified with vasectomised rams
- identify ewes carrying multiple lambs to preferentially feed these accordingly in pregnancy and lactation. Good feeding of multiples during lactation helps ewes wean a heavier weight of lamb and increases their chances of having multiples the next season
- split ewes into early, mid and late lambing groups
- plan lambing paddocks for single- and multiple-bearing ewes—e.g., allocating areas with better shelter and more pasture cover for multiple-bearing ewes if few suitable paddocks are available

- compare scanning percentage with expected percentage based on ewe liveweight at mating
- quantify lamb losses between scanning and birth or tailing
- knowledge of which paddocks have multiple born lambs in them can help improve selection decisions for replacements.

Pregnancy scanning information, obtained between days 60 and 90 of pregnancy, allows farmers to identify empty ewes and those with single or multiple pregnancies.

Not all farmers find scanning necessary. For example, at lambing percentages over about 160% farmers may prefer to treat all ewes as carrying multiples. Under 110% farmers accept almost all ewes carry singles. Some farmers with previous percentages of 110% or less have seen immediate performance gains from scanning through better understanding of the percentage conceived, leading to better treatment of multiple-bearing ewes and increased lamb survival.

Scanning results give farmers a measure of their potential lambing percentage and losses between scanning and tailing.

Scanning operators can gather important information on district performance, such as average scanned percentages and proportions of non-pregnant ewes. Farmers can find out how their performance ranks and

whether there are unusual results within their flock. An additional benefit can be provision of information including stage of foetal development and expected spread of lambing. Suggested three way splits of ewe lambing mobs are the first 10 days, second 10 days and all remaining.

An additional benefit from scanning can be separation of ewes into early (first 10 days), mid (second 10 days) and late (all remaining) lambing groups.

Scanning to identify multiples is most reliable when done up to 95 days after mating started and no more than 45 days after the rams were removed. Late scanning makes multiples harder to see as big lambs may “hide” another lamb.

If ewes with triplets can be identified at scanning, recent evidence suggests they should be managed separately and preferentially fed.

An important benefit from scanning is separation of ewes with multiples from those with singles for preferential feeding and lambing management.

It is also a good idea to weigh and condition score at least a proportion of ewes at pregnancy scanning to review targets for the rest of pregnancy.

At pregnancy scanning, review live weight and condition score targets for the remainder of pregnancy

Feeding recommendations for the second half of pregnancy based on scanning include:

- Maintain body condition in both single and multiple-bearing ewes. This means no more loss of conceptus free live weight than 3-5kg between mating and lambing (i.e. one condition score) i.e. allowing for weight of lamb(s), placenta and body fluids (see Appendix 5 for weight of conceptus)
- If feed is limited, restrict single-bearing ewes before multiple-bearing ewes. Avoid limiting feed to multiple-bearing ewes if at all possible.
- If feed is not limited and residual pasture is 800kg DM/ha or greater there is no benefit in separating twin bearing ewes from singles.

EWES FEEDING AND LAMB BIRTH WEIGHT

The major factors affecting foetal growth and lamb birth weight are ewe nutrition and the size of the placenta — and these act simultaneously. Placental development to day 90 of pregnancy (see chapter 2) has the greatest effect on lamb birth weight.

Feeding in mid pregnancy to maintain good body weight and condition will promote good placental growth and satisfactory lamb birth weights and survival with multiples.

Live weight gain in the ewe can have a positive influence on the birth weight of lambs. This influence can result in improved survival of multiple born lambs by moving these otherwise light weight lambs into a higher lamb live weight survival bracket.

Interactions between ewe condition and responses to feeding level are part of the problem in establishing the existence or otherwise of a relationship between pregnancy feeding and lamb birth weight.

Table 4.1. Litter size of Greyface ewes in high body condition at mating and given high, medium or low feeding in mid pregnancy.

From: Gunn et al., 1986.

	Mid pregnancy feeding level		
	High	Medium	Low
Litter size (lambs born per ewe lambing)	1.69	2.04	1.95

UNDERFEEDING IN MID PREGNANCY

Ewe liveweight at mating and plane of nutrition in mid pregnancy interact. Studies indicate poor nutrition in mid pregnancy (day 30-90 of pregnancy) *increased* placental weight in single-bearing ewes which were heavy at mating but *depressed* placental weight in ewes which were light at mating. Conversely, a high plane of nutrition increased placental weight in ewes which were light at mating but decreased placental weight in ewes which were heavy at mating.

In both heavy and light ewes with twins, a low level of feeding during mid pregnancy can decrease foetal weight, the effect being greatest in light ewes.

In both heavy and light ewes with twins, a low level of feeding during mid pregnancy can decrease foetal weight, the effect being greatest in light ewes which can result in reduced lamb survival

Some trials have found a depression in litter size from ewes which were very heavy at mating and fed at a high level (i.e. to maintain maternal body weight) in mid pregnancy (see Table 4.1). This appears to be caused by increased foetal losses in mid to late pregnancy. Ewes in very high condition (CS 4) at mating should be fed to lose 10% of liveweight to mid pregnancy.

The effects of under nutrition in mid pregnancy are very dependent on ewe body condition and feeding levels in late pregnancy. The effect of under nutrition in mid-pregnancy is likely to be greater in ewes in poor condition and those fed poorly in late pregnancy. It has been shown that severe malnutrition can result in fewer ewes lambing (78% compared with 85% for well fed ewes) and fewer with multiples (26% compared with 42%).

Severe underfeeding in mid pregnancy can reduce the number of lambs born. Ideally ewes should not graze below 800kg DM/ha or 3cm sward height in mid pregnancy, especially multiples. At grazing levels below this there is greater risk of negative consequences for the ewe and her lambs.

EFFECTS OF SHEARING DURING PREGNANCY ON LAMB BIRTH WEIGHT

Pre-lamb shearing in the last 4 weeks of pregnancy has not generally affected lamb birth weight in New Zealand field trials (see further discussion later in this chapter) but these have usually involved shearing in the last third of pregnancy.

Shearing ewes in mid pregnancy (between days 50-100) increases birth weight of multiples by up to 0.7kg.

Experiments at Massey University have clearly shown shearing earlier in pregnancy increases lamb birth weight, with interactions between shearing time and birth rank. Time of shearing (day 70, 100 or 110 of pregnancy) did not affect birth weight of single lambs but birth weight of twins increased by 0.7kg per lamb with shearing ewes at 70 days compared with lambs from unshorn ewes. Ewes of condition score 2.5 or greater are more likely to respond to mid-pregnancy shearing than ewes of poor body condition. This provides a practical strategy for increasing birth weights of twins in prolific flocks. Ewes should be shorn with a cover comb and farmers should take into consideration the weather before shearing to avoid ewe losses.

See also the “Pre-lamb shearing” section following, which relates to shearing in *late* pregnancy.

LATE PREGNANCY EWE NUTRITION

About 70% of foetal growth occurs in the last third of pregnancy, greatly increasing ewe energy requirements. Meeting these demands requires an increase in feed quantity and quality as intake is restricted by the abdominal space occupied by the conceptus and compressing the rumen. Ewes simply cannot eat enough of a poor quality feed to meet late pregnancy energy demands, no matter how much feed is offered.

During late pregnancy (days 100-150) foetal and udder growth is rapid with increased ewe energy requirements.

Foetal growth during the final third of pregnancy is very resilient to variations in ewe feeding level. These results reinforce the importance of good feeding in early and mid pregnancy to increase lamb survival. Attempts to increase lamb birth weight through high levels of ewe nutrition in late pregnancy are limited by placental development (which was determined by day 90 of pregnancy).

Foetal growth during late pregnancy is resilient to varying feeding levels except for severe underfeeding.

Trials have shown that when ewes were *severely* underfed in the last 40–50 days of pregnancy, foetal growth decreased by 30–70% within three days and almost ceased in some cases. Single foetuses were immediately affected by large reductions in ewe intake after day 110 of pregnancy, twins were vulnerable after day 95 and triplets after day 80.

Recovery of foetal growth after ewe underfeeding depended on the duration of the underfeeding. If it lasted 16 days or less, foetal growth usually increased when ewes were “re-fed” but these lambs did not make up all of their lost growth compared with control groups. After prolonged underfeeding of 21 days or more, foetal growth did not change when ewe feeding levels were increased.

Lamb birth weight and survival, especially of multiples, will be affected if ewes are very poorly fed in late pregnancy. Ewes in good condition (CS3) 6 weeks before lambing will mobilise body reserves and can make up some shortfall in feeding, especially for multiple lambs. Table 4.2 shows the extra energy intake required by ewes in late pregnancy.

Underfeeding of ewes during late pregnancy will cause loss of ewe body condition and possibly metabolic disorders and if severe will reduce lamb birth weight.

These increased requirements mean 0.1–0.5kg DM more for ewes with singles and 0.2–1.0kg DM more for multiples during the last eight weeks of pregnancy. Such increases will be difficult to achieve with multiples requiring pasture covers of over 800kg DM/ha or 3cm in length (see Appendix 4.2).

Increased ewe feed requirements above maintenance during the final 8 weeks of pregnancy are 0.1–0.5kg DM per day for singles and 0.2–0.9kg DM per day for multiples. To achieve these target intakes in the last 2–3 weeks of pregnancy ewes should not be grazing swards less than 1200kg DM/ha or 4cm sward height.

Feed supplements may be necessary to meet ewe feed requirements in late pregnancy. Ideal supplements are high quality and high dry matter (e.g. grains or sheep nuts) so intake is not limited by feed bulk. Low energy, high bulk feeds such as straw or hay are not suitable.

Table 4.2. Extra energy (in addition to maintenance) required by pregnant ewes to achieve 4.0kg lamb birth weight.

From: Geenty and Rattray, 1987.

Weeks before term	12	8	6	4	2	Term
Extra MJME/day, single lamb	0.4	1.1	1.7	2.6	3.8	5.3
Extra MJME/day, twin lambs	0.7	1.9	3.0	4.6	6.7	9.3

For larger litters, add a further 75% of the single lamb value for each extra lamb.

ewe feeding effects on milk production

As well as effects on lamb birth weight, there is evidence that poor nutrition in mid pregnancy may penalise lamb growth to weaning through reductions in both ewe milk production and/or lamb vigour.

Undernutrition in late pregnancy restricts mammary growth and development. It also depletes ewe body reserves, causing poorer energetic efficiency in lactation and may reduce lamb birth weight and subsequent ability to withdraw milk.

Ewes poorly fed in late pregnancy and losing liveweight are slower to reach full milk production due to reduced mammary gland growth and have lower total milk production over lactation. With underfeeding at lambing time, copious lactation may not begin until up to 12 hours after lambing, depriving lambs of colostrum, and ewes may produce as little as half as much milk as ewes which maintain or gain weight in late pregnancy. Poorly fed ewes may not produce enough milk to ensure the survival of a single lamb.

Under feeding in mid-late pregnancy restricts udder development and subsequent milk production.

With underfeeding during mid-late pregnancy lambs are born with lower energy reserves and are more prone to starvation and exposure. Lambs from ewes poorly fed in late pregnancy may have only 40% of the energy reserves of lambs born to well fed ewes. In addition, birth may be prolonged and ewes may show poorer mothering ability and increased lamb losses.

Lambs from ewes underfed during mid-late pregnancy will have lower body fat reserves when they are born with less chance of survival.

Lambs born to ewes fed well in late pregnancy have more energy stored as fat reserves and are better equipped to survive starvation and windy, wet conditions. They also maintain their suckling drive longer than those whose dams were poorly fed. Ewes in poor condition must be well fed around parturition to encourage the onset of full milk production.

protein supplementation

Supplementing ewes with by-pass protein protected against rumen breakdown (eg. Methionine) from mid-pregnancy and into lactation may provide more colostrum and increased lamb survival. This increased survival is independent of effects on lamb birth weight and level of pasture available. Ewe protein supplementation does not appear to affect lamb growth after birth. If intending to use these supplements farmers must consider the cost effectiveness of them.

Ewes supplemented with protein or concentrates in late pregnancy may produce more colostrum with improved lamb survival.

Supplementing with by-pass protein may help lamb survival in highly fecund flocks even when ewes graze high quality pasture, perhaps by supporting increased mammary development and colostrum production. Underfed ewes may not produce enough colostrum to meet the energy requirements of twins in the first 18 hours of life. In addition, larger litters must cope with mismothering, even if temporary, and prolonged birth which depletes lamb energy reserves.

Similar effects to protein supplementation may be obtained using tannin containing plants in pastures such as lotus corniculatus or sulla which protect plant protein from breakdown in the rumen. Herb mixes containing chicory and plantain in the last two weeks of pregnancy have also been shown to be effective in increasing ewe milk production and lamb growth.

lamb growth to weaning

As well as reducing lamb survival and early ewe milking, severe underfeeding of ewes in late pregnancy (0.5 M) may penalise lamb growth for up to 7 months after birth. Ewe milking is reduced throughout lactation after pregnancy underfeeding.

lifetime performance of ewe lambs

Underfeeding ewes in late pregnancy or early lactation may reduce the lifetime performance of their daughters. Ewes and their daughters fed on a high plane in the last 100 days of pregnancy and the first 100 days of lactation had consistently lower ewe mortality than those underfed and also there was less barrenness in ewes. There is also evidence to indicate level of feeding of the ewe in pregnancy affects the milk production of their daughters which were in-utero.

Ewe lambs born to well fed ewes had the highest lifetime reproductive performance, producing 11% more lambs over three lamb crops than ewe lambs born to underfed groups.

Ewe lambs born to ewes well fed during pregnancy have better lifetime reproductive performance than those from ewes poorly fed.

Ovaries of foetal ewe lambs at day 47 of gestation whose dams were poorly fed from conception showed similar oestrogen secretion to those from ewes well fed but development of oogonia or precursors to ova was significantly retarded.

OUT OF SEASON LAMBING

Some farmers use out of season lambing to produce lambs for meat companies to kill at off peak times such as winter and early spring. This often means late spring or autumn lambing.

Autumn or winter lambing puts severe pressure on winter feed supplies as lactating ewes need good feed when pasture growth is normally slow. A change to 30% of ewes lambing in winter requires modification to winter grazing management and increased expenditure on animal health, especially to control internal parasites with lambs present on the farm most of the year. Two toothed entering the flock need higher liveweight gains to reach mating weight three months earlier than usual (i.e. December/January rather than March).

Autumn lambing requires a different feed profile which suites summer dry areas with good winter pasture growth like Northland.

It may be easier to achieve good mating weights for autumn-lambing than for spring-lambing ewes in areas with dry summers such as parts of Northland where out of season lambing is practised and where there is reasonable winter pasture growth for lactation.

Autumn lambing may expose ewes to FE in late pregnancy, causing ewe losses and lower lamb birth weight, tailing weight, weaning weight and lamb survival. A minor FE outbreak in autumn lambing ewes may result in 30% less weight of lamb weaned per ewe pregnant and 12% fewer ewes present at weaning. These losses are two to three times worse than the effect of a similar outbreak for ewes around mating time.

CONCLUSIONS/RECOMMENDATIONS ON FEEDING IN MID-LATE PREGNANCY

- Ewes should be fed in mid pregnancy, to at least maintain their mating body condition.
- Very fat ewes (CS 4 or greater) should lose up to 10% of their conceptus free weight over pregnancy, by 6–8 weeks before lambing.
- Weight loss should not continue into late pregnancy.
- Severe weight loss in mid pregnancy should be avoided.
- Good nutrition in late pregnancy will not make up for earlier losses in lamb birth weight with multiple lambs.
- Ewes with multiples should receive higher feeding in mid and late pregnancy compared with singles. Separate as early as possible after scanning unless residual pasture mass after grazing is 800kg DM/ha

until the last 2–3 weeks of pregnancy when it should be a minimum of 1200kg DM/ha.

- Good quality feed is important in the last 6 weeks of pregnancy to maintain ewe body condition. If pasture is limited, priority should be given to ewes carrying multiples.
- Feed requirements of ewes in late pregnancy are shown in Appendix 4.2.

PRE-LAMB SHEARING

Fine woolled sheep are commonly pre-lamb shorn in the last 4 weeks of pregnancy while crossbreds may be pre-lamb shorn as part of an eight month shearing regime. Some farmers believe shorn ewes eat more and may therefore have larger lambs and that they seek out shelter and thus providing protection for their lambs in rough weather.

British trials with housed sheep have found higher lamb birth weights and survival of multiples with ewes shorn during pregnancy. Shearing effects were more pronounced with earlier pregnancy shearing, as in the Massey University experiments referred to earlier, due to greater effects on placental development.

Shearing of ewes in mid pregnancy is more likely to increase lamb birth weight in twins than pre lamb shearing.

Ewes shorn close to lambing appear to make more use of shelter before, during and after lambing with increasing lamb survival. This tendency to seek shelter may be especially important in multiple-bearing ewes. Lambs may also grow faster when shelter is available for the first few days of life.

Pre lamb shearing of ewes encourages them to seek out shelter with better lamb survival, particularly for multiples. If this is done there needs to be shelter available in the lambing period, particularly for multiples.

Shearing with a winter comb leaves about two thirds more wool (5–6 mm) than a standard comb, which enhances ewe survival with pre-lamb shearing, especially in cold, wet, windy weather. Ewes maintain weight better as less energy is used to support body temperature and in some work, birth weight of multiples have shown increases. Shearing with a winter comb is a practical way to reduce cold stress in pre-lamb shorn ewes.

Pre-lamb shearing with a winter comb minimises ewe losses in bad weather.

ABORTION

The most common causes of abortion in sheep are toxoplasmosis and campylobacter (also known as “vibrio”). In the South Island *Salmonella* brandenburg is also a large contributor. They are contagious diseases which can be prevented with vaccination. Abortions due to other causes (bacterial or fungal agents) occasionally happen.

The most common causes of abortion in sheep are toxoplasmosis and campylobacter (also known as vibrio).

Toxoplasmosis and campylobacter usually have greater effects in young ewes as older ewes are more likely to have been exposed to the disease and become immune. Lambing percentage responses to vaccination vary depending on disease prevalence on farm. Many farmers regard vaccination as cheap insurance regardless of their farm’s abortion history.

Lamb losses due to abortion are generally greatest in younger ewes with less immunity.

As well as the lost lambs, abortion problems add cost in terms of ewes culled for failure to rear a lamb. Since exposure to each disease usually confers immunity to it, ewes losing lambs to confirmed abortion could be identified and retained. This is not without risk however, as these ewes may become shedders of infection and be a risk to other ewes especially if not vaccinated.

TOXOPLASMOSIS

Toxoplasmosis is caused by the *Toxoplasma gondii* parasite. This has a complicated life cycle which includes cats as an essential host. Wild cats spread the infection in their faeces, especially in hay, and sheep contract toxoplasmosis by eating contaminated hay or pasture. Aborted material may be eaten by other animals or birds which then become infected. Toxoplasmosis also affects humans — pregnant women may abort or babies may be born with defects such as eyesight impairment.

Lamb deaths due to toxoplasmosis can be at any stage during pregnancy or soon after lambing.

Toxoplasmosis can be contracted at any stage of pregnancy but may not be obvious. Infection in early pregnancy causes foetal death and re-adsorption which cannot be seen and is not detected because it occurs before pregnancy scanning. Mid pregnancy toxoplasmosis causes foetal death and abortion which farmers may notice as dead lambs in the paddock.

Toxoplasmosis contracted in late pregnancy may kill the foetus or lambs may be born weak and prone to starvation/exposure. There can be quite a delay between infection and abortion.

Ewes exposed to toxoplasmosis become immune. First-lambers are most susceptible as they are less likely to have been exposed to the disease. A toxoplasmosis problem is often only identified when there are large numbers of dry ewes (especially two toothed) or if aborted lambs are seen.

A single vaccination for toxoplasmosis gives lifetime immunity and is highly effective.

Vaccination is highly effective. One dose of Toxovax® gives lifetime protection. Vaccination must occur at least four weeks prior to mating. The vaccine is only to be given to non pregnant ewes. Toxovax® is a live vaccine which must be stored carefully and used as soon as possible. It must not be given with other live vaccines or when sheep are wet.

CAMPYLOBACTER (VIBRIOSIS)

Infection with *Campylobacter fetus* or *Vibrio fetus* in the last six to eight weeks of pregnancy can cause abortion or lamb death soon after birth. The disease is spread by ewes eating pasture contaminated by aborted material or discharges from aborting ewes. However, recent work with scanning data indicates *Campylobacter* can also cause losses throughout pregnancy including early embryonic loss. Protection against *Campylobacter* has been shown to reduce losses during pregnancy and to improve lambing performance on properties where *Campylobacter* has, and has not been, diagnosed.

Infection and lamb deaths with campylobacter is in the last 6-8 weeks of pregnancy.

Campylobacter can also be prevented by vaccination. The use of Campylovexin® is different to Toxovax® in that two doses are required when ewes are first vaccinated at about 6 weeks prior to mating and a booster shot is recommended a month later, each year thereafter. The first treatment should be eight weeks before mating and the booster just prior to mating. Failure to treat in subsequent years means ewes are unprotected although many farmers report good results despite failure to give boosters.

Salmonella Brandenburg has been a major cause of infectious abortion and deaths of ewes in late pregnancy in lower and central South Island since it first appeared in 1997/98. This disease is very regional and has fortunately not spread beyond Mid and South Canterbury, Southland and Otago, although the potential to spread is always there.

Vaccination with a killed vaccine, Salvexin+B, gives a degree of protection, plus considerable reduction in the clinical effects of the disease and the potential to spread infection.

Vaccination to protect against *S. brandenburg* requires an initial two shots prior to the risk period followed by an annual booster.

Vaccination for campylobacter is effective with a sensitiser and booster required in ewes prior to mating.

ewe deaths

Most ewe deaths occur in late pregnancy due to ewes being cast, bearings (vaginal prolapse), sleepy sickness, milk fever and sometimes fertiliser toxicity. Most of these can be avoided through careful husbandry and management.

The cost of 1% of ewe deaths in a 2,000 ewe flock is equivalent to 40 ewes wintered and 50 lambs tailed.

The cost of ewe deaths is large, as ewes have been carried all year, become pregnant and then lose all value. For example, suppose a farmer could save 1% ewe deaths in a 2000 ewe flock—i.e. 20 ewes. These ewes typically carry at least 25 lambs and probably more because it is often multiple-bearing ewes that die. In addition, 20 ewe hoggets must be carried to replace these ewes, displacing 20 additional ewes that could have been wintered (and their 25 lambs). Thus those 1% deaths in 2000 ewes have a *real cost* of at least 40 ewes wintered and 50 lambs tailed.

MILK FEVER

Milk fever is caused by calcium deficiency. It usually occurs after a sudden change or abrupt disruptions in feeding (e.g., shearing, vaccinating, crutching) in late pregnancy, especially in multiple-bearing ewes. Ewes become unsteady with a stilted gait and muscle trembling when standing. They go down quite rapidly and become drowsy.

Milk fever due to calcium deficiency can occur in late pregnancy, usually in ewes with multiples, due to sudden changes in feeding or disruptions such as shearing, crutching or vaccinating.

The classic signs of milk fever are a green discharge from the nose and the hind legs pushed out behind the ewe. Symptoms may be confused with sleepy sickness but milk fever is distinguishable by complete relaxation of the stomach muscles and an appearance

of flabbiness. Treatment is an injection of calcium borogluconate solution.

Treatment for milk fever is by injection with calcium borogluconate.

PREGNANCY TOXAEMIA (“SLEEPY SICKNESS”)

Sleepy sickness occurs when the ewe’s energy intake is considerably less than her requirements. Metabolism of body fat produces ketones which cause the ewe to become drowsy and move awkwardly. She may appear blind. Her feed intake declines making the problem worse until she goes down, slips into a coma and dies. Sleepy sickness is more common in ewes with multiples, especially if they have been fat earlier in pregnancy and then are underfed in late pregnancy when foetal demands are high.

Pregnancy toxaemia or “sleepy sickness” can occur in late pregnancy, usually in ewes carrying multiples, and is due to underfeeding or stress such as prolonged bad weather.

Sleepy sickness can be treated if detected early. Most farmers administer some kind of sugary solution or “ketol”. The mob should be offered more feed, preferably high quality, if ewes start to show sleepy sickness symptoms.

Pregnancy toxaemia can be treated orally with a sugary solution or “ketol”.

BEARINGS

Vaginal prolapse (“bearings”) limit reproductive performance through ewe and lamb deaths and have high labour and treatment costs. Bearings are most common in ewes carrying multiples, accentuating production losses. The incidence of bearings varies considerably between farms and between years, ranging from 4-12% of ewes. Incidences up to 17% have been reported in some North Island Merino flocks.

Vaginal prolapse, or “bearings” can occur in late pregnancy and are most prevalent in ewes with multiples.

Table 4.3. Seasonal variation in incidence of bearings. Incidence shown as percentage of total ewes.

From: McLean and Claxton, 1959.

	Year			
	1954	1955	1956	1957
Number of farms	27	90	105	74
Number of ewes	29,215	89,571	112,886	84,958
Incidence — all cases	0.42	0.47	0.41	0.60
— before lambing	0.38	0.40	0.35	0.51
— after lambing	0.04	0.07	0.06	0.09

There is no good scientific evidence on ways to avoid bearings. Many possible contributing factors have been suggested, including:

- intra-abdominal pressure due to conceptus and feed
- slope—incidence of bearings is higher on hill country; suggestion that lying with the hindquarters downhill increases intra-abdominal pressure further
- tail length—ewes docked very short may be more prone to bearings
- lack of exercise and poor muscle tone
- hormonal or mineral imbalance—e.g. due to phyto-oestrogens -increased bearings are regarded as a “symptom of clover disease”.

Bearings are associated with high abdominal pressure mainly in ewes with twins in late pregnancy—there are no known means of prevention.

Bearings can occur in ewes of all ages but are more common in mature and aged ewes, especially as the number of previous pregnancies increases. This may be linked to the higher incidence of multiple lambs in older ewes. Bearing trouble usually occurs close to lambing. Bearings are especially common in flocks carrying an unusually high number of lambs for the flock—i.e. where many ewes have not had multiples before.

Most problems (80–90%) occur shortly before lambing, as shown in Table 4.3 above.

Two thirds of the post-lambing bearings recorded were recurrences of pre-lambing problems. Of those ewes suffering bearings for the first time after lambing, many were two toothers which may have suffered injury during lambing.

RECOVERY

On farms where bearings were treated, about 61% of ewes recovered sufficiently to rear lambs, 27% died (before treatment or as a result of inadequate treatment or complications) and 13% were culled. If

affected ewes were kept, 30–35% recurrence was expected each year.

About one third of both single and multiple pregnancy bearing cases produced dead lambs only. In cases where twin lambs were present, both lambs were born alive in 55% of cases and 11% had only one live lamb. About 68% of singles were born alive.

TREATMENT OF EWES WITH BEARINGS

Successful treatment of bearings relies on early detection, gentle and clean replacement and effective retention. The bearing must be cleaned well and lifted up to allow the ewe to urinate. Lubricant should be used and gentle even pressure applied to replace. Replacing is easiest when the back end of the ewe is elevated.

Retention of the bearing can be by external pressure from ties attached to the wool, internal bearing retainers or a purse string suture around the vulva with cotton tape.

If the bearing is damaged or sutures are used penicillin should be administered. Ewes should be removed from the mob, placed on short feed and observed. (further detail in Appendix one).

PHYSIOLOGICAL CHANGES IN PREGNANCY

Vaginal volume increases markedly in pregnancy. Changes begin early in pregnancy and are usually apparent after about 60 days, continuing at a regular rate until about 120 days of pregnancy. The vaginal wall is more easily dilated as pregnancy advances and vaginal volume decreases rapidly back to the normal non-pregnant state about 14 days after lambing. Ewes which have lambed several times have greater vaginal volumes even when not pregnant.

Similarly, the vulva and vestibule distend in pregnancy and recover to a condition similar to early pregnancy by 14 days after lambing.

Given these physiological changes, it is probably not surprising that most bearings (80–90%) occur just before lambing.

OVERFEEDING IN LATE PREGNANCY

Many farmers believe that increasing ewe feeding in late pregnancy increases the risk of bearings although there is little scientific evidence to support this. Trials have shown no differences in incidence of bearings among Coopworth ewes offered pasture allowances from 0.7–7.0kgDM/ewe/day in the last 6 weeks of pregnancy. However, these feeding levels were introduced at 6 weeks before lambing and sudden changes were avoided close to lambing.

Underfeeding of ewes in late pregnancy is not recommended for prevention of bearings.

In choosing not to increase ewe feeding for fear of bearings, farmers must weigh the benefit of good ewe nutrition against the real cost of bearings if they eventuate. Increased lamb losses and poorer lamb growth from underfeeding during pregnancy may be a far greater cost than that of bearings.

There are no firm recommendations for reducing the incidence of bearings.

PRE-LAMB ANIMAL HEALTH CHECKS

Ewe vaccination with “5-in-1” protects the ewe and lambs from clostridial diseases. Low trace element levels should be treated in ewes pre-lamb to ensure adequate levels in newborn lambs. Selenium and iodine are discussed below as examples. Veterinarians can advise about likely local problems.

CLOSTRIDIAL DISEASES

Clostridial bacteria cause severe diseases such as pulpy kidney, blackleg, malignant oedema, black disease and tetanus. Although relatively uncommon in lambs between birth and tailing, these diseases are more important from tailing to weaning. They are easily prevented by “5-in-1” vaccination of ewes or lambs provided this is done at the correct time.

Ewe vaccination with “5-in-1” in late pregnancy protects ewes during lambing and lambs between birth and weaning against deaths caused by clostridial diseases.

Ewes are commonly vaccinated before mating and again before lambing in the first year, followed by annual vaccination no later than two weeks before lambing. Lambs can be vaccinated directly at tailing but this leaves them exposed to some risk before tailing time.

SELENIUM AND VITAMIN E DEFICIENCIES

Severe selenium deficiency causes white muscle disease. Lambs may be born dead or die within a few days of lambing. Delayed white muscle disease can occur in lambs 3–6 weeks old. Subclinical white muscle disease may also increase susceptibility to starvation/exposure as lambs are less active.

Selenium deficiency in newborn lambs is prevented by ensuring adequate selenium levels in ewes. In areas of selenium deficiency, ewes are often treated before mating to avoid selenium-related embryonic losses and about two weeks before lambing.

Some veterinarians have observed lamb survival responses to drenching ewes with Vitamin E part way through lambing and have also noted apparent white muscle disease in lambs with adequate selenium levels. Since Vitamin E and selenium work together, Vitamin E deficiencies are suspected. Testing Vitamin E levels is not helpful since reference values for newborn lambs are unknown.

Ewes should have adequate levels of selenium and vitamin E at lambing to avoid lamb deaths due to white muscle disease.

It appears that Vitamin E levels in newborn lambs are low and CK levels (CK is an enzyme that indicates muscle damage) in young lambs may be a better indicator of potential for white muscle disease. When normal levels are understood, veterinarians may be able to test one week old lambs with a view to giving Vitamin E to those below a trigger CK level yet to be determined. However, close veterinary post-mortem examination of new born lambs dying during or soon after birth is likely to be of more use.

IODINE DEFICIENCY

Iodine deficiency causes goitre with enlarged thyroid gland and increased deaths in newborn lambs. It is usually caused by ewes in late pregnancy grazing very low iodine diets or feeds such as kale which contain goitrogenic compounds. Severe deficiency in ewes in late pregnancy may reduce lamb birth weights, brain size and development. Treatment is normally with Flexidine injection or potassium iodide given orally. However veterinary advice should be sought regarding testing and treatment of iodine deficiency.

Iodine deficiency in ewes can hinder lamb development during pregnancy and cause lamb deaths soon after birth due to goitre. Treat with Flexidine injection or potassium iodide orally.

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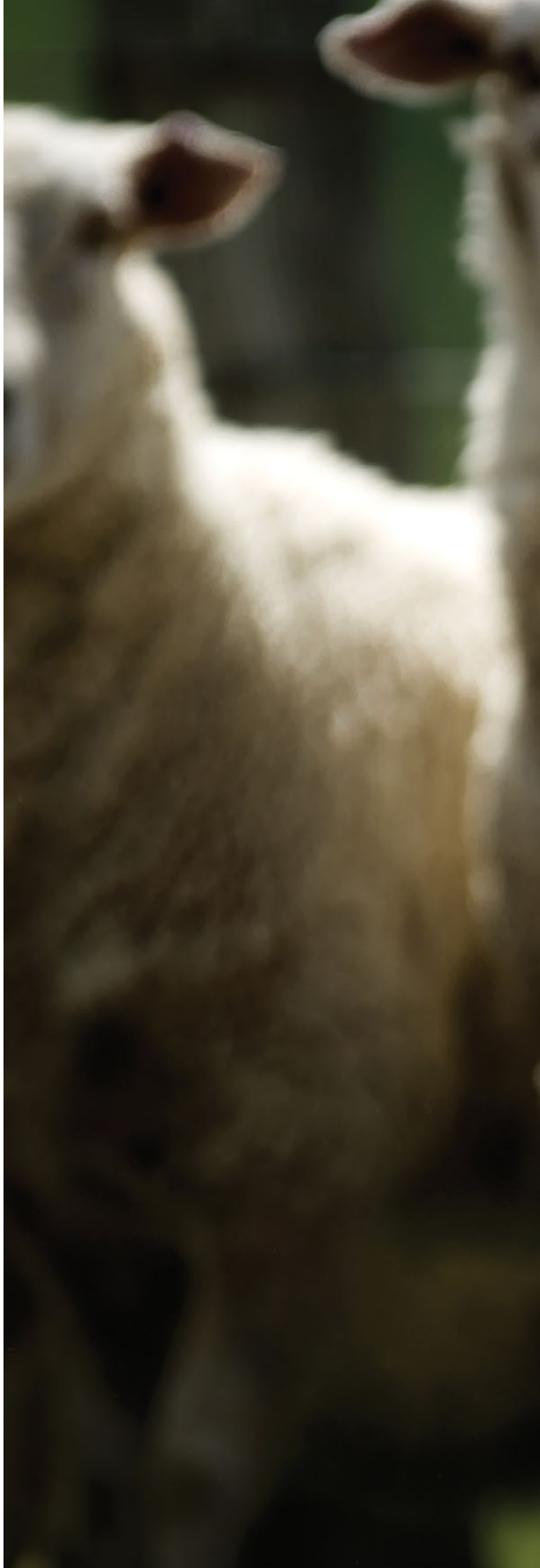
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CHAPTER FIVE LAMBING

RECOMMENDATIONS

- Choose lambing paddocks that protect from prevailing storms. and provide adequate feed for lambing ewes. Avoid cold wet sites and steep hills.
- If suitable areas are limited, give them to multiple-bearing ewes. Alternatively, allocate best areas to ewes due to lamb first—identified with ram crayons at mating or at pregnancy scanning.
- Choose a shepherding strategy to suit the stock, farm conditions and shepherd ability.
- Always respect the “lambing site” and try to avoid disturbing ewes that have chosen their site, especially if shedding off ewes that have not lambed.
- Pasture cover should be approximately 1200kgDM/ha at lambing. Good ewe nutrition according to ewe liveweight and litter size is important to achieve high milk production, and maintain and/or gain ewe condition.
- A ewe with a single lamb requires about 2.3–2.5 times maintenance in the first week of lactation, rising to about 2.8 times maintenance by the third week.
A ewe with twin or triplet lambs requires about 2.8 times maintenance in the first week of lactation, rising to about 3 times maintenance by the third week.
- Lamb deaths are highest in light multiples and heavy singles—optimum range of lamb birth weight is 4.2-7.4kg.
- Dystocia with large singles is moderately repeatable so ewes should be culled.
- See Appendix 4.2 for more detailed lactation feeding recommendations.

Lambing time is the ‘crunch’ period when benefits from all the work done before and during mating, and throughout pregnancy can be rewarded with a good lambing percentage.

The importance of providing the lambs with the best opportunity of surviving and thriving is discussed in this chapter. Issues covered include ewe feeding and milk production, choice of lambing paddocks, shepherding and background to other factors such as lamb birth weight which influence lamb survival.

CHOOSING LAMBING PADDOCKS

SLOPE

Trials show that lambs have higher survival on flat or gently sloping areas than on steep country, as shown in Table 5.1, because lambs born on slopes slipped off birth site and were mis-mothered.

Provided visual contact is maintained, single-lambing ewes usually follow the lamb to retrieve it. They sometimes fail if the lamb is stolen by another ewe, slips into a creek or through a fence. Twins or triplets are often separated, especially if the first lamb slips from the site while the second or third is born.

Lambs have difficulty on steep slopes during the first four to six hours after birth as they learn to stand and suckle. After this period they move around without great danger of separation.

Table 5.1. Deaths as a percentage of lambs born attributable to effects of slipping from the birth site.

Knight et al., 1983.

Slope	% of single-born lambs	% of twin-born lambs
0° to 24°	0	0
24° to 31°	4	12
32° to 44°	34	52

On steep land, 82% of ewes lambed at the top of the slope. When results were corrected for the relative area of each class of slope, exposed ridges were the most popular site followed by the flats and slopes. Ewes may have chosen ridges to isolate themselves from unlambed ewes congregating on flat areas.

Lamb survival is improved on flat or gently sloping paddocks than on steep hills.

Ewes lamb on any flat area large enough to lie down on and appear to have little ability to “select” safe lambing sites. Farmers must effectively do this for the ewes by providing lambing paddocks with few hazards.

Merino ewes have a reputation for poor maternal behaviour and low lambing performance, especially on hill country. Trials compared Romney and Merino ewes lambing on slopes of 33–44°. More Merino ewes lambed on the top third of slopes and their ability to follow a lamb that slipped off the birth site was similar to crossbreds. Merino ewes and lambs usually return to the top of the slope after retrieval whereas crossbreds tend to stay where the lamb has stopped.

When lambs are born on gentle contour, moving them to steeper paddocks within a few days did not cause extra losses. Lambs cope with slopes over 30° once they are mobile and feeding after 4–12 hours of age.

These results are important for farms with only small areas of flat land. If suitable lambing area is limited, give the best paddocks to ewes with multiples and put single-bearing ewes on steeper or colder areas. Alternatively, consider lambing on the flatter paddocks and moving ewes and lambs to the hills when lambs are 2–3 days old. This is easier to manage if ewes are marked at mating with ram crayons changed weekly so expected lambing dates are known. Or alternatively ewes can be allocated to early, mid or late lambing groups at pregnancy scanning time.

Beware of flat, waterlogged paddocks which can increase deaths from exposure, particularly if there is no shelter.

SHELTER

Shelter may help avoid deaths from starvation/exposure, although there are many other contributing factors. Shelter requirements vary depending on the timing of lambing and the severity of the weather. Shelter to reduce wind velocity and hence lamb heat loss can increase lamb survival. Survival increased from 83 to 91% for singles and from 49 to 64% for multiples when shelter was provided to Merino ewes lambing in winter.

Effective shelter will help lamb survival and should be used preferably for multiples.

Few farms can provide shelter for all lambing ewes. Multiple-bearing ewes, especially those known to carry triplets and poorly fed ewes during late pregnancy, should get top priority. Shelter can be provided by a number of means including:

- hills or slopes with protection from prevailing wind
- trees—blocks or shelter belts

- bushy plants and grasses—e.g. phalaris, pampas and tussock
- temporary polythene mesh or scrim attached to fencelines
- hay bales
- lamb covers made of plastic or wool.

Types of shelter include hills or slopes, trees or shelter belts, bushy plants and lamb covers.

Trials ewes shorn within a month of lambing tend to make more use of shelter than unshorn ewes and may therefore have higher lamb survival in rough weather. Provision of suitable shelter is difficult because ewes often fail to seek shelter at lambing unless they have been recently shorn. Ewes usually move away from the flock to lamb — if the flock is camped near shelter then lambing ewes will move out of shelter to give birth. Placing shelter near areas likely to be chosen by lambing ewes should increase its effectiveness. For example, in paddocks with varied topography, many ewes lamb on exposed ridges to escape the unlambed ewes on the flats. Shelter to reduce exposure on the ridge may increase lamb survival.

See also the discussion of “Starvation/Exposure” on page 67.

Paddock History

Some paddocks have a history of good lamb survival for no apparent, or obvious reasons. If these paddocks are identified they should be used for ewes with multiples wherever possible.

LAMB SURVIVAL

Average lamb deaths from birth to weaning range from 5–25%, although death rates up to 55% have been reported in some flocks. Survival of twin-born lambs is usually 3–10% lower than single-born animals. Typical death rates among singles are about 9–16% while twins in the same flocks have death rates of 15–22%. Lamb survival may appear poor in high fecundity flocks due to the larger numbers of triplets and quadruplets.

Average lamb deaths range from 5–26% between farms and are higher for multiples than singles.

Most lamb deaths occur by day three after birth. Table 5.2 summarises the main causes of lamb deaths.

Table 5.2. Causes of lamb deaths as a percentage of total lamb deaths

Adapted from Kerslake et al. 2005.

	Single lambs	Twin lambs	Triplet lambs	All lambs
Dystocia	57	46	48	47
Starvation/exposure	20	29	27	27
Other causes*	23	25	25	26

* includes disease such as contagious abortion, ruptures, misadventure and unknown.

Major causes of lamb death are dystocia in singles and starvation/exposure, which is more predominant in multiples. Combined these account for about 74% of all lamb deaths.

Lamb deaths are mainly due to dystocia in single-born lambs and to the starvation/exposure/mismothering complex in multiples. Both factors are heavily influenced by lamb birth weight, as large single lambs are most prone to dystocia and small multiples are susceptible to starvation/exposure. As described in earlier chapters, birth weight has already been established by genetics and maternal nutrition so lambing management must focus on helping newborn lambs cope with their new environment.

Recent work outlined in Table 5.2 above with high lambing performance breeds has confirmed that dystocia and starvation/exposure are the predominant causes of lamb death but has highlighted the relatively high incidence of dystocia in twin and triplet born lambs due to prolonged births.

Some 70% of all lamb deaths can be influenced by nutrition and preventive measures.

The requirements for good lamb survival can be summarised as:

- birth weight near optimum
- easy birth
- protection from cold
- maximum contact between ewe and lamb(s) for the first 12 hours after birth
- good supply of colostrum.

LAMB BIRTH WEIGHT

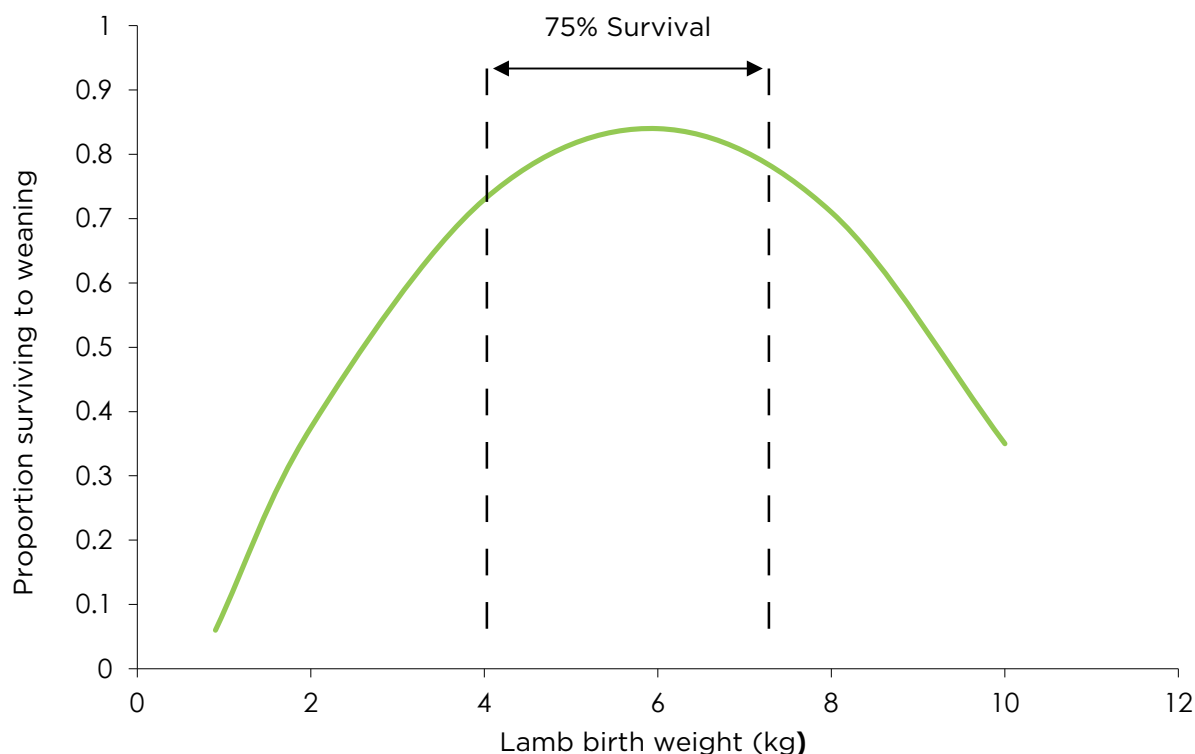
Lamb birth weight is the dominant factor in survival. Optimum birth weights for lamb survival have been estimated as about 4.2–7.4kg for both singles and multiples.

The birth weight-survival relationship is illustrated in the following Fig 5.1. with increased lamb mortality at birth weights under 4.2kg mainly with multiples and over 7.4kg with singles. Note that there are relatively fewer singles at the heavy end of the birth weight scale as most losses are in multiples.

Optimum lamb birth weight for best survival is 4.2–7.4kg for singles and multiples. Below this range increases the risk of starvation/exposure (mainly multiples) and above dystocia (mainly singles).

Figure 5.1. Birth weight—survival relationship

Adapted from Geenty et al.(2013).



The optimum birth weights for improved lamb survival outlined above are from extensive studies in both New Zealand and Australia which were conducted in many different environments and across a range of breeds. The optimum birth weights are considerably greater than the range of 3.5-5.5kg indicated by earlier New Zealand work in the 1970s and 1980s. This is likely due to a general increase in ram and ewe size and progressive selection for ease of lambing.

The optimum birth weights are almost always achieved in single lambs but are increasingly difficult as litter size increases. Each lamb weighs less as the litter size increases and this predisposes lambs from larger litters to starvation/exposure.

Good ewe nutrition is essential for optimum birth weights of multiple lambs (see chapter 4). Placental development is especially important in ewes lambing 150% or more to ensure lambs are of sufficient weight at birth. Ideally ewes carrying multiples should be identified as early as possible, separated, and preferentially fed.

Good nutrition throughout pregnancy is essential for optimum birth weights of multiple lambs

There is little evidence of breed effects on the relationship between lamb survival and birth weight in New Zealand's common Romney-based and composite breeds. However good survival at lower birth weights appears to occur in Merinos and some prolific breeds such as Finn and Finn crosses.

SEASONAL EFFECTS

Lambs born in autumn or winter are often much smaller than those born in spring to similar ewes. This effect is not only due to differences in seasonal feed supply, as even when ewes are the same weight at day 140 of pregnancy, significant differences in lamb birth weight (adjusted for litter size) may occur.

Lambs born in autumn or winter have lower birth weights than in spring.

June-lambing ewes achieve similar feed intakes to August-lambing ewes but lambs born in June will still be lighter than those born in August. These effects are important when mating out of season as not all differences can be attributed to ewe nutrition. Farmers practising out of season lambing should expect smaller multiple lambs even with good late pregnancy nutrition and plan lambing paddocks and shelter accordingly.

BREED

Breed effects on lamb survival are generally small and not important between Romney-based and composite breeds but the Merinos often have lower lamb survival than other breeds in the same district.

In New Zealand, pure Finns are noted for low lamb survival. Finn lambs are born with very little fat cover and a very fine fleece, making them prone to exposure even up to two weeks after birth. Finn crosses appear to have higher lamb survival than pure Finns. However, overseas information suggests the opposite, that at the same litter size more prolific sheep breeds such as Finns and their crosses, have higher lamb viability at lower average birth weights.

HETEROSIS

Lamb birth weight increase due to heterosis (or hybrid vigour) is estimated at approximately 6%. Crossbred multiple lambs are likely to be heavier than purebred lambs born to ewes of similar genetic background and management, and are thus less susceptible to starvation/exposure.

Lamb survival is often higher with crossbreeding due to positive heterosis for lamb birth weight and ewe milk production.

Benefits from heterosis occur in flocks using terminal sires for meat production and also in breeding flocks with crossbred ewes such as Border Leicester x Romney or Finn crosses. Survival generally increases from pure Romney lambs to F_2 lambs (i.e. progeny of Border Leicester x Romney F_1 ewes mated to similar rams) and then decreases again with interbreeding to produce F_3 and F_4 lambs. This could be due in part to better mothering and milking ability of F_1 ewes as well as heterosis increasing lamb birth weight and survival. Similar principles apply to multibreed composites.

LAMB SEX

Mortality in male lambs is approximately 6% higher than in females and is associated with, but not fully explained by about 0.25kg higher birth weights in male lambs which may cause increased dystocia. Practical steps to improve overall lamb survival will increase male lamb survival which cannot be influenced separately.

AGE OF EWE

Lamb survival is lowest in lambs born to hogget and two tooth ewes. Survival increases to a peak when ewes are four or five years old. Multiple-born lambs from five year old ewes have a better chance of survival than single-born lambs from two tooth ewes. Lamb survival may remain higher from ewes up to

six years of age but evidence conflicts, as some trials show peak lamb survival from five year old dams and a sharp decline for six year and older ewes. Dystocia appears more common in younger ewes while old ewes nearer 7 years old lose more lambs from starvation.

Farming conditions may influence results, with better performance from older ewes on easier farms. Some trials show peak lamb survival (79.5%) from ewes aged 4 to 6 years under poor conditions, with lower survival from both 2 year (69%) and 7 year old ewes (68.2%), but little effect of ewe age in better environments.

Lamb survival is generally lower in hoggets or young ewes than mixed age ewes.

Some farmers may limit reproductive performance by culling at a relatively young age of say 5 years and having a large proportion of first-lambers in the flock. Many farms cull for age at 5 years old regardless of ewe condition or performance and thus miss out on benefits in good ovulation rate, litter size and lamb survival, especially on easier country. It may be more profitable on easier country, to carry ewes to six or more years of age and take advantage of their higher reproductive performance.

SIRE EFFECTS

Individual sires can have an influence on lamb survival of their progeny. High survival rams produce smaller single lambs, with fewer deaths from dystocia, but sometimes higher deaths from multiple births. Low survival rams produce progeny requiring more assisted births and increased dystocia deaths from higher birth weights and larger heads.

Lamb survival could be improved if rams were progeny tested for this trait prior to use.

Significant differences in lamb survival have been shown between progeny of different sires.

TERATOGENS

Teratogens are agents which cause developmental abnormalities in the foetus. Lambs are not aborted but problems are seen at birth, causing death and/or poor performance in lambs that survive. Teratogens may be chemical agents or disease agents such as Hairly Shaker virus. Occurrence is thought to be small but further investigation may still be warranted.

HAIRY SHAKER

Hairy shaker disease is characterised by an extremely hairy fleece and minor to severe body tremors (or chorea) in newborn lambs. Lambs with and without chorea have a low survival rate and may die within two or three months. Others survive but have a slow rate of growth.

Long regarded as unimportant, hairy shaker is now thought to be a bigger problem than first realised as it may also cause early abortion and embryonic loss. It may be spread by surviving hairy shaker lambs and perhaps affected ewes. The disease has been observed throughout New Zealand and at present there is no cure or vaccine. Lambs identified with hairy shaker disease should be culled.

SELECTION FOR INCREASED LAMB SURVIVAL

Selection for better lamb survival can include components such as:

- ease of birth
- mothering ability—including birth site selection for shelter and isolation, period spent on the birth site, duration and intensity of lamb grooming, bond strength, ability to recognise multiples and keep lambs together, temperament
- lamb vigour
- cold resistance of lambs.

Selection for improved lamb survival can include components such as ease of lambing, mothering ability, lamb vigour and cold resistance of lambs.

Most components are difficult to measure under commercial farming conditions but ram breeders may be able to select for these traits. Many commercial farmers select indirectly by culling ewes which were pregnant but failed to rear a lamb.

DRAFTING EARLY/LATE LAMBERS

Separating early and later lambers is desirable for:

- differential feeding in late pregnancy and lactation
- to allow lambing of ewes on flats before moving to hills
- for ease of shepherding.

Accurate identification of lambing date is best done using ram harnesses and weekly changes of crayon colour at mating. Also some pregnancy scanners are able to classify ewes at scanning into early (first 10 days), mid (second 10 days) and late lambing groups.

“Bagging off” is less reliable, especially for very young or old ewes, and too late to allow differential feeding from six or more weeks before lambing.

Separating early and late lambers assists with differential feeding and allows more effective shepherding.

SHEPHERDING AT LAMBING

Farmer opinion about shepherding varies and commercial practice covers the full range from no intervention to intensive shepherding. Shepherding may decrease ewe and lamb losses by:

- assisting difficult births
- lifting cast ewes
- treating bearings
- fostering mis-mothered lambs
- reducing constipation in lambs with stuck-down tails
- warming and feeding lambs suffering starvation/exposure.

Shepherding intensity varies and can decrease lamb losses by assisting difficult births, attending to cast ewes, treating bearings and fostering mis-mothered lambs.

While good shepherding practices can increase lamb survival, farmers must decide for themselves the economics of shepherding. Opinions tend to swing with lamb prices, with more care being taken when lamb prices are high.

Successful shepherding depends on respect for sheep behaviour, careful treatment of stock and good hygiene if intervening in births. The shepherd *must* understand normal lambing behaviour and minimise disturbances. If it is to be successful ewes need to be acclimatised to the presence of the shepherd, therefore it is likely to be appropriate to begin ‘lambing beats’ well before the expected start of lambing.

The ewe may choose a lambing site many hours before lambing. When the foetal fluids release or “the waters break”, the lambing site is fixed. The lambing site can provide good information. Intact placental membranes with two veins and two arteries per lamb show the number of lambs born so twin and triplet births can be identified.

It is important not to disturb ewes from their lambing site to ensure effective bonding can occur.

Birth takes about an hour from fluid release, varying from 10 minutes to over 3 hours. If birth is prolonged (e.g. by dystocia) the ewe may wander from the lambing site which may necessitate mothering in a pen.

Most ewes groom their lambs within one minute of birth but this may be delayed after prolonged labour. A delay of over ten minutes has been associated with a longer time from birth to the lamb's first drink.

Grooming is important in bonding of the ewe and lamb, and ewes only suckle lambs to which they have bonded. Ideally ewes should have several hours of uninterrupted contact with their lambs to groom them and bond. Ewes will reject lambs if they have had no contact within about four hours following birth.

Most ewes leave the lambing site within 24 hours but some remain up to 72 hours after birth. First-lambers such as hoggets or two toothies tend to stay longer than older experienced ewes. Tagging and lamb handling may frighten first-lambers from the lambing site before bonding is established. Poorly fed ewes are more likely to move off earlier to graze.

Under natural conditions lambing ewes may not mix with the main flock for several days. High stocking rates and mobbing up of ewes interferes with this and contributes to mis-mothering. Multiple-bearing ewes should be stocked at lighter rates than single-bearing ewes, preferably in small paddocks.

"Shedding off" unlambed ewes is disruptive, especially if ewes are moved to another paddock after establishing their lambing site but before giving birth. Drifting unlambed ewes to other paddocks must not disturb the lambing ewes. Lambing ewes should not be moved until at least 24 hours after birth.

"Shedding off" of lambing ewes should not include lambs under 24 hr old.

LAMB STEALING AND SWAPPING

Lamb swapping is common and is most likely to occur when ewes are heavily stocked and choose close lambing sites. If lamb sharing occurs between two or three ewes with multiples, one lamb sometimes remains unattached and is left behind when the ewes moved off. About 10-20 % of ewes show they are about to lamb by taking an interest in other lambs, and often licking and stealing the lamb. This usually happens within eight

hours of giving birth but some ewes steal lambs days before giving birth to their own lamb.

Occasionally a lamb wanders from the lambing site while their mother gives birth to another lamb and follows a passing ewe. Such lambs are likely to die unless fostered by another ewe or found by their own mother within a short period.

Lamb swapping is not very important in commercial flocks, but interferes with pedigree recording for ram breeding. Observation showed misidentified dams and lambs approximately 10% of the time even when lambs were tagged as soon as possible after birth.

Lamb swapping and stealing often occurs with ewes crowded around the same site and is not a big problem with commercial farms but causes inaccuracies for pedigree recording in ram breeding flocks.

Some farmers claim that ewes provided with salt blocks at lambing are less likely to steal lambs and cause mis-mothering. They speculate that ewes seeking salt are attracted to birth fluids. Some have also observed greater ewe liveweights at weaning after access to salt but there is no relevant scientific evidence of this to date.

DYSTOCIA OR DIFFICULT BIRTH

Dystocia is caused mainly by difficulty in passing large single lambs out through the birth canal. However, studies show dystocia is also common when lamb birth weight is low, perhaps due to entanglement of lambs, weak lambs and ewes having poor uterine contractions causing birth to be slow. Flocks where 20-31% of ewes required assistance at birth have been recorded.

Dystocia is mainly caused by difficulty of passing large single lambs through the birth canal but can also occur with smaller weak multiple born lambs and poor ewe uterine contractions.

There is also increasing evidence that dystocia causes deaths in twin and triplet lambs due to prolonged births.

Repeatability of dystocia is about 18% so culling of ewes assisted at lambing and marking their female lambs to avoid keeping these as replacements is recommended. Ewes prone to dystocia may have relatively small pelvic inlet size compared with lamb size.

Since dystocia is repeatable, ewes assisted during birth, and their lambs should be identified for culling.

Lambs whose heads protrude for up to four hours usually survive if delivered but most die if left longer. As well as immediate deaths, dystocia may cause apparent starvation/exposure mortality because lambs suffer injuries during birth, such as spinal and cranial haemorrhages. Central nervous system (CNS) damage decreases the lamb's suckling drive which is accentuated at low temperatures. Warming such lambs and encouraging them to feed may improve survival.

If dystocia occurs frequently, ram effects, such as a tendency to produce large lambs should be considered. "Problem rams" can be difficult to identify unless single-sire mating is used. Rams known to have high birth weight lambs may be safely mated to high fecundity ewes where larger litter sizes and smaller lambs are likely to overcome the sire effects.

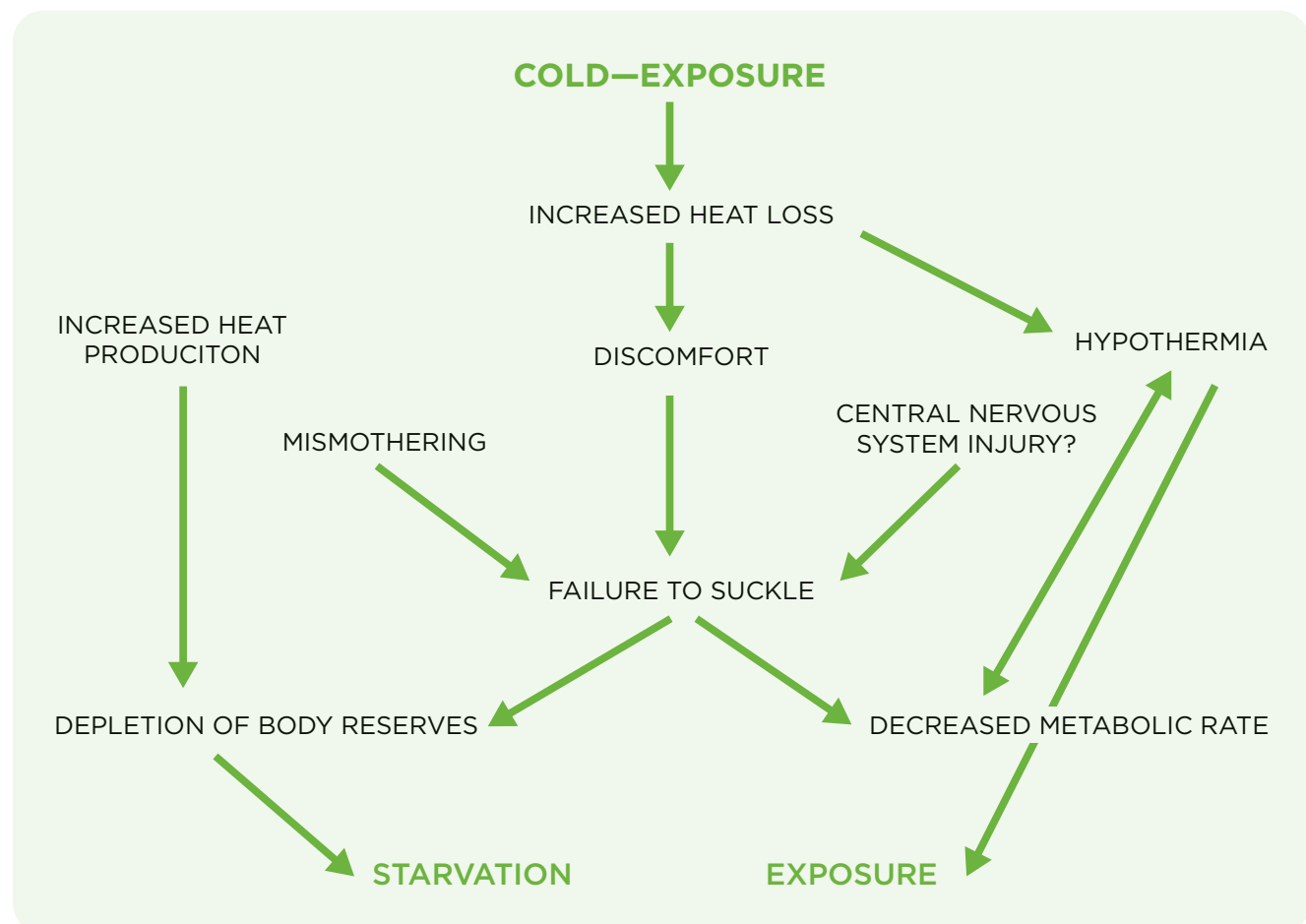
STARVATION/EXPOSURE

Starvation and exposure deaths are difficult to identify separately. "Simple starvation" is depletion of body reserves without hypothermia while "simple exposure" is lethal hypothermia with minimal depletion of body reserves. In practice the two effects often occur together and compound. Lambs which do not feed will suffer declining heat production and are likely to become hypothermic while lambs verging on exposure tend to stop feeding. The combination causes approximately 30% of all lamb deaths around lambing. Figure 5.2 illustrates the relationship between starvation and exposure effects.

At birth the lamb moves from a warm maternal environment, often to cold weather conditions. Measurements show the lamb must increase body heat production by up to 15 times from foetal level to compensate for heat loss to the surroundings. If the lamb's heat loss exceeds its summit metabolism (i.e. maximum heat production) then body temperature falls and it becomes hypothermic. Deep body temperature falls in many lambs at birth but most recover to normal temperature of 39–40°C within a few hours. If body

Figure 5.2. Starvation-exposure interactions

Adapted from McCutcheon et al., 1981.



temperature continues to fall, the lamb's rate of heat production declines further until death occurs at body temperatures below about 30°C.

Starvation/exposure can be caused by small weak lambs with little or no body fat reserves, severe cold weather, mis-mothering or lack of colostrum or ewe milk.

High heat production demands rapid utilisation of the lamb's energy reserves. Unless the lamb feeds, these reserves are quickly depleted and heat production falls. Starved lambs are very susceptible to exposure. Under field conditions, up to 16% of lambs have been observed to receive less milk than necessary for survival at temperatures below 10°C. These lambs are very likely to suffer starvation/exposure in cold weather. There appears to be no relationship between ewe maternal behaviour score and lamb colostrum intake.

Cold lambs are less likely to suckle. Lambs become less active and suckle less, increasing the problem until death occurs. Mild hypothermia, not fatal in itself, may make lambs susceptible to death from starvation. Cold windy conditions also affect ewe and lamb behaviour at birth and some lambs take much longer from birth to first feeding. Under intensive shepherding, these lambs can be warmed and fed. Lambs respond well once warmed, even though energy reserves may have been depleted. The "reward" of obtaining milk encourages further suckling.

Small lambs are especially prone to exposure. Heat production is proportional to body weight and surface area so small lambs have an added disadvantage. Merino lambs are more susceptible to hypothermia than crossbred lambs.

EFFECTS OF RAIN AND WIND

Dry lambs are unlikely to suffer from exposure unless air temperature falls below 0°C, even in the first 24 hours of life. Wet lambs, however, may become hypothermic at ambient temperatures as high as 15°C, even in still air. Shelter for low birth weight lambs, especially multiples, becomes very important when rain is accompanied by temperatures below 10°C.

The chilling effects of wind and rain combined are more likely to cause lamb deaths from exposure than low temperature alone.

In winds of approximately 20 km/hr, dry lambs maintain body temperature by increasing heat production to about four times basal levels. At temperatures below 10°C, the combined effect of wind and wetness can exceed many lambs' heat production ability and body temperature drops. Hypothermia can often be expected if wet lambs are exposed to wind.

Lambs from poorly fed ewes and those born to a difficult birth or dystocia have lower maximum heat production. They are likely to suffer hypothermia at higher temperatures than lambs from well fed ewes. This is made worse by the reduced milk production from poorly fed ewes.

LAMB HEAT RETENTION

Lambs show considerable differences in their ability to maintain body temperature. Some fail to maintain body temperature even under ambient temperatures as high as 15°C. These lambs would be very susceptible to hypothermia. Direct measurement of lamb heat production and selection for increases is not practical but indirect selection probably occurs when farmers cull ewes which fail to rear lambs.

Lambs vary in their ability to maintain body temperature in cold conditions but this is very difficult to select for.

Birthcoat also affects lambs' ability to maintain body temperature. Studies of Romney and Drysdale x Romney lambs show thicker birthcoats of up to about 20 mm are better insulators. Wool lamb covers are commercially available, improve heat retention and can increase survival but might be impractical for a commercial farmer.

Genetic influences on lambs' ability to resist cold have been found with estimated heritability of 0.44. Direct selection is not feasible, however, because of the practical difficulties in measuring lambs' cold resistance in the field.

EWES MILK PRODUCTION

Poor ewe nutrition in late pregnancy delays the onset of milking and reduces milk output (see previous chapter). Combined with low lamb energy reserves, this puts lambs at great risk of starvation/exposure. Even under good feeding, trials show milk output varies tremendously with the best ewes in a flock producing over three times as much as the lowest yielders, or 50% above the average. See also "Ewe milk production" on page 70.

Poor ewe nutrition in late pregnancy delays onset of milk secretion and increases the risk of lamb starvation.

Table 5.3. Ewe behaviour at lamb tagging and lamb survival rates

Adapted from Knight et al., 1988.

Ewe behaviour	% of ewes	Lamb survival %
Left the lamb and not seen to return	2	30.4
Moved more than 10 m from site but returned	31	79.8
Did not leave the birth site	67	87.7

MATERNAL BEHAVIOUR AND MOTHERING ABILITY

Ewe behaviour and desire to stay with their lamb(s) is an important factor in lamb survival. Ewes that leave their lamb when a shepherd handles it and are not seen to return have lower lamb survival than those that remain throughout the operation. Table 5.3 shows the relationship between ewe behaviour during lamb tagging and subsequent lamb survival rates.

A maternal behaviour score (MBS) can be used to rank ewes out of five as follows:

1. Ewe flees at the approach of the shepherd, and does not return
2. Ewe retreats further than 10m but comes back to her lamb(s) as the shepherd leaves them
3. Ewe retreats to a distance of 5-10m
4. Ewe retreats but stays within 5m
5. Ewe stays close to the shepherd during handling of her lambs.

Ewes vary in mothering ability which is repeatable and can be assessed in terms of their reaction to human presence.

Assessment of MBS can help lamb survival in ewes with a high proportion of multiples though inclement weather still remains a major factor in lamb mortality.

Ewes with multiples need more time to bond with their lambs than ewes with singles. Mismothering is less likely where ewes have minimal disturbance such as set-stocked and at a lower stocking rate than for singles. The ability to recognise or “count” large litters is highly desirable at high lambing percentages and there may be scope to select ewes which respond to separation from one of their lambs even when the rest of the litter is still present.

SELECTION FOR MATERNAL BEHAVIOUR

Ewe behaviour at tagging, as indicated by MBS, has a repeatability of 0.18–0.21 and heritability of 0.15. Genetic progress can be made and selection for ewes rearing a lamb may indirectly select for mothering ability. While selection for mothering ability is not practical for commercial farmers, ram breeders can score ewes at lambing and offer rams from good mothers.

Ewe nutrition

Good ewe nutrition in lactation is important in maintaining or increasing ewe liveweight as well as milk production and lamb growth. It can also improve ewe maternal behaviour in early lactation. Poorly fed ewes milk less and lose weight, with especially severe effects on ewes rearing multiples. Maximum milk yield is obtained by high feeding levels for ewes throughout late pregnancy and during lactation.

Good ewe nutrition in late pregnancy and early lactation improves lamb survival and early growth.

Ewes lambing during the spring flush of pasture growth have been shown to produce more milk than those lambing relatively earlier or later. New Zealand trials comparing July and September lambing dates show late lambing ewes produce more milk at peak lactation around week four (2.9kg/day) than early lambers (2.3kg/day) and have better lamb weaning weights. This study suggests better matching of feed supply and demand for later lambing ewes results in ewes having higher liveweights at lambing and better levels of nutrition during early lactation.

Pasture cover at lambing should be 1200kg DM/ha or 3 - 4cm long.

Table 5.4. Recommended feed requirements (kg DM/ewe/day) for lactating ewes.

Adapted from Geenty Rattray, 1987.

Liveweight (kg)	Single-suckling				Twin-suckling			
	Week				Week			
	1	3	6	9	1	3	6	9
40	2.10	2.30	2.00	1.85	2.30	2.60	2.30	2.00
50	2.45	2.85	2.45	2.05	2.85	3.20	2.85	2.20
60	2.60	3.00	2.60	2.20	3.00	3.40	3.00	2.40
70	2.80	3.20	2.80	2.40	3.20	3.60	3.20	2.60
Lamb pasture requirement		0.30	0.50	0.90		0.20	0.40	0.80

RECOMMENDED FEEDING LEVELS

Target cover at lambing should be around 1200kgDM/ha or typically about 3 – 4cm high for spring pasture and pasture should begin growing rapidly early in lactation. Ewes cannot be expected to milk well without sufficient pasture and good body condition with a minimum score about 2.5. Use of alternative forages including lucerne and various herb mixes such as chicory can be very beneficial.

Table 5.4 shows recommended feed requirements for ewes in lactation for rapid lamb growth.

During early lactation pasture cover should be 1400-1600kg DM/ha or 5-6cm length.

Notes:

1. Assuming average quality feed (10 MJ ME/kg DM).
2. Eachkg of ewe liveweight lost is equivalent to 1.7kg DM while eachkg of ewe liveweight gained requires an additional 6.5kg DM.
3. For triplets or quadruplets, add 0.1, 0.2 and 0.4kg DM/day for weeks 3, 6 and 9 respectively.

Achievement of the above ewe feed intakes requires pasture cover of 1400-1500kg DM/ha or 4-5cm length.

ewe milk production

Lamb survival and growth to weaning are heavily dependent on ewe milk production. The onset of lactation and colostrum production are affected by ewe nutrition in late pregnancy while total milk production is influenced by feeding in lactation and body condition.

Ewe milk production peaks 2-4 weeks after lambing then gradually declines.

Daily milk production peaks at about 2-4 weeks of lactation then gradually declines. Regardless of nutritional level, ewes rearing multiples produce more milk than similarly fed ewes with singles. Ewes with twins produce about 30-50% more than ewes with a single lamb but, as this is shared between two lambs, each lamb receives only two thirds as much milk as a single lamb. Peak production of single- and twin-suckled ewes has been measured at around 2.3 litres/day and 3.5 litres/day respectively. About 40-50% of total milk was produced during the first four weeks of lactation in each case.

Ewes with twins or triplets produce 30-50% more milk than those with singles.

Table 5.5. Average daily milk production for Romney and Dorset ewes at week five of lactation.

Breed	No. lambs feeding	Daily milk yield (kg)	Range
Romney	1	1.5	1.1–2.3
Romney	2	1.6	0.7–2.2
Dorset	1	2.2	0.7–4.0
Dorset	2	3.0	1.4–6.0

DIFFERENCES IN MILK PRODUCTION

There is large variation in milk production levels within flocks, as shown in Table 5.5.

Measurement of actual milk production is impractical in the field. While ewe selection based on weight of lamb weaned would favour higher milk producers, the effectiveness of this is reduced by the influence of lamb pasture intake from about three weeks of age. Analysis of several trials showed lamb liveweight gain from birth to six weeks old was a poor indicator of ewe milk production under good pasture feeding. Lambs successfully consumed more high quality spring pasture, with almost the same nutritional quality as milk, when there was a lack of milk.

This variation suggests considerable scope for selection for higher milk production.

There is large variation in ewe milk production levels within flocks but this is hard to select for as lambs substitute good quality pasture for milk.

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CONCLUSIONS

This and preceding chapters have discussed feeding, management and husbandry to maximise the number of lambs conceived and to give them the best possible opportunity of surviving and thriving. Achievement of this on farms is an important first step to improving profitability.

It must be emphasised, however, that realisation of such improved production potential and profit depends on carrying through with appropriate practices for high ewe and lamb performance.

This means provision of high quality feed for good lamb growth rates, sound animal health procedures and careful planning of lamb drafting or sales to allow sufficient feed for good ewe performance the following season.



A photograph of a brown leather hat with a mesh band and a dark jacket hanging on a wooden wall. The hat is on the left, and the jacket is on the right. The background is a wooden wall with a vertical plank. A black rectangular box with rounded corners is in the upper right, containing the word 'APPENDIX' in green capital letters.

APPENDIX

APPENDIX ONE

THE TREATMENT OF BEARINGS IN EWES

The successful treatment of bearings relies on early detection, gentle and clean replacement and effective retention.

- A bearing that has been Out for more than 48 hours is very difficult to treat successfully. If the bearing is excessively swollen and/or lacerated or ruptured the ewe should be destroyed.
- The bearing must be well cleaned before it is reduced. Diluted disinfectant in a squeeze bottle should be carried in a kit for this purpose. Gross contamination and grass should be physically removed. During the process of cleaning, the bearing should be lifted up to allow urination to occur. It is very important that the bladder is not full when the bearing is being retained.
- Replacing the bearing is easier if the back end of the ewe is elevated. Applying a small amount of lubricant to the bearing can significantly ease retention and will reduce the amount of damage sustained. Lube in a squeeze bottle should also be in the kit. Pressure will usually need to be applied and gently maintained all around the bearing to enable it to be replaced.
- Once replaced most bearings will need to be retained. In mild cases, tying of wool around the back of the ewe or the tying of other external holding systems such as string tied around the back of the ewe will retain the bearing.
- Bearing retainers that apply direct holding pressure inside the vagina can be very effective. They do require wool of at least 3cm length to be attached to.
- The application of safety pins or sutures across the lips of the vulva are only partially effective and can in themselves cause much damage.
- A purse string suture with cotton tape applied deeply around the margins of the vulva is very effective in holding the back of the vagina closed and preventing the bearing coming out again. A veterinarian should be consulted to demonstrate the application of a purse string suture. Using a specialised needle makes this retaining technique easy to apply. If such a suture is applied within two weeks of lambing it will need to be cut prior to lambing. If the suture is applied longer than two weeks before lambing it will break at the time of lambing.
- Penicillin should be given to any ewe that has a damaged bearing or if sutures have been applied.
- After the ewe has been treated she is best taken from the mob and held on short feed, ideally on a flat paddock and observed.

LAMB POST-MORTEM PROTOCOL FOR USE ON FARM: TO DIAGNOSE PRIMARY CAUSE OF LAMB DEATH FROM BIRTH TO 3 DAYS OF AGE

J.M. Everett-Hincks* and S.J. Duncan

AgResearch Ltd, Invermay Agricultural Centre, Private Bag 50034, Puddle Alley, Mosgiel, New Zealand.

ABSTRACT

Lamb survival is a key issue for sheep farming operations. The majority of lamb deaths from birth to weaning occur in the first 3 days after birth and range from 5% to 30% for individual sheep flocks. A simplified lamb post-mortem examination (PM) protocol has been developed for use on farm to determine the primary cause of lamb death between birth and 3 days of age. Firstly lamb viability at birth (LDVB) is determined and secondly the lamb death risk being dystocia (LDD), starvation and exposure (LDSE) or other (LDOTHER) is diagnosed. A trained lamb post-mortem practitioner is expected to take between 5 and 10 minutes to complete a post-mortem examination for one lamb using the protocol and decision tool described. The PM protocol is required for large scale use for AgResearch's gene marker discovery programme. Breeders involved in the Ovita Lamb Survival study are trained to use the post-mortem protocol and can access breeding values for the lamb mortality traits derived from PM: that is lamb viability at birth (LDVB), lamb death risk due to dystocia (LDD) and lamb death risk due to starvation/exposure (LDSE).

INTRODUCTION

Lamb survival is a key issue for sheep farming operations. It has been estimated that the survival to sale of an extra 100 lambs will, at last season's prices, boost income by \$5000 (pers. comm. Andy Bray, Meat & Wool NZ, 2007). Reducing lamb losses has production, economic and animal welfare benefits.

The majority of lamb deaths from birth to weaning occur in the first 3 days after birth and range from 5% to 30% for individual sheep flocks [1]. Previous research has shown that under New Zealand conditions starvation/exposure accounts for approximately 30% of new-born lamb losses [2]. Dalton's team reported dystocia rates of 27% in dead single lambs and 17% in dead multiple lambs [3]. A recent study showed that the predominant cause of death from birth to 3 days of age was dystocia in recorded Southland ram breeding flocks, accounting for 57% of single and 47% of multiple lamb deaths [1]. Haughey suggested that 20-60% of neonatal lamb deaths categorised as starvation/exposure were actually consequences of birth stress [4]. Differing results between studies may be due to differences in clinico-pathological diagnoses.

In 2003 AgResearch's Animal Genomics Group commenced the development of a Lamb Survival Resource for a genetic marker discovery programme (funded by Ovita Ltd). An investigation into 20 ram breeder flocks involving 15,821 lambs with birth weights recorded over the 2003 and 2004 seasons, reported 4% of all lambs died as a result of difficult births (dystocia) and 1% of all lambs died from starvation/exposure between birth and 3 days of age [5].

The Lamb Survival Resource will continue to increase in size and scope, as a powerful nationwide resource is necessary for gene marker discovery, association and validation studies. A lamb post-mortem protocol is required for use on a large scale to increase the resource for gene marker discovery. The protocol assigns the major causes of neonatal lamb death. Farmers can

use the protocol following a training session. Farmers involved in the Ovita lamb survival programme in 2007 record the major causes of lamb mortality on the national sheep recording database, Sheep Improvement Limited (SIL) [7]. Animal breeding values are available for traits derived from the post-mortem examination: that is lamb viability at birth (LDVB), lamb death risk due to dystocia (LDD) and lamb death risk due to starvation/exposure (LDSE).

The post-mortem procedure used for AgResearch's lamb survival resource was modified from McFarlane's examination method [8] in consultation with veterinary practitioners. This paper describes the post-mortem protocol that has been developed in 2007 and field tested in 43 flocks by farmers throughout New Zealand.

GENERAL EXTERNAL EXAMINATION

The basic equipment required includes a sharp butcher's knife, forceps, scales, gloves and scales to weigh the lamb and thyroids.

Lambs dead at birth and up to 3 days of age are collected, identified and recorded by the farmer during daily shepherding. The sex of the lamb is recorded. Lambs were postmortemed by trained farmers on average 12 hours after death (range 4 - 22 hours). Before the commencement of the post-mortem examination (PM) the lamb is examined externally for physical abnormalities (e.g. cleft palate, imperforate anus, hairy shaker disease¹ [9], Microphthalmia², skeletal defects, signs of predation and general status of the birth coat (e.g. groomed/cleaned, muddy).

¹ Lambs that are affected by Hairy Shaker Disease (HSD) have low viability and if survive, poor growth. The clinical signs of HSD are an abnormally coarse birth coat which may be pigmented, generally small lambs (around 1.5kg) but do not always show nervous signs (shaking).

² Microphthalmia is a well recognised inherited disease in Texel sheep. The retina is composed of an irregular mass and the animal is blind. A commercial gene marker test is available through Catapult (licensed to Ovita).

The lamb's hooves are examined to determine whether the lamb has or has not walked. A lamb has not walked if the membranes on the hooves (white to yellowish raised areas on the soles of the feet and accessory digits) are present. If the membranes have disappeared then the lamb has walked.

Lamb birth weight (BWT)

The lamb is weighed to the nearest 0.1kg and anatomical measurements such as crown rump length (cm) and girth (cm) can also be recorded. The effect of birth weight on the lamb death risk traits identified by postmortem has been reported by Everett-Hincks and Dodds [5].

DISSECTION AND INTERNAL EXAMINATION

The lamb carcass is placed in a dorsal recumbent position and is dissected using a sharp butcher's knife. The dissection technique used is similar to skinning a lamb; a continuous flap is reflected from the lower lip to the pelvis removing the ventral surface of the lamb. By maintaining an upward traction of the flap down the ventral side of the neck, a horizontal cut is made through the sternum exposing the thoracic cavity keeping the knife as close to the surface of the sternum as possible not to incise the heart. The incision proceeds to the abdomen and onto the pubis removing a flap of skin, muscles and peritoneum from the abdominal cavity. It is important to keep an upward traction on the flap being reflected to ensure that the abdominal viscera are not injured. The amount of blood escaping the incised umbilical veins should be noted. The abdominal cavity requires immediate examination of signs of haemorrhage as incision of the umbilical veins or an accidental incision or puncture of the liver may lead to misdiagnosis of haemorrhage, organ rupture and subsequently a difficult birth.

Next reflect the skin from the lateral regions around the jaw, head, ventral neck, sternum, ribcage and breech. All regions and the reflected skin require immediate examination for localised subcutaneous oedema (head, neck, brisket, ribs, sternum, abdomen and breech). It is important that signs, locality and severity of localised subcutaneous oedema are noted immediately as oedema will dissipate when exposed to the air. The prosection method has been described in detail by McFarlane [8].

DIAGNOSES

Lamb viability at birth (LDVB)

The thorax area is examined and the lungs are checked for aeration. If the lungs are aerated then the lamb had breathed. One of 3 classes can be assigned: full aeration, partial aeration and no aeration (Figure 6.1). Partial aeration and full aeration is a sign of viability at birth. If aeration is difficult to assign then lungs should be removed and placed in a bucket of water. If a lung floats the lamb has breathed.

Organ autolysis: Lambs with signs of organ autolysis and tissue degradation have died before parturition and are

predominantly characterized as an intrauterine death and therefore not viable at birth. The liver will show a degree of softening. There may also be generalized oedema. As the time the lamb has been dead within the ewe advances the hemoglobin breaks down giving post-mortem discoloration (tissues appear a pinkish/brown color). The period of rapid autolysis is followed by a prolonged period of absorption of all fluids from the fetus eventually resulting in mummification (marked dehydration of all organs).

Lamb death risk from dystocia (LDD)

A positive diagnosis of lamb death risk from dystocia is where there is evidence of at least one of the following 3 signs: abdominal haemorrhage, liver rupture and moderate to severe localised subcutaneous oedema resulting from birth trauma.

Haemorrhage: Free or clotted blood in the abdominal cavity which is not sourced from the umbilical veins is characterised as haemorrhage. Abdominal haemorrhage is the sign of birth trauma. The source of the haemorrhage is usually from the liver.

Liver rupture: All surfaces of the liver capsule are examined for rupture (jagged cut appearance). Care must be taken during the dissection not to accidentally incise the liver or puncture or damage a soft liver. The rupture is not to be confused with the natural folds of the lobes located on the underside of the liver.

Localized subcutaneous oedema: Localized subcutaneous oedema is a sign of viability during the parturition process and the quantity is a function of time [8]. This is usually a sign of a difficult or prolonged birth [6]. It is important that the location and severity of oedema is recorded, as the location and severity can indicate different causes (Figure 6.2). One of four severity grades can be assigned: no oedema, minor oedema (visible but not measurable), moderate oedema (greater than 3mm and up to 1cm in depth) and severe oedema (greater than 1cm depth).

Oedema in distal limbs (extremities) is observed in prolonged hypothermia. Skin from the medial to lateral aspect of the hind and forelimbs is reflected for diagnosis. Oedema on the abdomen originating from the navel is a sign of infection, but uncommon in lambs that die in the first few days after birth. Generalised oedema has been suggested to be a sign of placental insufficiency, or infection in-utero and is generally classified as minor severity (<1mm thick) in all regions.

The protocol specifies that localised subcutaneous oedema has to be greater than 3mm thick (i.e. moderate severity) in at least one location before dystocia is assigned the primary cause of death (Figure 6.2) [1, 6].

The post mortem procedure detailed in this report prioritises dystocia as the primary cause of lamb death, as the parturition process precedes post-parturient events. Lambs that endure difficult births have trouble maintaining body temperature and have inhibited behaviours in teat searching and suckling [10]. This can increase the chances of death when subjected to cold

stress or under-nutrition. Therefore lambs with dystocia and the starvation/exposure complex are assigned dystocia as the primary cause of death.

The post-mortem examination stops here if a positive diagnosis of lamb death risk to dystocia is reached. If dystocia is not assigned the post-mortem examination continues.

Lamb death risk from starvation/exposure (LDSE)

A positive diagnosis of lamb death risk from starvation/exposure is where there is evidence for all 3 of the following signs: pericardial and perirenal brown fat has been completely metabolised (Figure 6.3 and 6.4), there are no milk clots in the stomach and there is no evidence of milk absorption in the gastrointestinal tract. However this is a simplified view and there are equally valid variations to this. In extreme cold weather you may observe that some lambs have metabolised all of their brown fat but have milk clots in their stomach. These lambs have died from cold exposure and not starvation.

Firstly examine the heart and kidneys for metabolic fat depletion (Figure 6.3). One of 3 classes can be assigned: full depletion, partial depletion and no depletion. If the lamb was born alive, but fails to feed, it immediately commences to metabolise the extensive body fat depots. Body fat is depleted first from the pericardium (heart) and then the perirenal (kidney) area [8]. Fat metabolism progresses from a slight softening to complete absorption where the fat tissue has become a dark reddish brown colour, is soft and gelatinous (Figure 6.4).

Secondly the stomach is cut open and examined for milk clots. Presence of a milk clot in the abomasum is a sign that the lamb has suckled. However this is not to be confused with a lamb which has been artificially fed.

Thirdly the gastrointestinal tract is checked for milk absorption. Presence of a white scattered substance in lacteals (supporting membrane of the intestines containing the lymphatic system) indicates that the lamb has fed and digested milk. There may be no remaining milk clots in the stomach but evidence of milk absorption in the gastrointestinal tract. It is important to record if milk has passed through the whole intestinal tract. Meconium¹ in the rectum is passed shortly after birth if the gastrointestinal tract is functioning normally. Meconium present in delayed and late post-parturient deaths indicates abnormal intestine function.

The post-mortem examination stops here if a positive diagnosis of lamb death risk from starvation/mismothering/exposure (SE) is reached. If lamb death from SE is not assigned the post-mortem examination continues.

¹ Meconium is the earliest faeces of a lamb. Unlike later faeces, meconium is composed of materials ingested during the time the lamb spends in the uterus: intestinal epithelial cells, mucus, amniotic fluid, bile and water. Meconium is sterile, unlike later faeces, is viscous and sticky like tar, and has no odour. It should be completely passed by the end of the first few days of postpartum life, with the faeces progressing toward yellow (digested milk).

Lamb death from other causes (LDOTHER)

The majority of lamb deaths between birth and 3 days of age have been assigned either LDD or LDSE [5]. There will be a smaller proportion of lambs that died from other causes. These are recorded as LDOTHER and a remark is added recording whether it was infection, abnormality or unknown.

Infection: The navel area, umbilical arteries and membranes are checked for the presence of infection. Evidence of infection may include any or all of the following: inflammation, black and/or blue tissue discolouration and oedema. The liver is checked for infection. The presence of disease foci on the liver are evidence of infection and variation in liver colour should not be confused with infection. Lamb death from infection (e.g. navel ill) is more common in older lambs.

Abnormality: Check for congenital abnormalities such as cleft palate, imperforate anus, joint problems and skeletal defects. Note other abnormalities such as enlarged liver, enlarged kidneys, enlarged heart, brittle/weak ribs.

Unknown: There are always a number of dead lambs where a diagnosis for cause of death cannot be found using the post-mortem examination protocol. If symptoms do not fit any of the criteria described, record the lamb death as unknown.

Iodine deficiency

Iodine deficiency can affect fertility and perinatal mortality, as deficient lambs have a low metabolic rate, are prone to hypothermia and have impaired suckling behaviour [11,12]. At post-mortem examination both thyroid glands are removed and weighed in grams to determine the thyroid-weight:birthweight ratios (g/kg) in newborn lambs. It has been widely accepted that a thyroid-weight:birthweight ratio (g/kg) of >0.4 indicate iodine deficiency [13,14]. It is recommended that breeding ewes are supplemented with iodine the following season to reduce iodine deficiency in their lambs. This is particularly important if ewes are fed brassica crops during pregnancy (as brassica crops are goitrogenic).

SUMMARY

An important outcome of AgResearch's lamb survival programme was the identification of simplified protocol for assessing field lamb survival and mortality measurements, which can be undertaken by ram breeders (and researchers) with minimal training. This system is scientifically backed by more detailed measurements and has resulted in accurate trait definition.

This post-mortem protocol is being used to collect data from a range of industry flocks for a gene marker discovery programme funded by Ovita Ltd. The Ovita lamb survival programme currently includes over 8000 post mortem records from 50,000 dams and 700 sires across 43 performance recorded flocks. Breeders involved in the Ovita Lamb Survival study are trained to use the post-mortem protocol and can access breeding

values for the lamb mortality traits on SIL [7]. Lamb survival has an extremely high economic value within SIL (\$63) so even a small improvement in its genetic evaluation will have a significant impact on the dual purpose index. Farmers can then choose to use these selection indices to improve lamb survival rates faster than has been previously possible.

ACKNOWLEDGEMENTS

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APPENDIX TWO

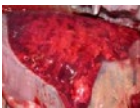
POST MORTEM EXAMINATION AND DECISION SUPPORT TOOL

Step	
1	Weigh lamb (kg) to nearest 0.1 of akg
2	Record the lamb's gender (E=ewe lamb, R=ram lamb)
	Examine the lamb externally for physical abnormalities

3	Has the lamb walked?	No	Yes
			

4	Dissect the lamb & expose organs	
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Optional:	Remove both thyroids, weigh and determine if the lamb is iodine deficient		 Thyroid size not to scale Lamb is iodine deficient if thyroid weight in grams ÷ lamb weight in kg is ≥ 0.4
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Has the lamb breathed?	Picture evidence examples (if Yes)	No	Yes
5	Check the lungs. Are the lungs aerated? (pink = aerated; crimson = not aerated)   Fully aerated Partly aerated	If No, go to Step 6	If Yes, go to Step 7
★	SIL Trait	If answer 'yellow' / Yes then LDVB=1	LDVB=0 LDVB=1

6	Is there evidence of tissue degradation?		If No, go to Step 7	If Yes, lamb died before birth, go to Step 7
		pinkish/brown		

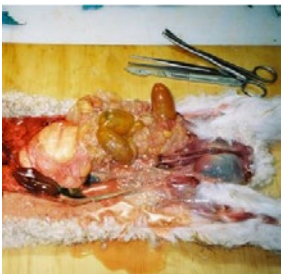
Has the lamb died from Dystocia (difficult birth)?		Picture evidence examples (if Yes)	No	Yes
7	Is there evidence of a haemorrhage?		If No, go to Step 8	☒ LDD=1 (Dystocia) Go to Step 8
8	Has the liver ruptured?		If No, go to Step 9	☒ LDD=1 (Dystocia) Go to Step 9
9	Is there oedema under the skin? (check head, neck, sternum & ribcage- refer to arrows)	 Localised subcutaneous oedema / 'jelly' has to be greater than 3mm thick	If No, go to Step 10	☒ LDD=1 (Dystocia)
★	SIL Trait	If one of the answers 'red'/Yes Then LDD=1	LDD=0	LDD=1

If LDD=1 lamb has died from dystocia, STOP here.

Has the lamb died from starvation/mismothering/exposure?		Picture evidence examples (if Yes)	No	Yes
10	Examine the heart and kidneys. Has all of the brown fat been used?		If No, go to Step 11	If Yes, go to Step 11
11	Examine the stomach. Is there a milk clot?		If No, go to Step 12	If Yes, go to Step 12

12	Is there evidence of milk absorption in the gastrointestinal tract?		If No, go to Step 13	If Yes, go to Step 13
★	SIL Trait	If all answers are 'blue' then LDSE=1	LDSE = 0	LDSE=1

If LDSE=1 lamb has died from starvation/exposure, STOP here.

Has the lamb died from OTHER causes?		Picture evidence examples (if Yes)	No	Yes
13	Is there infection around the navel?		If No, go to Step 14	If Yes then ☒ LDOTHER=1 (LDremark=Infection) Go to STEP 14
14	Are there lesions on the liver?		If No, go to Step 15	If Yes then ☒ LDOTHER=1 (LDremark=Infection) Go to Step 15
15	Is there an abnormality?		If No, go to Step 16	If Yes ☒ LDOTHER=1 (LDremark=abnormality) Go to STEP 16
16	Is the cause of death is unknown?	Don't force a diagnosis, if in doubt ☒ LDOTHER=1		☒ Yes ☒ LDOTHER=1 (LDremark=unknown)
★	SIL Trait	If answers 'green' then LDOTHER=1 and add LDremark	LDOTHER=0	LDOTHER=1

If LDOTHER=1 lamb has died from Other causes. Add Remark.

**Check that you have completed the ★
(★ refer to the SIL traits)**

Figure 6.1. Lung fully aerated, partially aerated and not aerated (from left to right).

(Image courtesy of Keith Thompson, Institute of Veterinary Animal and Biomedical Sciences, Massey University, Palmerston North, New Zealand).



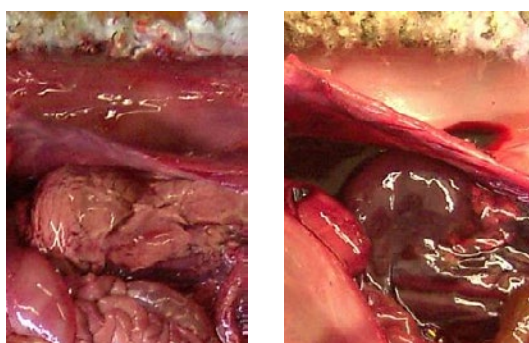
Figure 6.2. Localised subcutaneous oedema on the ventral side of the jaw, severe subcutaneous oedema on body (discoloured red from freezing thawing storage process), localised subcutaneous oedema on breech (from left to right).



Figure 6.3. Pericardial and perirenal fat: present and mobilised (from left to right).



Figure 6.4. Close up of perirenal fat: present and mobilised (from left to right).



APPENDIX THREE

FEED REQUIREMENTS OF SHEEP

EXPLANATORY NOTES

These feeding tables give daily requirements of metabolisable energy in megajoules per day (MJ ME/d) for different levels of production.

The ME values in the tables can easily be converted to kilograms of dry-matter per day (kg DM/d) for different feeds using the ME feed values in Appendix 4.3 and the ready reckoner in Appendix 3.6.

For example the daily ME requirement to maintain weight for a 50kg ewe grazing mixed length leafy pasture with an ME content of 10.8 (from Appendix 4.3) would be 10 MJME/d (from Appendix 3.1). Using the ready reckoner in Appendix 3.6 this comes to 0.9 kg DM/d i.e. 10 MJ ME/d at a concentration of 11 MJ ME/kg DM. (see values circled on Appendix 3.1 and 3.6 for this example).

Appendix 3.1. ME requirements for maintenance and liveweight gain in mature ewes (MJ ME/d).

	Liveweight (kg)				
Liveweight gain (g/d)	40	45	50	55	60
Maintenance	8.5	9.0	10.0	11.0	11.5
50	11.0	12.0	13.0	14.0	14.5
100	13.5	15.0	16.5	17.0	18.0
150	16.0	18.0	20.0	20.5	22.0

Appendix 3.2. ME requirements of wether and ram lambs (MJME/d).

	Liveweight (kg)				
Liveweight gain (g/d)	20	25	30	35	40
0	6.5	8.0	9.0	10.0	11.0
50	8.0	9.5	11.0	12.0	13.5
100	9.5	11.0	13.0	14.5	16.0
150	11.0	13.0	15.0	16.5	18.5
200	12.5	14.5	17.0	19.0	21.0
250	14.0	16.5	19.0	21.0	23.5
300	15.5	18.0	21.0	23.0	26.0

Appendix 3.3. ME requirements of ewe hoggets (MJME/d).

	Liveweight (kg)				
Liveweight gain (g/d)	25	30	35	40	45
0	8.0	9.0	10.0	11.0	12.0
50	10.0	11.5	13.0	14.0	15.5
100	12.5	14.0	16.0	17.5	19.0
150	14.5	17.0	19.0	21.0	23.0
200	17.0	19.5	22.0	24.5	26.5

Appendix 3.4. ME requirements of ewes (MJME/d) during different stages of lactation.

	Single-suckling				Twin-suckling			
Liveweight	week				week			
(kg)	1	3	6	9	1	3	6	9
40	12.0	23.0	20.0	18.5	23.0	26.0	23.0	20.0
45	21.0	24.0	21.0	19.5	24.0	27.0	24.0	21.0
50	24.5	28.5	24.5	20.5	28.5	32.0	28.5	22.0
55	25.0	29.0	25.0	21.5	29.0	33.0	29.0	23.0
60	26.0	30.0	26.0	22.0	30.0	34.0	30.0	24.0
65	27.0	31.0	27.0	23.0	31.0	35.0	31.0	25.0
70	28.0	32.0	28.0	24.0	32.0	36.0	32.0	26.0
Lamb pasture requirement	-	3.0	5.0	9.0	-	2.0	4.0	8.0

Note:

(1) Eachkg of ewe liveweight lost is equivalent to 17MJ ME while eachkg of ewe liveweight gained requires an additional 65 MJ ME.

(2) For triplets or quads add 1.0, 2.0 and 4.0 MJ ME/d for weeks 3, 6 and 9 respectively.

Appendix 3.5. ME required (MJME/D) during pregnancy by ewes, in addition to maternal requirements, for a lamb birth weight of 4kg.

	MJ ME/d					
Weeks before term	12	8	6	4	2	Term
Ewes	0.4	1.1	1.7	2.6	0.8	5.3

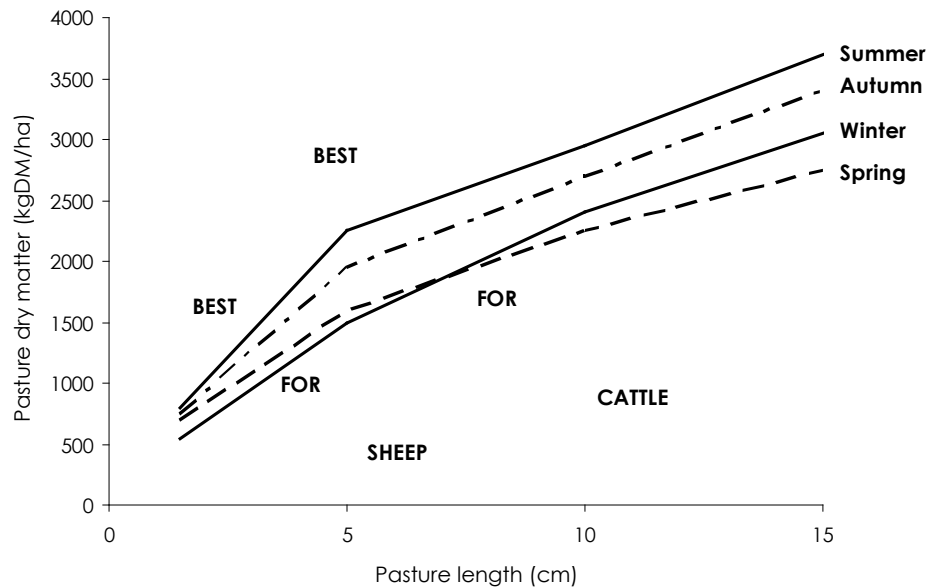
Note: Add 75% of these values for each additional foetus carried.

Appendix 3.6. Ready reckoner to convert metabolisable energy (MJ ME/day) to dry-matter (kg DM/day).

kg DM per day for different ME concentrations in feed (MJME/kgDM)						kg DM per day for different ME concentrations in feed (MJME/kgDM)					
	8	9	10	11	12		8	9	10	11	12
MJME/d	kg DM/d					MJME/d	kg DM/d				
1	0.1	0.1	0.1	0.1	0.1	21	2.6	2.3	2.1	1.9	1.7
2	0.2	0.2	0.2	0.2	0.2	22	2.7	2.4	2.2	2.0	1.8
3	0.4	0.3	0.3	0.3	0.2	23	2.9	2.5	2.3	2.1	1.9
4	0.5	0.4	0.4	0.4	0.3	24	3.0	2.7	2.4	2.2	2.0
5	0.6	0.5	0.5	0.4	0.4	25	3.1	2.8	2.5	2.3	2.1
6	0.7	0.7	0.6	0.5	0.5	26	3.2	2.8	2.6	2.4	2.2
7	0.9	0.8	0.7	0.6	0.6	27	3.4	3.0	2.7	2.4	2.2
8	1.0	0.9	0.8	0.7	0.7	28	3.5	3.1	2.8	2.5	2.3
9	1.1	1.0	0.9	0.8	0.7	29	3.6	3.2	2.9	2.6	2.4
10	1.2	1.1	1.0	0.9	0.8	30	3.7	3.3	3.0	2.7	2.5
11	1.4	1.2	1.1	1.0	0.9	31	3.9	3.4	3.1	2.8	2.6
12	1.5	1.3	1.2	1.1	1.0	32	4.0	3.5	3.2	2.9	2.7
13	1.6	1.4	1.3	1.2	1.1	33	4.1	3.7	3.3	3.0	2.7
14	1.7	1.5	1.4	1.3	1.2	34	4.2	3.8	3.4	3.1	2.8
15	1.9	1.7	1.5	1.4	1.2	35	4.4	3.9	3.5	3.2	2.9
16	2.0	1.8	1.6	1.4	1.3	36	4.5	4.0	3.6	3.3	3.0
17	2.1	1.9	1.7	1.5	1.4	37	4.6	4.1	3.7	3.4	3.1
18	2.2	2.0	1.8	1.6	1.5	38	4.7	4.2	3.8	3.4	3.2
19	2.4	2.1	1.9	1.7	1.6	39	4.9	4.3	3.9	3.5	3.2
20	2.5	2.2	2.0	1.8	1.7	40	5.0	4.4	4.0	3.6	3.3

APPENDIX FOUR

Appendix 4.1. Generalised seasonal conversion of pasture length to pasture dry matter for an average rye grass-clover pasture.



Appendix 4.2. Minimum pasture length and dry matter quantities for different sheep production levels during the year.

	Pasture Length (cm)	Pasture DM (kg/ha)	Feed Intake (kg DM/d)	Production level
Ewes				
Mid pregnancy	1-2	400-500	1.0	Maintenance
6 weeks pre-lamb	2-3	600-800	1.3	60-80 g/d
Ewes and Lambs	4-5	1400-1600	1.8	180-200 g/d
				(lambs)
Summer	1-2	900-1000	1.0	Maintenance
Mating	2-3	1200-1400	1.4	120-150 g/d
Lambs				
Weaned- - spring	3-4	1200-1400	0.8	160-200 g/d
- summer	2-3	1400	1.0	130-150 g/d
- autumn	2-3	1200	1.2	80-100 g/d
- winter	3	1100	1.2	100-120 g/d
Hoggets - summer	2-3	1400	1.3	60-80 g/d

Appendix 4.3. Nutritional value of different feeds

	% DM	*Relative ME Value on DM Basis	ME Concentration (MJME/kg DM)	% Crude Protein DM Basis
Pasture				
Short leafy	15	1.1	11.7	27
Mixed-length leafy	18	1.0	10.8	21
Dry stalky	28	0.8	8.1	10
Lucerne				
Green vegetative	15-25	0.9	8.5-11.0	30
Bud formation		0.8	8.5-9.5	25
10-20% flowering		0.8	8.0-9.5	22
Silages	15-20	0.9	8.4-9.5	12-20
Lucerne	19	0.8	7.1-8.5	21
Formic acid lucerne	19	0.8	8.0-9.5	21
Wilted lucerne	30			
Maize	33	1.0	10.2-10.8	8
Hays				
Pasture Good quality	85	0.8	8.4	12
Poor quality	85	0.7	7.3	12
Lucerne	85	0.8	8.0-9.5	17
Straws				
Oats	86	0.6	7.0	4
Wheat	86	0.5	5.7	3
Barley	86	0.7	7.1	5
Ryegrass	86	0.7	7.1-8.0	6
Pea	86	0.7	7.2	9
Corn stover	84	0.8	6.9-9.4	5
Crops				
Swede tops	15	1.3	13.5	15
bulb	10	1.3	13.5	11
Turnip tops	13	1.3	14.1	20
Bulb	9	1.2	12.9	12
Choumoellier	15	1.1	11.7	14
Rape	20	1.2	12.4	16
Kale	16	1.1	11.9	15
Mangels	13	1.1	11.9	15
Fodder beet	20	1.1	12.1	9
Carrots	13	1.2	13.0	9
Potatoes	24	1.2	12.6	8
Green maize	24	0.9	8.8-11.3	10
Lupins (sweet)	18	1.0	10.3	17
Fodder radish	11	1.0	11.5	10

*Relative ME values are relative to leafy pasture with a value of 1.0(ME concentration of 10.8 MJME/kg DM)

Appendix 4.3. continued. Nutritional value of different feeds.

	% DM	*Relative ME Value on DM Basis	ME Concentration (MJME/kg DM)	% Crude Protein DM Basis
Green Feeds				
Oats	17	1.2	13.0	15
Barley	17	1.2	12.5	15
Ryecorn	17	1.1	12.5	15
Wheat	17	0.9	9.5	15
Concentrates				
Wheat	86	1.3	13.5	14
Barley	86	1.2	13.1	12
Oats	86	1.1	12.0	13
Maize meal	86	1.3	13.9	10
Linseed cake	86	1.1	12.0	26
Peas	86	1.2	13.1	26
Bran	86	0.9	9.6	17
Pollard	86	1.1	12.2	18
Brewer's grains	30-40	0.9	10.0	25
Molasses	75	1.1	11.8	4
Lucerne meal	86	0.9	9.5-10.3	22

*Relative ME values are relative to leafy pasture with a value of 1.0 (ME concentration of 10.8 MJME/kg DM)

Note: The feed values in Appendix 4.3 refer to the important components of energy and protein but it should be remembered that sheep also require a balance of vitamins, minerals and water. Fortunately good quality pasture contains about the right balance except where known mineral deficiencies such as selenium occur. It is considered that energy is the main limiting feed component, hence its use for estimating feed quantities. As a rule, protein concentration of a sheep's diet should be around 6-8% for adult maintenance, 12-16% for young growing stock and at least 15% for lactating ewes.

APPENDIX FIVE

Appendix 5.1. Weight of gravid uterus for ewes.

Stage of gestation	Ewes	
	single	twin (kg)
70	1.5	2.0
100	3.0	5.0
125	5.5	10.0
140	8.5	14.5

APPENDIX SIX

CONDITION SCORING OF SHEEP

EXPLANATORY NOTES

Condition scoring of sheep assesses the amount of body fat or condition by feeling the vertical (spine) and horizontal processes along the loin area as shown in the diagrams below. The technique is valuable as it relates to production ability of sheep regardless of

body weight eg. at 55kg liveweight a small framed ewe may have a condition score of 4, a large framed ewe a condition score of 2. As a rule for a given sheep there will be about a 5kg difference in liveweight between condition scores.

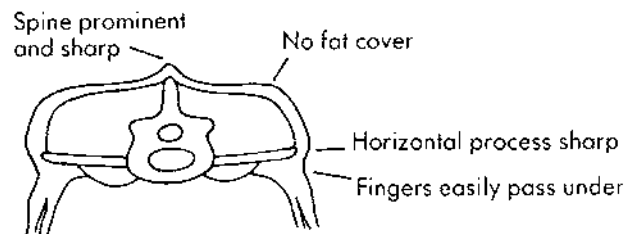
A. CONDITION SCORES 0, 1 AND 2: INDICATE UNDER FEEDING AND LOW PRODUCTION

Score 0

This is seldom used as it only applies to ewes which are extremely emaciated and on the point of death. It is not possible to feel any muscle or fatty tissue between skin and bone.

Score 1

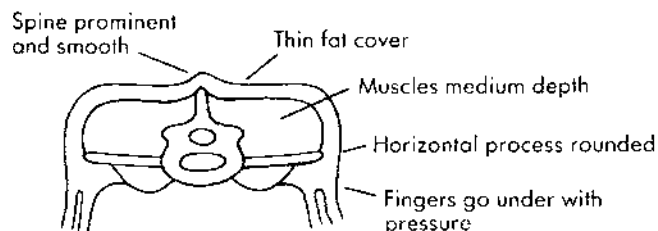
The vertical (spine) and horizontal (lumbar) processes are prominent and sharp. The fingers can be pushed easily below the horizontals and each process can be felt. The loin muscle is thin with no fat cover. **GR 0-5mm**



Score 2

The vertical processes are prominent but smooth, individual processes being felt only as corrugations. The horizontal processes are smooth and rounded, but it is still possible to press the fingers under. The loin muscle is of moderate depth but with little fat cover.

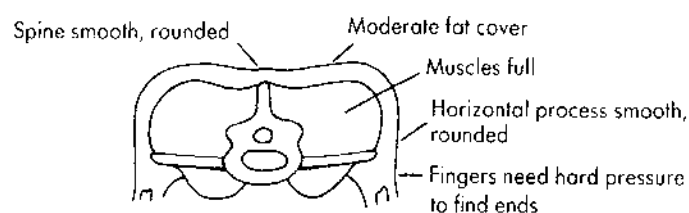
GR 5- 8mm



B. CONDITION SCORES 3 AND 4: INDICATE GOOD FEEDING AND HIGH PRODUCTION

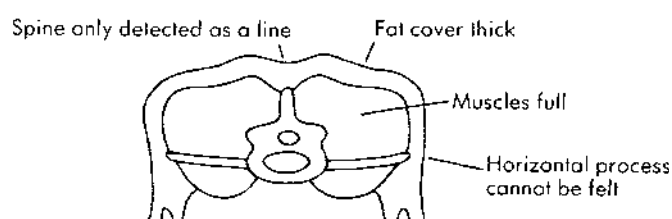
Score 3

The vertical processes are smooth and rounded; the bone is only felt with pressure. The horizontal processes are also smooth and well covered; hard pressure with the fingers is needed to find the ends. The loin muscle is full, with a moderate fat cover. **GR 9 - 15mm**



Score 4

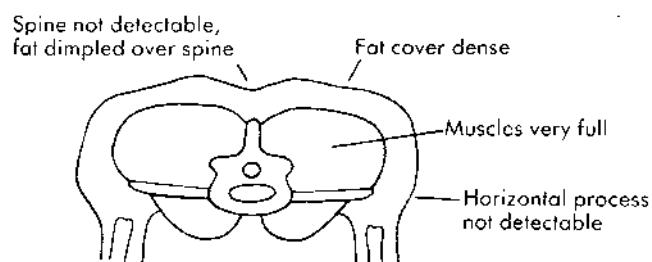
The vertical processes are only detectable as a line; the ends of the horizontal processes cannot be felt. The loin muscles are full and have a thick covering of fat. **GR 15- 20mm**



C. CONDITION SCORE 5: OVERFED AND OVERFAT (GR OVER 21MM)

Score 5

The vertical processes cannot be detected even with pressure; there is a dimple in the fat layers where the processes should be. The horizontal processes cannot be detected. The loin muscles are very full and covered with very thick fat. **GR over 20mm**



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