Chapter 4
MID TO LATE PREGNANCY

Recommendations

- *Feed ewes well in mid pregnancy to ensure good lamb birth weight.*
- *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 residual pasture after grazing is more than 800 kg DM/ha, there is no benefit in grazing multiple-bearing ewes separately).*
- *It is important to feed ewes 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 throughout 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-lamb to avoid clostridial diseases.*
- *Treat trace element deficiencies (as advised by a veterinarian) to ensure adequate levels in newborn lambs.*

This chapter covers management in the second and third 50 days of pregnancy (from day 51 of pregnancy to lambing), 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 is still influenced by mid-pregnancy nutrition and maintaining ewe condition is a priority for late pregnancy, particularly in ewes with multiples. Good 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 foetuses carried by commercial ewes. It is increasingly common and practised on all New Zealand breeds (see farm scanning survey in Chapter 1).

Scanning information allows farmers to:

- identify non-pregnant ewes and quit these (if not already identified with harnessed vasectomised rams)
- identify ewes carrying multiple lambs and 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.
- plan lambing paddocks for single- and multiple-bearing ewes — e.g., allocating areas with better shelter and more pasture cover to multiple-bearing ewes if few suitable paddocks are available
- compare scanning percentage with expected percentage (based on ewe live weight at mating)
- quantify lamb losses between scanning and birth or tailing

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 conditions within their flock. UK scanning operators provide additional information including expected spread of lambing according to lamb size and stage of development at scanning.

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

Scanning to identify multiples is most reliable when done up to 90 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.

Feeding recommendations based on scanning include:

- maintain body condition in both single and multiple-bearing ewes. This means no more loss of live weight than 3-5 kg between mating and lambing (i.e. one condition score) allowing for weight of conceptus (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 800 kg DM/ha or greater there is little benefit in separating twin bearing ewes from singles

Ewe feeding and lamb birth weight

The major factors affecting foetal growth (and hence, lamb birth weight) are ewe nutrition and size of the placenta — and these act simultaneously. Placental development to day 90 of pregnancy (see Chapter 3) 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.***

The effect of ewe live weight gain during the first 50 days of pregnancy has been shown to influence lamb birth weight by 46g for every one kg of ewe weight gained (Orleans-Probee and Beatson, 1989) in both single and multiple pregnancies. This effect was not apparent during the second 50 days of pregnancy while during the final 50 days lamb birth weight increased by 111g/kg of ewe live weight gain.

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.

> ***In both heavy and light ewes carrying twins a high level of feeding during mid pregnancy increases foetal weight, especially in light ewes.***

Ewe live weight at mating and plane of nutrition in mid pregnancy interact. British trials showed 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 (De Barro *et al.*, 1992).

In heavy and light ewes with twins a high level of feeding during mid pregnancy increased foetal weight, the effect greatest in light ewes in the above study.

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. Ewes in very high condition (CS 4) at mating should be fed to lose 10% of live weight to mid pregnancy (Gunn *et al.*, 1986).

Table 9: Litter size of Greyface ewes in high body condition at mating and given high, medium or low feeding in mid pregnancy (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

Trial results are somewhat contradictory. Some trials show no strong evidence of reduced lamb birth weight or lamb survival following ewe undernutrition in mid pregnancy (Fogarty *et al.*, 1992; Orleans-Pobee and Beatson, 1989; Hawker and Thompson, 1987; Monteath, 1971). Other trials show fewer ewes lambing (78% compared with 85% for well fed ewes) and fewer with multiples (26% compared with 42%) with ewes fed at *very* low levels in mid pregnancy (Smeaton *et al.*, 1985).

Severe underfeeding in mid pregnancy can reduce the number of lambs born.

Effects of shearing during pregnancy on lamb birth weight

Pre-lamb shearing 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.

Some evidence suggests shearing ewes in mid pregnancy (between days 50-100) significantly increases birth weight of multiples.

Recent experiments show shearing earlier in pregnancy may alter lamb birth weight, with interactions between shearing time and birth rank (Morris and McCutcheon, 1996). Time of shearing (day 70, 100 or 130 of pregnancy) did not affect birth weight of single lambs but birth weight of twins increased by 0.7 kg per lamb with shearing ewes at 70 days compared with lambs born to unshorn ewes . This may be a practical strategy for increasing birth weights in prolific flocks.

See also the "Pre-lamb shearing" section (i.e. shearing in *late* pregnancy, p.66).

Late pregnancy ewe nutrition

About 70% of foetal growth occurs in the last third of pregnancy (see Fig. 5, p.57), 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, 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 this period is largely unaffected by variations in ewe feeding level (Dalton *et al.*, 1980; Knight *et al.*, 1988). 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 (Davis *et al.*, 1981).

> ***Foetal growth during late pregnancy is largely unaffected by varying feeding levels.***

Trials showed 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 (Mellor, 1983). 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 controls. After prolonged underfeeding for 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 (McClymont and Lambourne, 1958; Russell *et al.*, 1977). Ewes in good condition (CS3) six weeks before lambing will mobilise body reserves and can make up some shortfall in feeding, especially for multiple lambs. Table 10 shows the extra energy intake required by ewes in late pregnancy.

Table 10: Extra energy (in addition to maintenance) required by pregnant ewes to achieve 4.0 kg lamb birth weight (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.

These increased requirements mean 0.1-0.5 kg DM more for ewes with singles and 0.2-1.0 kg DM more for multiples during the last 60 days of pregnancy. Such increases will be difficult to achieve with multiples requiring pasture covers of over 800 kg DM/ha or 3cm in length (see Appendix 4.2).

Increased ewe feed requirements above maintenance during the final 60 days of pregnancy are 0.1-0.5 kg DM per day for singles and 0.2-0.9 kg DM for multiples.

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 (e.g. straw or hay) are not suitable.

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 (Curll *et al.*, 1975) through changes in both ewe milk production and/or lamb vigour.

Undernutrition in pregnancy restricts mammary growth and development (Thompson and Thompson, 1953; Russel *et al.*, 1977). It also depletes ewe body reserves, causing poorer energetic efficiency in lactation (Geenty and Sykes, 1986) and reduces lamb birth weight and subsequent ability to withdraw milk (Peart, 1967).

Ewes poorly fed in late pregnancy (i.e. ewes losing live weight) 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 (Wallace, 1948; McCance and Alexander, 1959). 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 (internal fat stores)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 (McDonald, 1962). In addition, birth may be prolonged and ewes may show poorer mothering ability (McDonald, 1962; Hight and Jury, 1970).

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 (Hight and Jury, 1970). 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) from mid-pregnancy and into lactation may cause more colostrum and increased lamb survival (Hinch *et al.*, 1996). This increased survival is independent of effects on lamb birth weight. Ewe protein supplementation does not appear to affect lamb growth after birth.

Ewes supplemented with protein or concentrates in late pregnancy may produce more colostrum and cause 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 (Hinch *et al.*, 1996). 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 temporary) and prolonged birth which depletes lamb energy reserves.

Similar effects to protein supplementation may be obtained using tannin containing plants in pastures (eg *lotus corniculatus* or *sulla)* which protect plant protein from breakdown in the rumen.

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 seven months after birth (Everitt, 1967). Ewe milking is reduced throughout lactation after pregnancy underfeeding (Wallace, 1948; Everitt, 1967).

Lifetime performance of ewe lambs

Underfeeding ewes in late pregnancy or early lactation may reduce the lifetime performance of their daughters (Gunn *et al.*, 1995). 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.

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 (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 (precursors to ova) was significantly retarded (Borwick *et al.*, 1994).

Out of season lambing

Some farmers use out of season lambing to produce lambs for meat companies to process 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 (Hawkins *et al.*, 1989). Two tooths entering the flock need higher live weight 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 suits 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 (e.g. 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 (McMillan *et al.*, 1988). These losses are two to three times worse than the effect of a similar outbreak in ewes around mating time.

Conclusions on feeding in mid-late pregnancy

General recommendations are:

- ewes should be fed in mid pregnancy to at least maintain their mating body weight and condition
- very fat ewes (CS 4 or greater) should lose up to 10% of their 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 800 kg DM/ha or more.
- good quality feed is important in the last six 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 Table 10 on p.63

Pre-lamb shearing

Fine wool sheep are commonly pre-lamb shorn 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 provide protection for their lambs in rough weather.

British trials with housed sheep have found higher lamb birth weight and survival of multiples with ewes shorn during pregnancy (Maund, 1980; Kirk *et al.*, 1984; Symonds *et al.*, 1986; Vipond *et al.*, 1987; Black and Chestnutt, 1990). Shearing effects were more pronounced with earlier pregnancy shearing due to greater effects on placental development (Black and Chestnutt, 1990).

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

New Zealand trials suggest pre-lamb shearing does not significantly increase lamb birth weight (Dabiri *et al.*, 1995b; Orleans-Pobee and Beatson, 1989) despite the above British results to the contrary. However recent New Zealand work shows that shearing by day 70 of pregnancy increases birth weight of single and multiple lambs (D.Revell, *pers.comm.*)(see also p.61).

Ewes shorn close to lambing appear to make more use of shelter before, during and after lambing (Alexander and Lynch, 1976) 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 (Alexander and Lynch, 1976).

Pre lamb shearing of ewes can cause them to seek out shelter with better lamb survival.

Shearing with a winter comb leaves about two thirds more wool (5-6 mm) than a standard comb and enhances ewe survival with pre-lamb shearing (Dabiri *et al.*, 1995a), especially in cold, wet, windy weather. Ewes maintain weight better as less energy is used to maintain body temperature. Shearing with a winter comb is a practical way to reduce cold stress in pre-lamb shorn ewes.

Abortion

The most common causes of abortion in sheep are toxoplasmosis and campylobacter (also known as "vibrio"). Both 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 the 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 abortion should be identified and retained.

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 resorption 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 tooths) 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. Non-pregnant ewes can be vaccinated at any time but not less than four weeks before mating. 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 bacteria in aborted material or discharges from aborting ewes.

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 and a booster shot is recommended each year thereafter. The first treatment should be before mating and the booster eight weeks later. Failure to treat in subsequent years means ewes are unprotected although some farmers report good results despite failure to give boosters (T. Knight, *pers. comm.*).

Vaccination for campylobacter is effective with a sensitiser and booster required in the first year and a booster each year thereafter.

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 are lost. 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 ewes with multiples 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 but remain apparently bright and alert.

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, again 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.

Treatment for pregnancy toxaemia is orally with a sugary solution or "ketol".

Bearings

Vaginal prolapse ("bearings") limits reproductive performance through ewe and lamb deaths and has 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 (McLean, 1956). Incidences up to 17% have been reported in some North Island Merino flocks (Matthews, 1996).

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

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 (McLean, 1957)
- 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", Shackell *et al.*, 1993a)

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 11 (McLean and Claxton, 1959).

Table 11: Seasonal variation in incidence of bearings. Incidence shown as percentage of total ewes (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

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 tooths which may have suffered injury during lambing.

Treatment

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 killed (McLean, 1959). If affected ewes were kept, 30–35% recurrence was expected each year.

Treatment of ewes with bearings

Successful treatment of bearings relies on early detection, gentle and clean replacement and effective retention. The bearing must be well cleaned 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 Appendix1.0).

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.

Physiological changes in pregnancy

Vaginal volume increases markedly in pregnancy (McLean, 1956; McLean and Claxton, 1958). 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 0.7–7.0 kgDM/ewe/day in the last six weeks of pregnancy (Rattray *et al.*, 1982). However, these feeding levels were introduced at six 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 will be a far greater cost than that of bearings.

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

Pre-lamb health checks

Ewe vaccination with "5-in-1" protects lambs from clostridial diseases and blood poisoning. 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.

Ewe vaccination with "5-in-1" in late pregnancy protects lambs against deaths between lambing and weaning caused by clostridial diseases and blood poisoning.

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 (Millar, 1983). 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.

Current work is determining normal values for newborn lambs and comparing Vitamin E levels in those with unexplained white muscle disease. It appears that Vitamin E levels in newborns 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.

Iodine deficiency

Iodine deficiency causes goitre (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 (Barry, 1983). Veterinary advice should be sought regarding testing and treatment of iodine deficiency (see also p.46).

Iodine deficiency in ewes can hinder lamb development during pregnancy and cause lamb deaths soon after birth due to goitre.

Chapter 5
LAMBING

Recommendations

- ***Choose lambing paddocks to avoid cold wet sites and steep hills, protect from prevailing storms and provide adequate feed for lambing ewes.***
- ***If suitable areas are limited, give them to multiple-bearing ewes. Alternatively, allocate best areas to ewes due to lamb (identified with ram crayons at mating).***
- ***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 (e.g., if shedding off unlambed ewes)..***
- ***Pasture cover should be around 1200 kgDM/ha at lambing. Good ewe nutrition according to ewe liveweight and litter size is important for high milk production and maintenance or gain of 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 lambs requires about 2.8 times maintenance in the first week of lactation, rising to about 3 times maintenance by the third week.***
- ***See Appendix 3.4 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 realised with a good lambing percentage.

The importance of providing the lambs that are 'on board' 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 influencing 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 12 (T.Knight *et al.*, 1983), because lambs born on slopes slipped off the birth site and were mis-mothered.

Table 12: Deaths (as percentage of lambs born) attributable to effects of slipping from the birth site (T.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

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 are often separated, especially if the first lamb slips from the site while the second 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.

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 (Knight *et al.*, 1983).

Lamb survival is better 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° (Knight *et al.*, 1990). 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 Romneys. Merino ewes and lambs usually return to the top of the slope after retrieval whereas Romneys tend to stay where the lamb has stopped.

When lambs are born on gentle contour, moving them to steeper paddocks within a few days does not cause extra losses (McMillan and Knight, 1985). Lambs cope with slopes over 30° once they are mobile and feeding (i.e. 4–12 hours old).

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.

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 (Alexander, 1983). 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 ewes not fed well in 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
- lamb covers (plastic or wool)

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

Trials show shorn ewes tend to make more use of shelter than unshorn ewes and may therefore have higher lamb survival in rough weather (Alexander and Lynch, 1976). 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 (T.Knight, *pers. comm.*). 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 88.

Paddock history

Some paddocks have a history of good lamb survival for no apparently 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 North Island Merino flocks (Matthews, 1996). Survival of twin-born lambs is usually 3-10% lower than for single-born animals (Hinch *et al.*, 1983). Typical death rates among singles are about 9-16% while twins in the same flocks have death rates of 15-22% (Knight *et al.*, 1979). Lamb survival may appear poor in high fecundity flocks due to the larger numbers of triplets and quadruplets (Hinch *et al.*, 1985).

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 (Hight and Jury, 1970; Dalton *et al.*, 1980). Table 13 summarises the main causes of lamb deaths.

Table 13: Causes of lamb deaths as a percentage of total lamb deaths (adapted from Hight and Jury, 1970)

	single lambs	twin lambs	all lambs
prenatal death*	8	14	10
dystocia	45	15	32
starvation/exposure	15	42	27
infection	11	11	11
abnormal lambs	1	1	1
misadventure	3	4	4
unknown	17	12	15

*(*Note: "prenatal death" refers to loss of established pregnancy — e.g. lambs dying in utero, mummified foetuses, lost due to Brucella abortus, campylobacter, and toxoplasmosis. It does not include early embryonic losses.)*

Major causes of lamb death are dystocia in singles and starvation/exposure in multiples.

Lamb deaths are mainly due to dystocia in single-born lambs and to the starvation/exposure 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.

Some 70% of all lamb deaths can be avboided by good ewe and lamb nutrition and preventive measures.

The requirements for good lamb survival (Alexander, 1983) can be summarised as:

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

Attention to all these above factors can avoid up to 70% of all lamb deaths

Lamb birth weight

Lamb birth weight is the dominant factor in survival of both singles and multiples (Hinch *et al.*, 1985). Optimum birth weights for lamb survival have been estimated as about 3.9–5.0 kg for single lambs and 3.2–4.5 kg for twin lambs (Hight and Jury, 1970) or 3.5–5.5 kg for both singles and twins with an optimal birth weight of 4.7 ±0.2 kg for maximum lamb survival (Dalton *et al.*, 1980). Lambs weighing less than about 3.0 kg or more than 6.5 kg at birth have a very low survival rate (Hight and Jury, 1970; Dalton *et al.*, 1980).

Optimum lamb birth weight for best survival is 3.5-5.5 kg for singles and multiples. Below this range increases the risk of starvation/exposure (mainly multiples) and above dystocia (mainly singles).

Figure 6 demonstrates the changing prevalence of starvation/exposure and dystocia, the two main causes of lamb death near lambing, according to lamb birth weight.

Figs 6.1- 6.3 Lamb death statistics (from Dalton *et al.*, 1980).

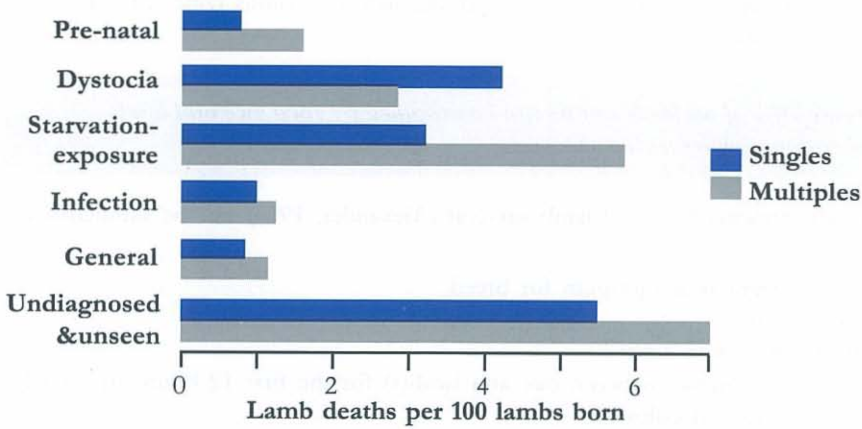

Fig. 6.1 : Causes of lamb death

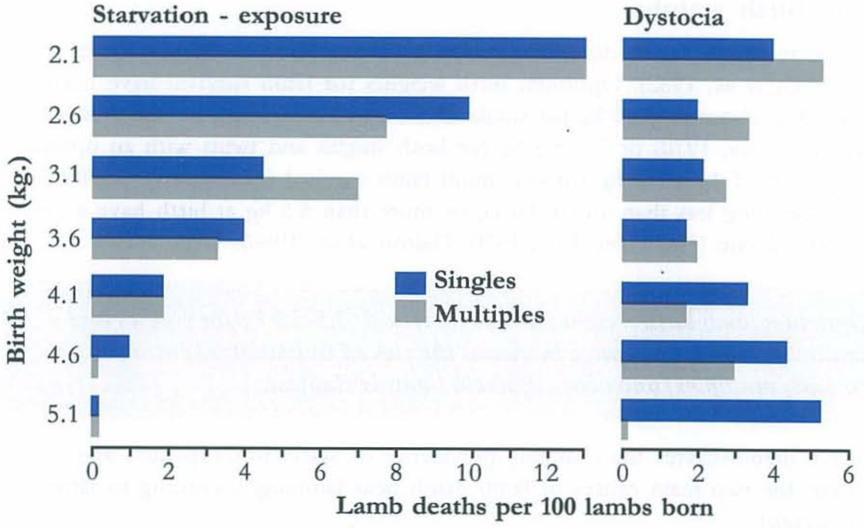

Fig. 6.2: Lamb deaths from dystocia and starvation-exposure classified according to birth weight

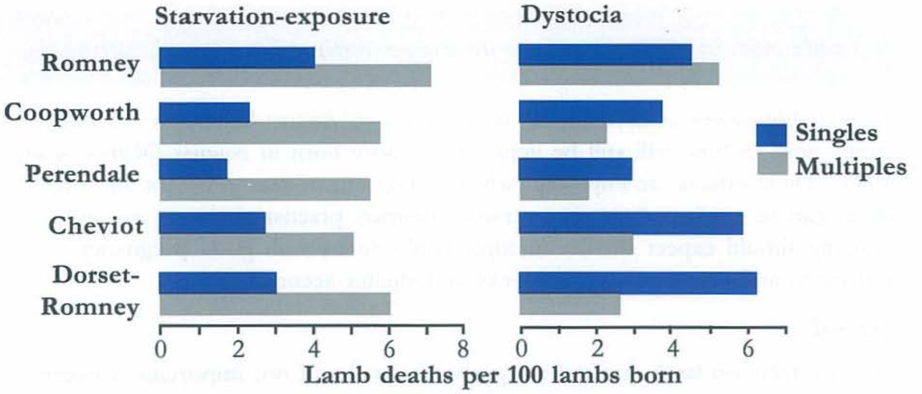

Fig. 6.3: Breed differences in incidence of Dystocia and starvation-exposure

The results in Fig 6.2 suggest lambs need to be at least 3.2 kg at birth, preferably 4 kg. This is almost always achieved in single lambs but is 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. Dystocia increases at lamb weights over 5.0 kg (most common in single lambs) although weights up to almost 6 kg may be acceptable for easy birth strains and breeds (Rohloff, 1984).

Good ewe nutrition is essential for optimum birth weights of multiple lambs (see chapter 3). Placental development is especially important in ewes lambing 150% or more to ensure lambs are sufficiently heavy at birth. Ideally ewes with multiples should be identified as early as possible, separated, and preferentially fed.

Generally Merinos have lower lamb survival than crossbreds. So too do pure Finns with larger litter size.

There is no evidence of a breed effect for the relationship between survival and birth weight in New Zealand's common Romney-based breeds. However, survival at lower birth weights appears to be higher in Merinos and some prolific breeds (notably 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 due only 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 (Jenkinson *et al.*, 1995).

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 (Morris *et al.*, 1993). 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 pregnancy nutrition) and plan lambing paddocks and shelter accordingly.

Breed

Breed effects on lamb survival are generally small and not important between Romney-based breeds but the Merino often has lower lamb survival than other breeds in the same district. North Island farmers with Merinos since the 1980s report poorer reproductive performance than for other breeds. While fertility and fecundity appear acceptable in Merinos (assessed at pregnancy scanning), low final lambing percentages often result from high lamb mortality ranging from 25-55% with an average of 35% (Matthews, 1996).

Overseas information suggests that at the same litter size and ratio of lamb birth weight to mature size, more prolific sheep such as Finns have higher lamb viability and lower optimum birth weights (Gama *et al.*, 1991). However New Zealand experiences do not support this and 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 (Cook, 1996). Finn crosses appear to have higher lamb survival than pure Finns.

Heterosis

Lamb birth weight increase due to heterosis (hybrid vigour) is estimated at around 6% (Dalton, 1980). 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 (e.g. Border Leicester x Romney, 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 (Hight and Jury, 1970). This could be due in part to better mothering and milking ability of F_1 ewes as well as heterosis increasing lamb birth weight,ewe milk production and survival.

Lamb sex

Mortality in male lambs is about 6% higher than in females (Hight and Jury, 1970; Dalton *et al.*, 1980; Knight *et al.*, 1988) and is associated with, but not fully explained by, higher birth weights in male lambs (averaging about 0.25 kg more) 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 (Hight and Jury, 1970; Dalton *et al.*, 1980; Knight *et al.*, 1988). 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 about six years old (McDonald, 1966; Vesely and Peters, 1965) 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 (Knight *et al.*, 1988; Bichard and Cooper, 1966). Dystocia appears more common in younger ewes while old ewes (e.g. seven years old) lose more lambs from starvation (McDonald, 1966).

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 four to six years under poor conditions, with lower survival from both two year (69%) and seven year old ewes (68.2%), but little effect of ewe age in better environments (Lax and Turner, 1965).

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

Some farmers may limit reproductive performance by culling at a relatively young age and having a large proportion of first-lambers in the flock. Many farms cast for age at five years old regardless of ewe condition or performance and thus miss out on benefits in ovulation rate, litter size and lamb survival. Especially on easier country, it may be more profitable 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 survival of their progeny. High survival rams leave smaller single lambs with fewer deaths from dystocia but sometimes with higher deaths from multiple births (Knight *et al.*, 1979). Low survival rams leave progeny requiring more assisted births and increased dystocia deaths from higher birth weight 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 Hairy Shaker virus. Effects are thought to be small but further investigation may be warranted.

Hairy Shaker

Hairy shaker disease is characterised by an extremely hairy fleece and minor to severe body tremors (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 (Manktelow *et al.*, 1969).

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 infected ewes. The disease has been observed throughout New Zealand (Manktelow *et al.*, 1969) and there is no cure or vaccine.

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 like 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 some. Many commercial farmers select indirectly by culling ewes which were pregnant but failed to rear a lamb.

Shepherding and intervention

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. "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, 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.

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

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

Birth takes about an hour from fluid release, varying from ten minutes to over three hours (Kilgour, 1982). If birth is prolonged (e.g. by dystocia) the ewe may wander from the lambing site which may neccessitate 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 (Arnold and Morgan, 1975).

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 (Kilgour, 1982).

Most ewes leave the lambing site within 24 hours but some remain up to 72 hours after birth (Kilgour, 1982). First-lambers (hoggets or two tooths) tend to stay longer than older experienced ewes. Tagging and lamb handling may frighten first-lambers from the lambing site before bonding is established. Low pasture cover (less than 1000kgDM/ha) often results in ewe mis-mothering as ewes are inclined to wander further to graze immediately following lambing. Poorly fed ewes are more likely to move off earlier to graze.

Low pasture cover at lambing (less than 1000 kgDm/ha) is likely to cause increased mis-mothering and lamb deaths

Under natural conditions lambed 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 lambed ewes. Lambed ewes should not be moved until at least 24 hours after birth.

Lamb stealing and swapping

Lamb swapping is common and is most likely when ewes are heavily stocked and choose close lambing sites (Welch and Kilgour, 1970). 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 (Welch and Kilgour, 1970; Arnold and Morgan, 1975). 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 (e.g. 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 important in commercial flocks, but interferes with pedigree recording for ram breeding. Observation showed misidentifed dams and lambs about 10% of the time even when lambs were tagged as soon as possible after birth (Welch and Kilgour, 1970).

Lamb swapping and stealing often occurs with ewes crowded around the same site and is not a big problem with commercial farms but causes inacuracies 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 mismothering. 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 good scientific evidence of this.

Main causes of lamb death

Dystocia (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 (Dalton *et al.*, 1980). Flocks where 20-31% of ewes required assistance at birth have been recorded (McSporran *et al.*, 1977).

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.

Repeatability of dystocia is about 18% (McSporran *et al.*, 1977) 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 (McSporran and Fielden, 1979).

Since dystocia is repeatable ewes assisted 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 (Kilgour, 1982). As well as immediate deaths, dystocia may cause apparent starvation/exposure mortality because lambs suffer injuries during birth, eg. spinal and cranial haemorrhages. Central nervous system (CNS) damage decreases the lamb's suckling drive and is accentuated at low temperatures (Haughey, 1975). Warming such lambs and encouraging them to feed may improve survival.

If dystocia occurs frequently, ram tendency to leave 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 (Smith, 1977).

Selection for ease of lambing

Ease of lambing can be improved through selection. For example, Marshall Romneys (selected for this trait for 40–50 years) show a 10–14% increase in ease of lambing and 8.5% higher lamb survival than control Romneys (Hight, 1978 & 1979, Knight *et al.*, 1988). Lambs of Marshall Romney ewes suffer significantly fewer lamb deaths due to both dystocia and starvation (Knight *et al.*, 1988) and ewes are also more likely to stay with their lamb(s) during tagging.

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 about 30% of all lamb deaths around lambing. Figure 7 (p.89) illustrates the relationship between starvation and exposure.

At birth the lamb moves from a warm environment to the cold. 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 (Dawes & Mott, 1959; Alexander, 1962b). If the lamb's heat loss exceeds its summit metabolism (i.e. maximum heat production) then body temperature falls and becomes hypothermic. Deep body temperature falls in many lambs at birth but most recover to normal temperature (39–40°C) within a few hours. If body temperature continues to fall, the lamb's rate of heat production declines further until death occurs at body temperatures below about 30°C (Alexander and McCance, 1958)

Small weak lambs with little or no body fat reserves or subject to severe cold weather, mis- mothering or lack of colostrum or ewe milk may suffer starvation/exposure

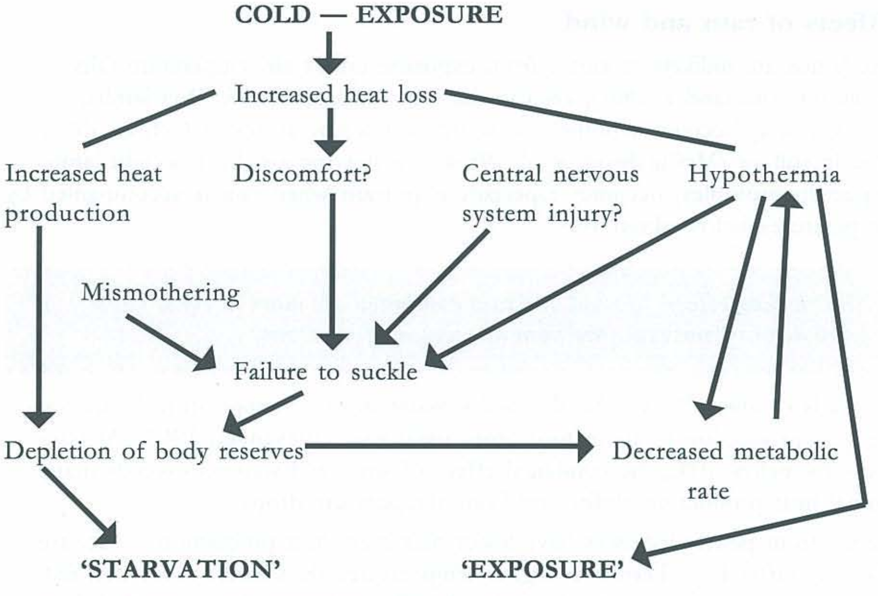

Figure 7: Starvation-exposure interactions
(adapted from McCutcheon *et al.*, 1981).

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 (Parker and Nicol, 1990). 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 (Alexander and Williams, 1966a). 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 (McBride *et al.*, 1967). 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 (Alexander and Williams, 1966).

Small lambs are especially prone to exposure. Heat production is proportional to body weight and surface area so small lambs have an added disadvantage (Hight and Jury, 1970).

Effects of rain and wind

Dry lambs are unlikely to suffer from exposure unless air temperature falls below 0°C (Alexander, 1961), 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 (McCutcheon *et al.*, 1983a). Shelter for low birth weight lambs (especially multiples) becomes especially important when rain is accompanied by temperatures below about 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 about 20 km/hr, dry lambs maintain body temperature by increasing heat production to about four times basal level (Alexander, 1962). At temperatures below 10°C, the combined effect of wind and wetness exceeds many lambs' heat production ability and body temperature drops.

Lambs from poorly fed ewes have lower maximum heat production — i.e. 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 (Alexander, 1962).

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 (McCutcheon *et al.*, 1983a). 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 deeper birthcoats (up to about 20 mm) are better insulators (McCutcheon *et al.*, 1981). Commercially available wool lamb covers improve heat retention and can increase survival.

Genetic influences on lambs' ability to resist cold have been found with estimated heritability of 0.44 (Wolff *et al.*, 1987). Direct selection is not feasible, however, because of the practical difficulties in measuring lambs' cold resistance in the field.

Effects on lactation

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 (Barnicoat *et al.*, 1949).

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

See also "Ewe milk production" on page 93.

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 them and are not seen to return have lower lamb survival than those that remain throughout the operation (Knight *et al.*, 1988). Table 14 shows the relationship between ewe behaviour during lamb tagging and subsequent lamb survival rates.

Table 14: 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

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

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

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

Assessment of MBS can help lamb survival in ewes with a high proportion of multiples (O'Connor *et al.*, 1985) though inclement weather still remains a major factor in lamb mortality (Arnold and Morgan, 1975).

Evidence suggests Merino ewes are generally poorer mothers and especially prone to leaving behind one lamb in a set of twins (Quinlivan, 1993). This increases the risk of starvation/exposure and contributes to the lower reproductive performance of Merinos.

Ewes with multiples need more time to bond with their lambs than ewes with singles. Mis-mothering is less likely where ewes have minimal disturbance — e.g. set-stocked and at a lower stocking rate than for singles. The ability to recognise ("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 (Poindron *et al.*, 1996).

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 (Knight *et al.*, 1988). 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

Ewe nutrition in lactation is important in maintaining or increasing ewe liveweight as well as milk production and lamb growth (Rattray and Jagusch, 1978). 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 in late pregnancy and throughout lactation (Barnicoat *et al.*, 1949).

Good ewe nutrition in late pregnancy and early lactation improves ewe milk production, 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 (Barnicoat *et al.*, 1957). New Zealand trials comparing July and September lambing dates show late lambing ewes produce more milk at peak lactation around week four (2.9 kg/day) than early lambers (2.3 kg/day) and have better lamb weaning weights (Geenty, 1986). 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 1200 kg DM/ha or 2-3 cm long.

Recommended feeding levels

Target cover at lambing should be around 1200 kgDM/ha (typically about 2–3 cm 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 (minimum condition score of 2.5).

During early lactation pasture cover should be 1400-1600 kg DM/ha or 4-5 cm length.

Table 15 shows recommended feed requirements for ewes in lactation for rapid lamb growth.

Table 15: Recommended feed requirements (kg DM/ewe/day) for lactating ewes (adapted from Geenty Rattray, 1987)

	Single-suckling Week				Twin-suckling Week			
Liveweight (kg)	1	3	6	9	1	3	6	9
40	2.1	2.3	2.0	1.8	2.3	2.6	2.3	2.0
50	2.4	2.8	2.4	2.0	2.8	3.2	2.8	2.2
60	2.6	3.0	2.6	2.2	3.0	3.4	3.0	2.4
70	2.8	3.2	2.8	2.4	3.2	3.6	3.2	2.6
Lamb pasture requirement		0.3	0.5	0.9		0.2	0.4	0.8

Notes:

1. ***Assuming average quality feed (10 MJ ME/kg DM).***
2. ***Each kg of ewe liveweight lost is equivalent to 1.7 kg DM while each kg of ewe liveweight gained requires an additional 6.5 kg DM.***

For triplets or quadruplets, add 0.1, 0.2 and 0.4 kg DM/day for weeks 3, 6 and 9 respectively.

Achievement of the above ewe feed intakes requires pasture cover of 1400-1500 kg DM/ha or 4-5 cm length (see Appendix 4.2).

Ewe milk production

Lamb survival and growth to weaning are heavily dependant 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.

Ewe milk production peaks 2-3 weeks after lambing then gradually declines.

Daily milk production peaks at about 2–3 weeks of lactation then gradually declines. Regardless of nutritional level, ewes rearing multiples produce more milk than similarly fed ewes with singles (Wallace, 1948). 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 (Barnicoat *et al.*, 1949). 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 (Geenty, 1979).

Ewes with twins produce 30-50% more milk then those with singles.

Differences in milk production

There is large variation in milk production levels within flocks, as shown in Table 16 (P. Muir, *pers comm.*).

Table 16: 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

This variation suggests considerable scope for selection for higher milk production. 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 (Geenty and Dyson, 1986). Lambs successfully substituted high quality spring pasture, with almost the same nutritional quality as milk, for the lack of milk.

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

CONCLUSIONS

This and preceeding 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.