400 Plus

A Guide to Improved Lamb Growth for Farmers and Advisors

November 2010

Edited by Peter Kerr

Originally published by the New Zealand Sheep Council

in association with

WoolPro and Meat New Zealand

September 2000

Acknowledgements

To the authors of a comprehensive review commissioned by the New Zealand Sheep Council of the literature on the factors affecting lamb growth used as the basis of this book Dr Roger Purchas (Massey University), Dr David Stevens (AgResearch, Invermay) and Dr Alex Familton (Ancrum Consultancies, Christchurch).

Provision of material and comments on the text came from Dick Arnst (Wrightson, Christchurch), Mark Aspin (Meat New Zealand, Wellington), Trevor Cooke (veterinarian, Feilding), Philip Dinniss (Dinniss & Associates, Wellington), Dr Lester Fletcher (AgResearch, Lincoln), Dr Ken Geenty (Woolpro, Palmerston North), Dr Neville Grace (AgResearch, Wallaceville), Dr Mark Hamilton-Mann (consultant, Feilding), Dr John Hodgson and Dr Paul Kenyon (Massey University), Dr Alan Kirton (AgResearch, Ruakura), Dr Greg Lambert (AgResearch, Palmerston North), Andy McFarlane (consultant, Christchurch), Alan Marshall (Woolpro, Christchurch) Allister Moorhead (PGG Seeds, Christchurch), Dr Paul Muir (AgResearch, Poukawa), Dr Alistair Nicol (Lincoln University), Dr Peter Rattray (consultant, Ohaupo), Dr Gavin Sheath (AgResearch, Hamilton), Malcolm Taylor (New Zealand Sheep Council National Chairman), Dr Neil Towers and Dr Rex Webby (AgResearch, Ruakura), Dr Dave West (Massey University).

Assistance with cover design was from Rosemary Hamilton, Southern South Island Sheep Council.

ISBN 0-908768-96-6
Publishing Consultants Dinniss & Associates

FOREWORD

Livestock farming is all about growing grass and processing it through an animal to make money. Now the most successful agribusiness people are adding a new twist. Their aim is to grow three blades of grass where they previously grew two and then put this material through an animal with maximum efficiency for maximum net profit. There are numerous case studies showing that the better an animal is fed the quicker it grows. This booklet has been published by the New Zealand Sheep Council to help farmers achieve this.

The Council's function is to provide a link and communication path between science, agriculture leadership and practical farmers. This booklet *400 Plus* endeavours to do just that.

When a topic like lamb growth is raised among farmers, consultants and scientists, the references and opinions are scattered and varied. There is a vast body of scientific information on factors affecting lamb growth and to provide the basis for *400 Plus* the Sheep Council commissioned three specific reviews:

- Patterns of Growth and Physiological Constraints, Dr Roger Purchas, Massey University.
- Nutrition, Pastures, Genetics and Geographical Variations, Dr David Stevens, AgResearch.
- Disease Factors, Dr Alex Familton, Ancnun Consultancies.

From these reviews and considerable conunuunication among scientists and consultants, *400 Plus* has emerged. It translates the science into practical farmers' language and also reveals aspects of the topic that need further research.

The modern agribusiness person needs to seek information aggressively. This information should be accessible, readable and accurate. This booklet is part of a series of publications the Sheep Council has produced to aid in this process. It should be used in conjunction with the *Feed Planning* booklet and *200 by 2000* (improving lambing percentages), together with other booklets, brochures, articles and seminars that the Sheep Council and others present from time to time.

The Editorial Committee is indebted to the very capable folk who have freely supplied us with help and information. We are extremely grateful to Peter Kerr for his patience, forbearance, energy and considerable skill he has displayed in bringing the text together. Our thanks go also to Philip Dinniss who again has been excellent to work with. My own personal thanks to Alan Marshall and Ken Geenty who, as always have bought exceptional skill, knowledge, energy and professionalism to the challenge. Last, but no means least, we acknowledge Meat New Zealand and WoolPro without whom none of this would be possible. We are confident the levy payers of New Zealand will see this as good use of a small segment of their funds.

On behalf of the New Zealand Sheep Council team I take this opportunity to wish all those involved in this tremendous sheep industry of ours every success in their future endeavours. Itis our sincere desire that you may be able to grow your young stock at superior performance rates and that in some small part *400 Plus* may help you in your endeavours.

Malcolm Taylor
Chairman New Zealand Sheep Council
Corrie Downs
Ward

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CHAPTER ONE – SETTING THE SCENE

This book shows how 400+g/day lamb growth can be achieved. It provides a background and broad recipe for better lamb growth, as well as the science behind the management.

Given that the average daily growth rate of lambs in New Zealand is probably around 150g/day, suggesting that 400+g/day is possible may seem a major stretch. However a number of farmers, as well as researchers and consultants, have demonstrated that such daily gains are possible.

Achieving 400+g/day can mean huge on-farm advantages:

- A lamb born on 1st September at 4.5kg LW, growing at 400g/day reaches 37kg LW (16.6kg CW) on 20th November in 81 days.
- Most lambs would be sold 'off mother'.
- Lamb dressing percentage (carcass weight to liveweight) would be higher.
- Lambs would be subject to less parasite challenge. Many lambs would never be drenched.
- Fewer lambs would be subject to endophyte challenge.
- A greater proportion of lambs from an August/September lambing would fall in the premium price chilled trade market.
- Considerable feed otherwise eaten by lambs would be freed up for cattle, a second lamb crop, an arable crop or to flush ewes.

However, it should be remembered that generating high lamb growth rates at low stocking rates may not result in increased profits per hectare.

Another illustration of why growing lambs fast is of great advantage is that less overall feed is required to achieve an acceptable weight. This is seen in the following table:

Table 1:1 Feed conversion efficiency for different lamb growth rates between weaning at 24kg and a target liveweight of 34kg

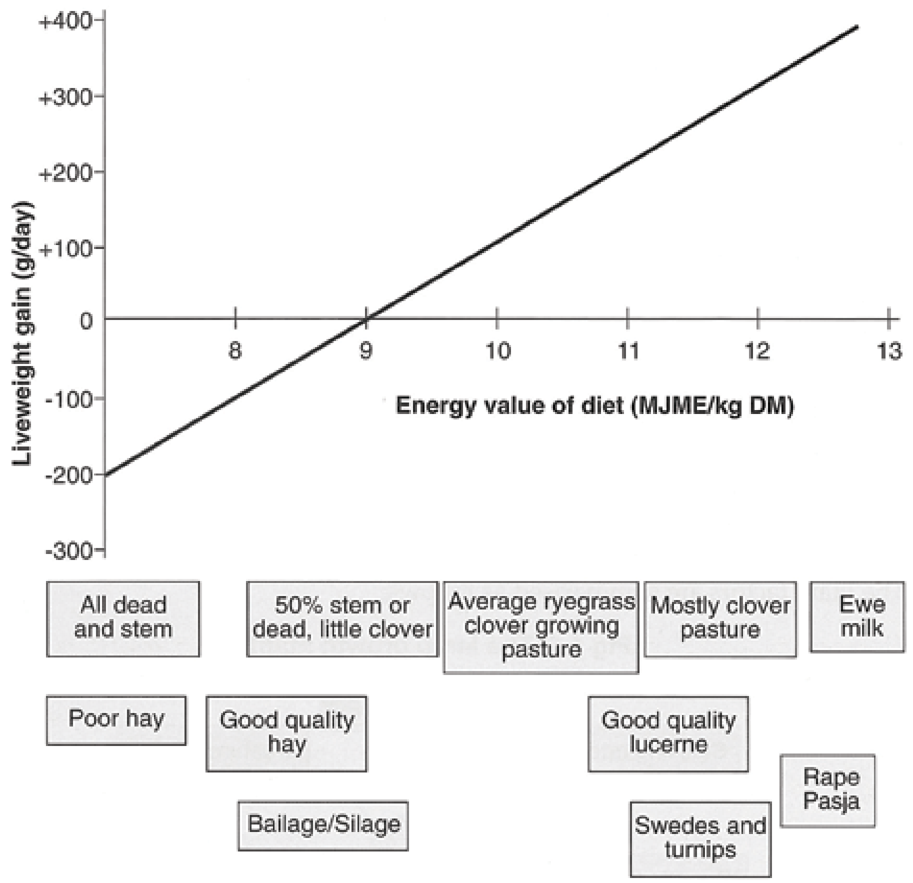
	Lamb growth rate (g/day) from 24-34kg			
	100	200	300	400
Feed requirement (kg DM/day)	1.2	1.5	1.9	2.4
Days to target weight (34kg)	100	50	33	25
Feed consumed (kg DM)	120	75	63	60
Conversion efficiency % (kg DM/liveweight gain x 100	8.3	13.3	15.8	16.6

Source: Geenty, 2000

Much of a lamb's ability to grow rapidly is determined by the energy level of its feed.

The following graph demonstrates the importance of energy (megajoules of metabolisable energy – MJ ME) levels of feed.

Fig 1:1 Liveweight gain of a 30kg lamb and the energy value of the diet



Source: Stevens, 1999

Lambing date and leafy greens

Lamb growth management systems should attempt to work with natural growth characteristics of pastures. With a planned approach a farm can be:

1. Working lambing in with the spring feed flush (or if deliberately lambing earlier or later than the flush, being aware of what this means in terms of pasture quality and quantity).
2. Maintaining control of early and late spring growth to:
   - maximise quality – produce leafy greens.
   - maximise production – maintain optimum pasture length/cover.
3. Setting up pastures to optimise production for the rest of the year – and maintain its quality and quantity.

Understanding the importance of pasture quality and quantity is key in growing lambs rapidly.

Equally, understanding that 'grass grows grass' is another key concept to growing lambs quickly on ryegrass/white clover pastures.

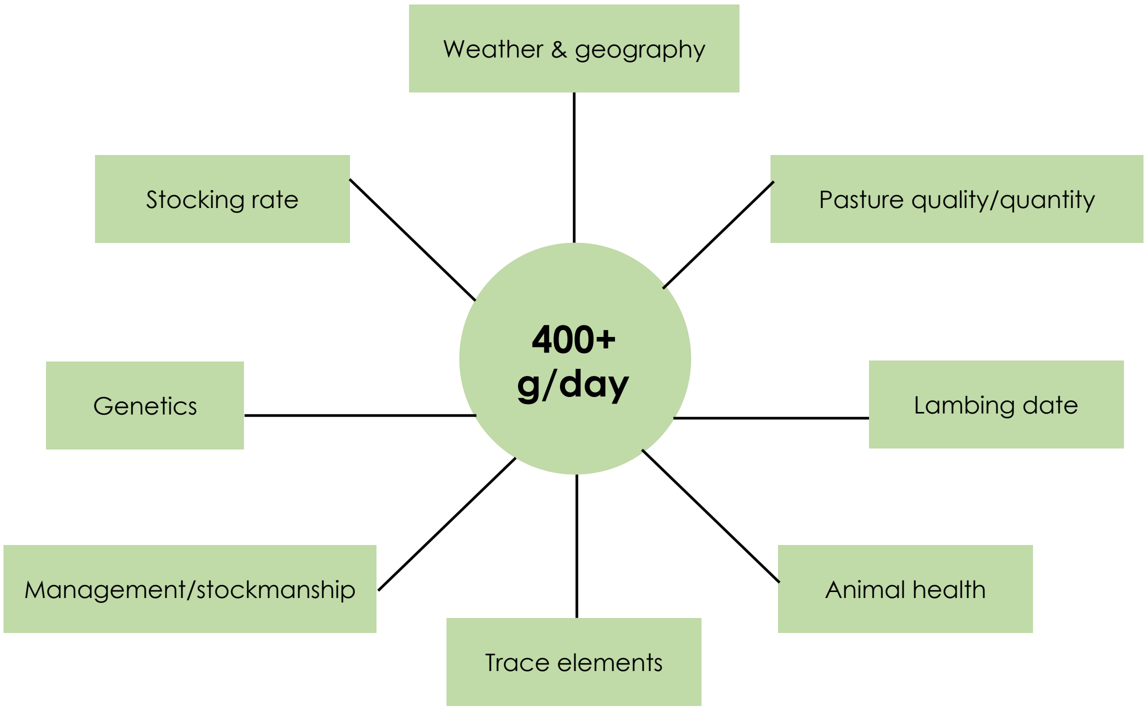
- A pasture with 1200kg DM/ha is able to grow at about 80% of its potential.
- A pasture with 900kg DM/ha is able to grow at about 60% of its potential.

More explanation of these components is provided in the post-weaning section in chapter 6.

Maximising lamb growth requires managing a matrix of factors and skills. These are covered to some extent in this book, and follow a chronological pattern starting with pregnancy.

The main factors are summarised as follows:

Fig 1:2 The lamb growth matrix



One weak or missing spoke in the wheel and the 400+ target will be missed.

CHAPTER TWO – PRE-TUP DECISIONS

Decisions made well before mating provide the building blocks for maximum lamb growth.

Increased profit because of improved lamb growth is a balance between the desired end product matched against the particular farm system. The choice of sheep genetics will modify achievement of these two components.

How to make more money

End product

Improved lamb growth can provide a number of benefits to the whole farm system.

- Bigger lambs at a earlier dates.
- Better grown hoggets (with the possibility of mating and lambing these younger animals).
- Improved ewe mating weights and improved ewe efficiency. A farm will make more money by achieving any or all of these goals.

If new-born lambs start their lives well and continue in the same manner, then their carcass weight, hogget weight and ewe performance will all be enhanced.

The decision to improve lamb growth will therefore impact favourably on all aspects of farm profitability.

But achieving high lamb growth requires an all-encompassing view of management, as well as planning to achieve pre-set goals.

Farm system

The major decision for lamb growth is whether the property is able to grow lambs through to a target slaughter weight and condition.

Many farms may have environmental constraints which means it is more profitable to grow and sell healthy store lambs, rather than trying to grow those animals to killable weights.

Many farms have become more profitable by reverting to a store lamb sale policy, rather than attempting to grow lambs to a later slaughter weight. By concentrating on growing breeding stock, some farms actually improve almost overnight.

A way for both store lamb producers and prime lamb finishers to maximise their profits may be to adopt a cooperative 'In Line' farming system. Under a pre-arranged deal, the lamb supplier and finisher determine how and when lambs will be farmed. Different profit-sharing arrangements are possible under an operation thought out in advance – allowing each farm to specialise in what it does best.

Lambing date

This is one of the most important farm management decisions to be made on a property.

Ideally lambing should begin at the same time as the annual increase in spring pasture production.

However a high proportion of New Zealand farmers lamb too for their feed supply to achieve high growth rates.

Contrary to popular opinion, earlier lambing does not necessarily produce heavier lamb weaning weights. McEwan et al (1983) found lamb weaning weights were the same from ewes lambing in early, mid and late September in Southland. Pasture supply was more readily matched by the later lambings and ewe liveweight at weaning was improved as lambing dates got later. A similar result was found in Canterbury by Geenty (1986).

Better to lamb later and get bigger growth rates.

Early lambing

Sometimes early lambing has the objective of mismatching pasture supply and demand. This is a bid to control mid to late spring seedhead development, as well as enhance clover development – especially in the summer.

This regime may have some application in North Island hill country areas where pasture control cannot be maintained in late spring (Rattray, 1977; McCall et al., 1986).

Seventy percent of yearly pasture production takes place between September and December. It is only possible for stock to consume two thirds to three quarters of that pasture. On steeper country in particular, hay or silage making may not be an option.

While animal intake should be maximised, this doesn't necessarily mean the whole farm should be grazed.

If weaning has taken place early, the recommendation is that a very fast rotation of 20-25 days be carried out. Without a fast rotation, the pre-grazing quantity of pasture may be too high. Ewes can't consume all the pasture and its quality drops.

By following up the sheep with cattle when residual pastures are 1500-1600 kg DM/ha, the cattle will be able to clean up the surplus left by the sheep.

However, if weaning hasn't taken place and ewes and lambs are set-stocked, areas of ungrazed pasture may be found. By having cows and calves in the same paddocks, they will eat the patches rejected by the sheep.

In both cases though, some pastures may begin to get out of control. When dry matter levels exceed 3000 kg DM/ha, pasture quality drops as dead and seedhead material accumulates.

In this case it is better to drop 2-3 paddocks out of the rotation and sacrifice them, make hay or silage, or graze them with other classes of stock (eg cattle).

Drop out paddocks

By dropping these paddocks out it is possible to better maintain the pasture quality for the majority of the farm.

It is generally better to have these drop out paddocks on the easier country.

If steep country is used as the drop out paddocks, it is often difficult to remove the rank feed, improve quality or to have these paddocks produce in winter. Woody weeds such as gorse are more likely to reappear on this steeper country.

Conversely it is easier to get rid of the poorer grasses and weeds when easier country has been used as the drop out paddock. These paddocks can very quickly be brought into the winter rotation when grazed in the autumn.

The same land should not be used as drop out paddocks for more than two years because pasture quality can deteriorate quite quickly. Grass species change to more browntop and goose grass and it takes at least three years of good management to get them back to higher producing grass species.

Conservation will be an option for some on this easier country, particularly now with the popularity of baleage.

However, it should be made by late November, early December, otherwise poor quality herbage which can't compact properly will result.

It is good farm practice to plan for and have an early closure of surplus feed. If paddocks aren't shut up until the surplus is observed, it is often too late.

Generally however later lambing will enhance both lamb growth and ewe condition when pastures can be controlled by cattle grazing or mechanical topping.

Information on the average annual start date for spring pasture growth is generally available on a regional basis from farm consultants.

There are a number of variables to take into consideration when assessing when spring actually starts on a particular property. These include:

- Soil fertility
- Grass species present (ryegrass begins growing much more quickly than browntop)
- Sunlight hours
- Soil temperature
- Soil nitrogen levels
- Soil moisture levels

Aligning lambing dates with this spring flush will almost invariably result in similar weaning weights and dates as lambing before the flush. As well, ewes will maintain better condition, and because pasture growth isn't restricted by low leaf area (through over-grazing), pasture growth is optimised through late spring, summer and the rest of the year.

The practice of lambing before pasture growth matches feed demand usually restricts future pasture production.

As pasture cover drops below 1200kg DM/ha, the potential pasture growth also declines. (Many farm systems reduce pasture covers to between 800-1000kg DM/ha during winter–early spring).

Pasture growth at these pasture covers is restricted by low leaf area, and is well below its potential.

A system that is only allowed to provide 50-60% of its total pasture production potential will grow a 25kg weaned lamb at 100 days. This is a 260g/day gain on average.

Improved pasture management in spring to better match supply and demand offers potential lamb growth rates of between 300-350g/day. This provides a 100 day weaning weight of 34-37kg.

Early season lambing for chilled lamb contracts

An increasing number of farmers, especially on the East Coast of New Zealand, are lambing earlier than the spring flush in order to capture premiums for early chilled lamb.

Such a move often doesn't optimise either the pasture or animal performance. One gains at the expense of the other, or a class of stock may, comparatively speaking, suffer.

Whether or not an earlier lambing is required should also be weighed against the fact that later born lambs, if grown to their potential, can reach a suitable carcass weight, given feed supply and droughts, just as soon as earlier born lambs.

It should be noted that if a significant proportion of ewes lamb early, carrying capacity, especially during the winter, will probably have to be reduced.

On some properties lambing is split, with only a proportion of ewes lambing early. A 'flying flock' policy, in which older ewes with poorer mouths lamb early is another option – providing early lambs and enabling these ewes which would probably be sold or killed to leave the property early as well.

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Flexible management policy

Many pasture management systems rely on the small mismatch in pasture supply and feed demand to:

- Ensure high enough grazing pressure to control seedhead development in mid to late spring, and
- To enhance clover development and subsequent summer clover growth.

In systems such as the North Island hill country where pasture control cannot be maintained in late spring, earlier lambing can improve weaning weights and maintain summer pasture quality (Rattray, 1977, McCall et al., 1986).

But later lambing will enhance both lamb and ewe growth where pasture control can be maintained in late spring through cattle grazing or mechanical topping.

White clover growth is an important feature for improving summer pasture quality. Hay and Baxter (1984) found continuous grazing from lambing to weaning is a reliable management tool to maximise later summer white clover content. Continual defoliation increased clover growing point numbers and provided enough light and suppression of grass growth to maximise white clover development. This regime however suppresses grass growth and spring animal production. Further research is required to examine the optimum balance between clover development and pasture growth.

Genetic decisions

The breed of ewe and ram used on a farm is a longer term decision.

In breeding for optimum lamb growth most genetic improvement comes from the rams bought.

- A check list for breeder selection includes:

  clear breeding objective

  performance records (& uses SIL)

  sire referencing across flock analysis

  genetic trends available

  breeding values provided

  production records available for flock and leading clients

The decision whether to breed own replacements, or to buy in capital breeding stock annually is dependent on the farm type, management style and objectives.

The rams to be used can have a strong bearing on lamb growth. Terminal lamb sires in particular will generally produce a faster growing earlier maturing lamb than the breeding stock. Some terminal sires may also be more suited to early, quick maturing lambs, while other rams may produce fast growing lambs that can achieve heavy carcass weights without becoming overfat.

As with most decisions in farming, first determine what end product is desired, and then work back to ascertain the genetics and management required to achieve it.

There are several factors to take into consideration when choosing a ram. These are discussed below.

Selection for lamb growth

There is a link between overall growth rate and fat deposition.

As liveweight increases, so too does fat deposition – with the market preferring lean, large carcasses.

Dam breed selection

The best breeders within traditional breeds farm flocks that regularly lamb 180% and wean 30-35kg lambs at 12 weeks of age.

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Finn – true maternal dam with high fecundity, hardiness and good lamb growth potential, as well as higher total solids in its milk compared with other breeds. A relatively small frame size with increased overall feed conversion efficiency contributes to low ewe maintenance requirements.

East Friesian – high fecundity, high growth and improved milking ability though with an increase in mature body size. Its milk has a lower solids component than the Finn.

Texel – new born lamb hardiness, parasite tolerance, improved overall carcass composition.

Poll Dorset – milking ability, fertility, ability to lamb out of season, good carcass composition.

Traditional breeds such as the Romney, Coopworth, Perendale, Borderdale, Corriedale and halfbred also provide much variation from which to select improved dams that meet fecundity, milk production, lamb survival and carcass conformation targets (Baker et al., 1987).

Note: check carcass conformation requirements with individual meat companies.

In summary, there are various considerations for dam breed selection:

- Milking ability is important in large litter sizes and variable grass growing seasons
- Number of lambs born, lamb survival and growth traits are important
- A high growth option is composite breeds (slight penalty in wool weight)
- To maintain hybrid vigour in composites, a breeding plan is essential.

Terminal sires

Lamb carcass weight production advantages from terminal sires have been estimated to be around 30% with the use of sires such as Dorset and Suffolk (Clarke & Meyer, 1982).

Much of the improvement comes from hybrid vigour. Lamb production increases are greater when the terminal sire has a superior growth rate to the maternal breed and when weaning percentages are high (Parratt & Young, 1985).

Market trends towards larger, leaner carcasses favour the use of imported breeds such as the Texel and American Suffolk, as well as the Poll Dorset and Dorset Down. The latter three breeds have made much progress in lowering fat depth (GR) in recent breeding programmes.

In summary, considerations for terminal ram breed selection include:

- Carcass weight
- Growth rate
- Increased lean meat
- Maintain or decrease fat weight
- Maintain or improve meat quality; tenderness, colour, pH

Crossbreeding

Crossbreeding can produce significant advantages through heterosis or hybrid vigour. Expected gains due to heterosis are in growth related traits including birth weight, weaning weight and post-weaning growth rate, as well as lamb survival.

Hybrid vigour is estimated to contribute 5% for weaning weight, and 5-10% for liveweight and carcass weight.

An example is:

- Dam breed 35kg at 150 days

- Sire breed 45kg at 150 days
- 10% hybrid vigour for slaughter weight
- Crossbred progeny =(35 + 45)/2 x 110% =44kg

The combination of these factors as total weight of lamb reared per ewe joined gives increase of 18-50% due to heterosis. Growth rate factors within that increase only account for between 0-6% (Clarke, 1982).

Hybrid vigour is an important factor – use it as much as possible.

For more explanation about the importance hybrid vigour see 'A Guide to Genetic Improvement in Sheep', a Sheep Improvement Ltd publication in association with Meat New Zealand and Woolpro.

Interactions between genetics and nutrition

Traditional breeds have been bred to fill a range of environmental and nutritional niches within New Zealand.

The Perendale was bred for hardiness and efficiency to maximise production from poorer hill country. The Romney has filled a range of niches, with strains being suited to a wide range of environments. The Coopworth has generally higher performance and needs better nutrition to express its genetic potential.

Within the more recently imported breeds there are also a range of animals that respond differently to the environment they are in.

The Finn is a hardy breed with low maintenance requirements, though it will respond well to improved nutrition.

The East Friesian, as a dairy breed, needs good nutrition to maximise production.

Other selection criteria that may impact on lamb growth

Maintenance requirements – Because of the trend towards lean sheep, and the greater energy requirement to maintain muscle, larger leaner sheep will generally increase feed requirements per unit of liveweight and maintenance requirements will be greater.

At a total system level maintaining a big lean ewe may require higher overall feed maintenance levels.

Internal Parasite Control – Two approaches have been taken in breeding animals with improved internal parasite control. The first is that of resistance where the adult sheep maintains a greater immunity to internal parasite challenge, reducing faecal egg outputs especially under stress.

The second is resilience where animals have an improved ability to tolerate an internal parasite challenge until natural immunity takes over.

CHAPTER THREE – PREGNANCY

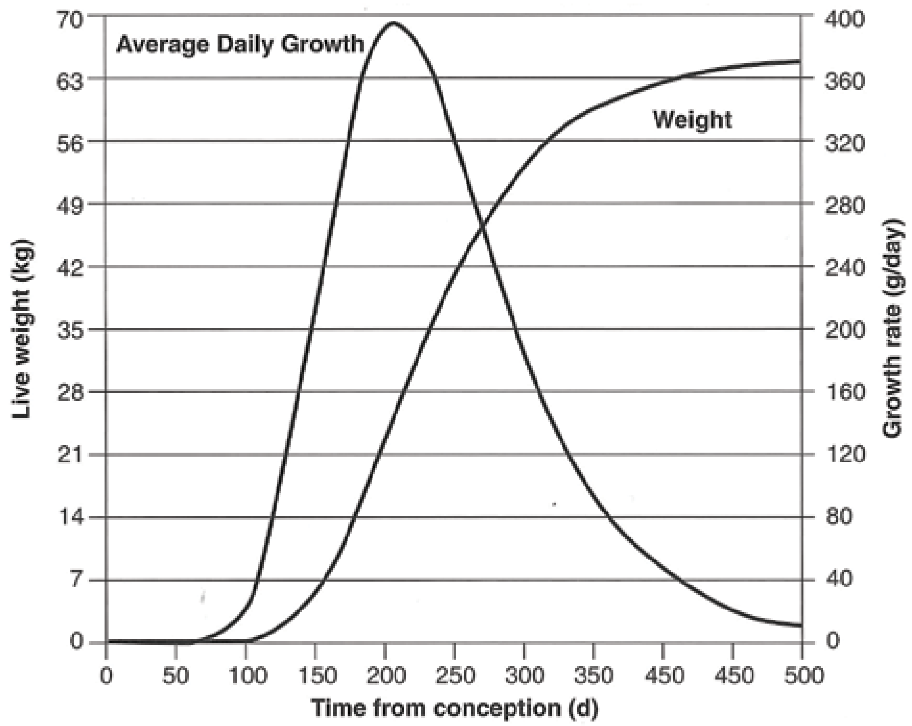
Just as human beings find pregnancy to be a bit of a trial, so it is with a ewe.

As a mother-to-be, a ewe is undergoing physiological changes to prepare for the birth and nourishment of her lamb.

By treating a pregnant ewe as gently as possible, not only is the forthcoming lambing likely to be more profitable, but subsequent pregnancies should also be more fruitful.

There is a definite pattern followed by a growing lamb. The Sigmoid Growth Curve, which includes foetal growth during pregnancy, is shown in the following diagram.

Fig 3:1 Sigmoid Growth Curve – includes foetal growth during pregnancy



Source: Fitzhugh, 1976

Implantation

During implantation in the uterus 12-14 days after fertilisation, lamb embryos are extremely vulnerable. Some or even all of multiple conceptions can be lost at this stage.

Therefore the most important point to remember for a ewe at mating is 'don't rattle those eggs'. From a week before until some weeks after mating starts avoid if possible:

- Yarding
- Button-hole dagging or taking a ewe over the board
- Drenching
- Dipping
- Vaccinations

Minimising stress during mating and early pregnancy avoids upsetting oestrus and maximises embryo survival.

Most of the knowledge on this subject is anecdotal, but is appears that stress (which is variable for different breeds and farms) reduces egg development and embryo survival.

It is vital that a ewe is treated with kid gloves and she has a minimum of physical pressure imposed on her around ovulating time.

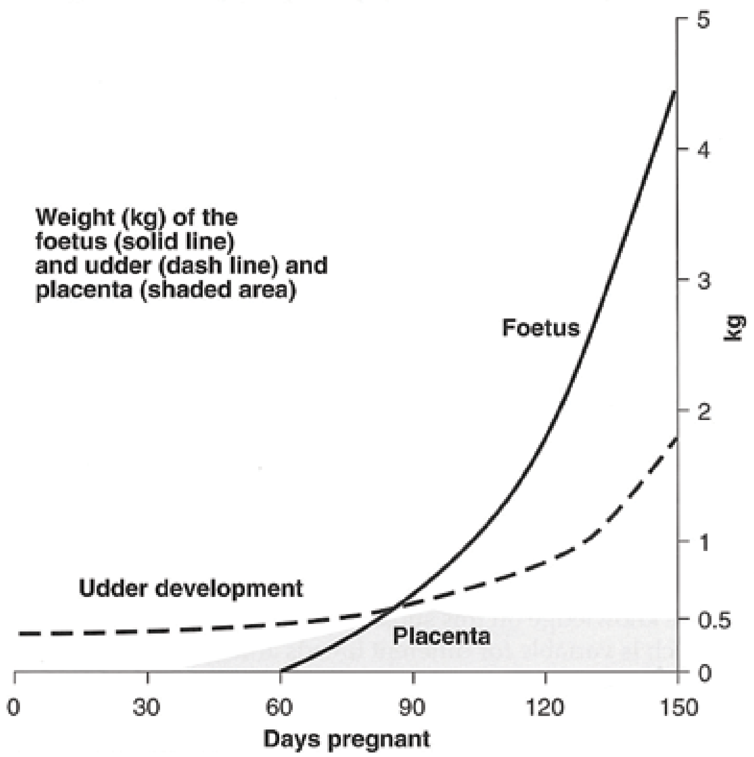
Any dam that is under pressure seems to have eggs which aren't as fit to survive and which also aren't as easy to fertilise.

In the end, sheep breeding is a game of chance, and doing anything stressful to the ewe around the time of implantation is simply diluting the odds of successful conception.

(Much more detail is provided on this subject in *A Guide to Improved Lambing Percentage – 200 by 2000.*)

Early-mid pregnancy

Fig 3:2 Schematic diagram showing the increase in weight of the foetus, placenta and mammary gland during pregnancy (source: D. Revell).



Source: 200 by 2000, 1997

Placental development is linked to lamb birth weight, with most of its growth taking place in the second 50 days of pregnancy.

Underfeeding the ewe in the first third of her pregnancy can reduce cotyledon numbers and development. This reduces nutrient transfer from the ewe to lamb, and causes lower birth weights (Dingwall et al., 1987).

A lamb's post-birth physiological responses are also laid down during early foetal development. That is, early womb environment determines how quickly a lamb can grow later on. (Note: The Auckland School of Medicine's use of pregnant sheep as a research and experimental model has resulted in world-recognised understanding of human foetal and post-birth development and importance.)

A lamb's production potential is largely determined during the first 50 days of early cell differentiation. Scottish animal scientist Professor John Robinson has been a leading light in pointing out the importance of the first third of a ewe's pregnancy in a ewe.

The developing foetus sends signals to the ewe regarding its potential as a lamb. This is why a ewe bearing twins produces more milk than a single, or why a hybrid lambing ewe produces more milk than one with a pure-bred lamb. A bigger placenta, determined by placental cotyledons produces a bigger udder via placental hormones.

Poor nutrition of light ewes during mid-pregnancy resulted in weaning weights up to 2.4 kg lower than lambs born to ewes on better nutrition. This effect appears to be greatest when ewe liveweight losses are greater than 4 kg during pregnancy and in twin lambs (Smeaton et al., 1999).

Lambs of lower birth weight grew at a slower rate up to 20 kg liveweight. While this difference was approximately 5%, it is enough over the course of the 90-100 days to weaning to significantly alter weaning weight (Greenwood et al., 1998).

Feeding to maintain ewe weight and condition from mating through mid¬pregnancy aids conception and encourages good placental development.

Avoid abrupt changes in feeding level.

The effect of ewe liveweight 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.

These findings therefore contradict a practice among some farmers of tightening up ewe feed intake during early pregnancy. Such restrictions simply reduce potential lambing percentages.

Scanning

Ultrasound scanning between days 60-90 of pregnancy allows a separation of ewes with multiples from singles. This allows preferential feeding and lambing management.

The major points in scanning are:

- Separate single and multiple bearing ewes and allow feeding levels to be appropriate to control the size of the lamb at birth.
- Good feeding of multiples during late pregnancy and lactation which helps ewes wean a heavier weight of lamb. It also increases their chances of the ewe having multiple lambs the next season.
- Aim for lamb birth weights of 4kg to 5kg. (This will usually mean improving the birthweight of multiples and controlling the birthweight of singles.)
- Scanning also allows:

  removal of dries.

  establishment of a flock's genetic merits.

  tracking of genetic progress through time.

  identification of the magnitude of lamb losses from scanning to docking.
- Note: the success of scanning and its influence on subsequent management should be seen in ewe liveweight if twin bearing ewes are the same weight at weaning as single bearing ewes.

It should also be noted that the use of a vasectomised ram with a different coloured crayon after two mating cycles can also help identify dry ewes.

Late pregnancy

Feeding

Feeding of ewes during this stage is aimed at optimising the birth weight of a healthy lamb.

Severe underfeeding in mid pregnancy can reduce the number of lambs born, though most NZ situations will never reach this situation.

About 70% of foetal growth occurs in the last third of pregnancy, greatly increasing ewe energy requirements.

Meeting these feed demands requires an increase in feed quantity and possibly quality, as intake may be restricted by the abdominal space occupied by the conceptus, compressing the rumen. Ewes cannot eat enough poor quality feed such as straw or hay to meet late pregnancy energy demands, no matter how much feed is offered. This is generally not an issue in New Zealand.

Lamb birth weight is largely determined by placental development determined by day 90 of pregnancy, but is also affected by late pregnancy nutrition.

Ewe feed requirements increase in the latter stages of pregnancy and even more so during lactation.

The recommended feeding levels during pregnancy and lactation for 60kg ewes is illustrated in the following table.

Table 3:1 Recommended feeding levels during pregnancy and lactation (60kg ewes)

		Feeding level	
		x Maintenance	MJME/day (11 MJ/kg DM)
Early pregnancy		1.0	11.0
Mid pregnancy[a]		1.0	11.0
Late pregnancy	Singles	1.5	16.5
	Twins	1.75	19.3
Lactation	Singles	2.0	22.00
	Twins	3.0	33.00

[a] for light ewes (50k) – feed maintenance – shearing/birth weight effect – especially twins

Source: Rattray, 1979

Maintenance is an energy requirement which isn't merely indicated by a ewe staying a similar weight.

A 60kg ewe at tupping needs to be about 73kg a week before lambing to be in a similar condition. This is illustrated as follows:

If the ewe's condition is maintained throughout pregnancy, immediately prior to lambing the following factors comprise the ewe's weight:

Ewe's weight at tupping			60kg
Twin lambs	2 x 4kg	=	8kg
Amniotic fluid/placenta			4kg
Udder			1kg
			73kg

Feed supplements may be necessary to meet ewe maintenance in late pregnancy. High quality and high dry matter supplements such as grains or sheep nuts are ideal so intake is not limited by feed bulk.

Ewes with triplets or more need to be ad lib fed from scanning and recent research suggests that a high protein diet will increase lamb survival.

Winter – spring transition

Lower weaning weights were observed in lambs born to ewes that were set stocked four weeks prior to lambing compared with ewes when set stocked one week before lambing. This is because feed reserves were used before lactation.

The amount of pasture onto which ewes are set stocked also has an impact on lamb growth (Litherland et al., 1999; McCall et al., 1986). Weaning weights improved by 2 kg/lamb for each additional 100 kg/ha of pasture cover at set stocking in early lambing flocks (Litherland et al., 1999).

Controlled grazing intake prior to lambing also showed an advantage in improved pasture cover for both early and conventional lambing flocks by 3kg and 3.3 kg greater weaning weight for singles and twins respectively (McCall et al., 1986). The important point to remember is to not set stock too early before lambing (and the spring feed flush) begins. Spreading ewes out too early across all the feed runs the risk of it all being eaten before lambing begins.

From a management point of view this means:

- Ewes about to lamb shouldn't be mixed with those three weeks away
- Split the first two mating/lambing cycles into four. (This can be achieved by using mating harnesses and crayons, or at scanning, and separating these ewes out as lambing approaches.)

Milk and survival

As well as affecting lamb birth weight, poor nutrition in mid and late pregnancy may penalise lamb growth to weaning through changes in both ewe milk production and/or lamb vigour (Curll et al., 1975).

Undernutrition in pregnancy may restrict mammary growth and development. It also depletes ewe body reserves, causing poorer energetic efficiency in lactation, a reduction in lamb birth weight and which subsequently affects the lamb's ability to suckle (Peart, 1967).

Ewes losing liveweight in late pregnancy are slower to reach full milk production due to reduced mammary gland growth, and have lower total milk production over lactation. If underfeeding at lambing time occurs, copious lactation may not begin until up to 12 hours after lambing, depriving lambs of colostrum and halving milk production compared to ewes maintaining or gaining weight in late pregnancy. Poorly fed ewes may not produce enough milk to ensure the survival of even a single lamb (Wallace, 1948; McCance and Alexander, 1959). Again, this is an extreme state, unlikely to happen in New Zealand conditions.

Underfeeding in mid-late pregnancy produces lambs with lower energy reserves (internal fat stores and glycogen) which are more prone to starvation and exposure.

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.

Well fed ewes also have stored energy (as fat and protein/muscle) to assist milk production in early lactation.

Feeding levels and ewe health

Some animal health effects can be due to underfeeding, especially during late pregnancy.

When pregnancy toxaemia (sleepy sickness) occurs it is usually in ewes carrying multiples, and is due to underfeeding or stress such as prolonged bad weather. Metabolism of body fat produces ketones which cause the ewe to become drowsy and move awkwardly. It can be treated orally with a sugary solution or 'ketol'.

Bearings (vaginal prolapse) have numerous causes and are most common in obese ewes and those carrying multiples, being more prevalent in mature and aged animals. There is no good scientific evidence on ways to avoid bearings, and if affected ewes are retained after treatment, a 30-35% recurrence can be expected the next season. Cull these animals.

Dystocia is mainly caused by difficulties passing large single lambs through the birth canal, but can also occur with small weak lambs and poor ewe uterine contractions. Overfeeding of ewes, resulting in a large lamb can exacerbate the problem. Since dystocia is repeatable, ewes assisted at lambing, and their lambs, should be identified for culling.

This is another reason to aim to have lamb birthweight of four to five kg.

Shearing effects on lamb birth weight

Recent experimental work by Morris, Kenyon et al., 1999, indicates that a late Autumn early Winter shearing can offer real advantages to farmers wishing to increase lamb survival at birth.

Shearing ewes in mid-pregnancy can increase lamb birthweight by up to 1.0kg compared to shearing just before lambing. The best time to shear ewes to gain a maximum response is likely to be pregnancy day 50 to 100. In a large field trial involving 1002 twin-born lambs, there was a 3% reduction in mortality rate in lambs born to ewes shorn at pregnancy day 67 compared with those lambs born to unshorn ewes (i.e. 15% versus 18%).

It would appear that early pregnancy shearing increases birthweight of multiple lambs by (a conservative) 0.5kg. This has the effect of 'moving' each lamb up one birthweight category (e.g. lambs which would have been in the 2.0 -2.5kg range are now in the 2.5 -3.0kg range).

More work is being carried out on this effect, though it appears that both placental development and the greater time available for altered foetal growth before the lamb is born is evident.

Current thinking is that because a shorn ewe is colder, more thyroid hormone is released, which in turn speeds up the ewe's metabolism. She seems to mobilise her reserves better and promote lamb growth.

However, if a ewe is already in poor condition, or if in very good condition and in good feed, response to pre-lamb shearing appears to be less.

This variation is not properly understood, and more research is currently being carried out to evaluate best practice.

The use of a cover comb has been suggested whenever pre-lamb shearing occurs in order to decrease the potential losses from hypothermia in newly shorn sheep (Dabiri et al., 1995).

The use of a cover comb also saves on a ewe's feed requirements.

Points to consider about winter shearing:

- Extra feed is required.
- Ewes will be eating more feed at a time of year when it is slow growing. It takes 10-15 days for feed requirements to get back to equilibrium.
- Easier lambing through less wool on the ewe.
- Reduces management pressures for hill country farmers.
- Improved wool quality.

CHAPTER FOUR – BIRTH TO WEANING

The easiest time to achieve 400 g/day growth is between birth and weaning. Then it becomes progressively harder.

While lambs increasingly eat more grass as they age, and twins in particular have to consume pasture sooner than singles, protein supply via the ewe's milk is the crucial element in providing a good start.

Therefore ensuring good ewe nutrition to aid ewe milking is critical, particularly in early lactation.

Milk supply and the lactation curve

The onset of lactation and colostrum production are affected by ewe nutrition in late pregnancy, while feeding during lactation influences total milk production.

Daily milk production peaks at about 2-3 weeks of lactation, then gradually declines.

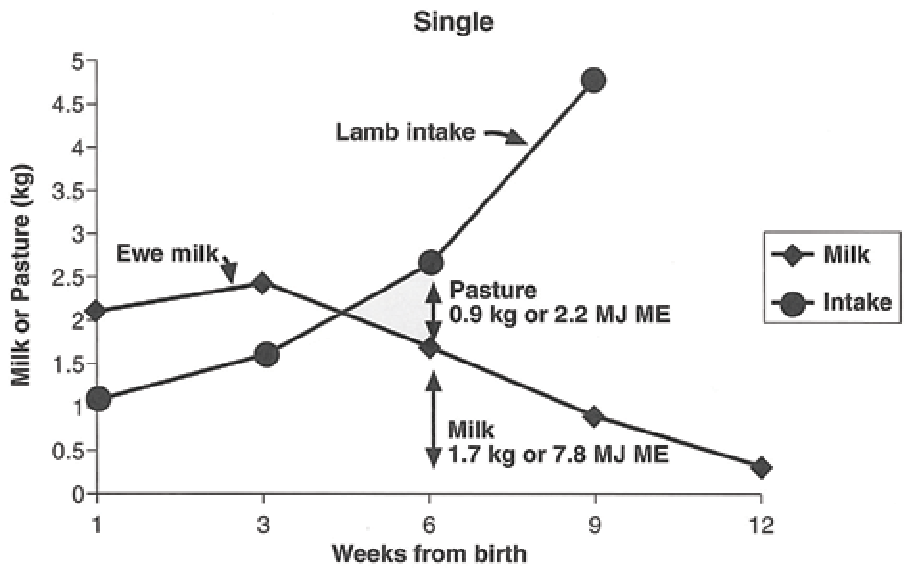
Regardless of its nutritional level, ewes rearing multiples produce more milk than similarly fed ewes with singles.

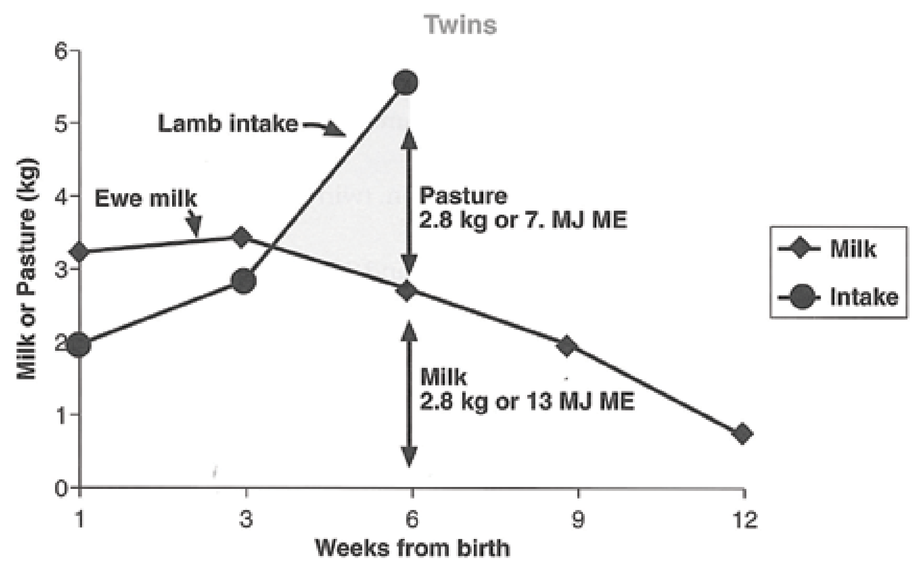
Ewes with twins produce 30%-50% more milk than those with singles, but as this is shared between two lambs, each lamb receives only two thirds as much milk as a single lamb.

To make up for this lower milk consumption, twin lambs are forced to start eating pasture at an earlier age than singles.

Peak production has been measured at around 2.3 litres/day for a single suckled ewe and 3.5 litre/day for twins. About 40-50% of total milk is produced during the first four weeks of lactation in each case (Geenty, 1979).

Fig 4:1 The milk/pasture transition



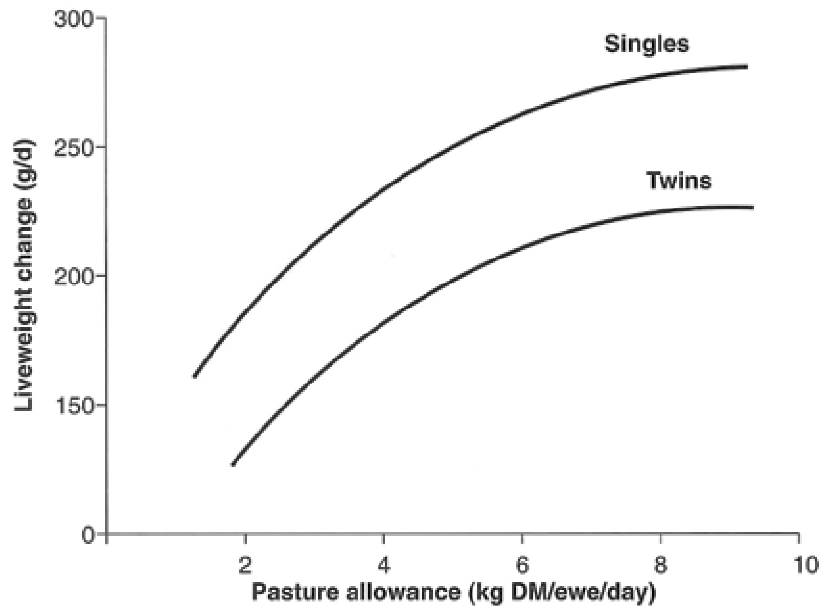


Source: Geenty, 2000

The ewe uses both dietary metabolizable energy (ME) and her own body reserves for milk production. This normally occurs during early lactation, regardless of the level of feeding, and particularly in ewes rearing twins. The ewe normally replaces some of these body energy reserves (mainly fat and muscle) during the second half of lactation.

Due to the high feed cost of replacing body tissue (50 to 65 MJ ME/kg weight gain), weight losses during pregnancy and lactation should be minimised.

Fig 4:2 Pasture allowance during lactation and LW gain in suckling lambs



Source: Rattray, 1987

> It is recommended that ewes are offered 6-8 kg green DM/day to ensure they eat 2-3 kg DM/day. This requires 1500-2000 kg DM/ ha.

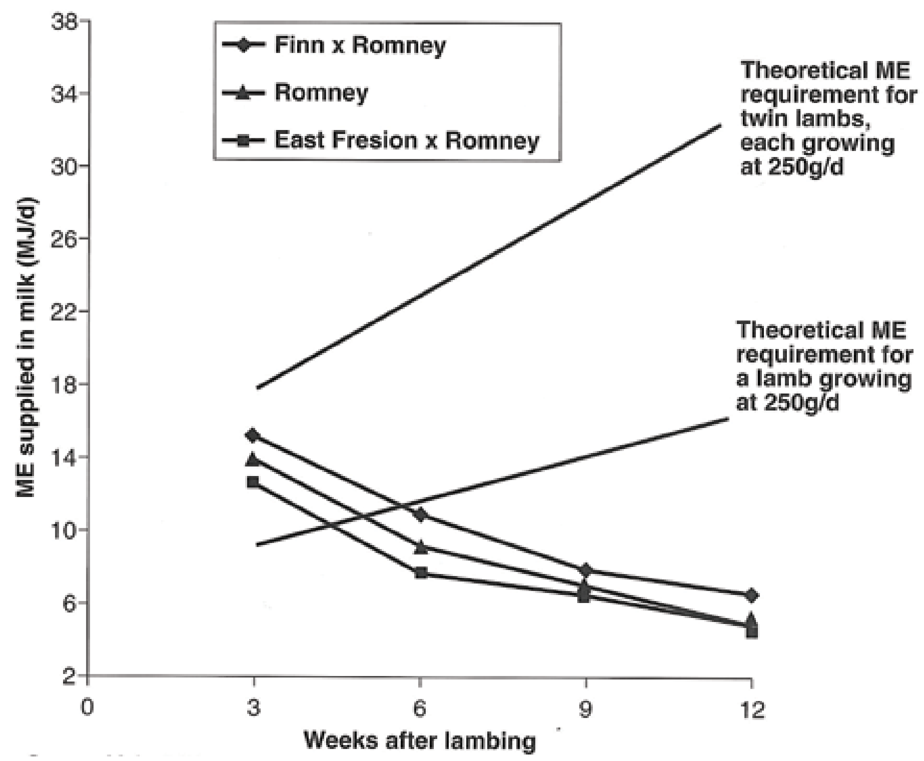
Milk production versus pasture consumption by lambs

Recent research has focused on the benefits that ewes of higher milking ability may bring to a flock. The development of a milking industry based on Poll Dorsets and the recent importation of East Friesians have refocused attention on milk production.

Milk production is more important in years with poor pasture growth and for twin lambs. Producing heavy lambs within specified time frames means milk production is the key to ensuring a reliable weaning weight. Some seasons may not see a benefit in increased milk production, but generally it will be very important to ensure consistency of lamb supply.

Milk production is most important during the first six weeks from birth, and multiples are more dependent on pasture than singles (Geenty & Dyson, 1986).

Fig 4:3 Contribution of milk to lamb's feed requirements *Ewe milk energy vs lamb energy requirements for growth*



Source: Muir, 1998

The interaction between pasture supply and lamb growth in spring generally means a ewe's lactation ability becomes especially important when pasture growth is low (Geenty & Dyson, 1986; Muir et al., 1998). Both authors note that milk volume becomes more important when lambing percentage increases.

High milking ability increased twin lamb growth by between 8-15% depending on pasture conditions, being lower when pasture conditions were favourable (Muir et a11998). The economic advantage to high milking ability was expressed in years of both good and poor pasture growth (Muir et al., 1999). Further work with East Friesian x Romney ewes has also shown advantages in lamb growth (Muir pers. comm) due mainly to improved milk production.

Weaning age flexibility

Ideally lambs should be left with their mothers until they are around 25kg-30kg or more. Usually it isn't managerially difficult to achieve this, since there is plenty of good quality pasture after the spring flush – the management of its quality in fact being the bigger challenge.

Occasionally however, either due to lambing before the spring flush or exceptionally dry conditions meaning it doesn't occur, a feed shortage may develop so weaning age flexibility is important (Geenty, 1979).

New born lambs are not sufficiently developed to eat grass (witness mismothered new born lambs with fat tummies, full of grass they are unable to be digest).

CHAPTER FOUR

A lamb gradually changes from a monogastric to ruminant stomach over its first three to five weeks of life. The length of time required to achieve this varies on the milk supplied by the ewe as well as the quality of feed on offer.

As a lamb ages, it moves into competition with its ewe for available pasture intake. As shown in the following diagrams, if feed is short, by weaning lambs earlier than 12 weeks, total dry matter requirements are about the same. However lambs reach an acceptable slaughter weight ahead of what would occur if they stayed on their mothers. This is because the lambs are not competing with the ewes for limited available feed.

The two scenarios on the next page illustrate the following principles:

Scenario one – feed limited from week nine

- 20-30% feed reduction weeks 9-12

  If unweaned – 4kg lower weaning weight
  If weaned at nine weeks – no reduction

Scenario two – feed limited from week six

- 20-30% feed reduction weeks 6-12

  If unweaned – 7kg lower weaning weight
  If weaned at six weeks – no reduction

Table 4:1 Lamb Weaning Strategies

Scenario one – feed limited from week 9
Feed requirement-live weight profile (60 kg ewe + 1.3 lambs)

Week of lactation	3	6	9	12
Ewe DM req. (kg/d)	2.2	2.0	1.8	1.6
– weaned		1.0	1.0	1.0
Lamb weight @ 300g/d	10	16	23	30
Lamb DM req. (kg/d)	0.2	0.5	1.0	1.3
– weaned		1.0	1.5	1.8
Total DM req. – weaned	2.4	2.5	2.8	2.9
– unweaned		2.0	2.5	2.8

Scenario two – feed limited from week 6
Feed requirement-live weight profile (60 kg ewe + 1.3 lambs)

Week of lactation	3	6	9	12
Ewe DM req. (kg/d)	2.2	2.0	1.8	1.6
– weaned		1.0	1.0	1.0
Lamb weight @ 300g/d	10	16	23	30
Lamb DM req. (kg/d)	0.2	0.5	1.0	1.3
– weaned		1.0	1.5	1.8
Total DM req. – weaned	2.4	2.5	2.8	2.9
– unweaned		2.0	2.5	2.8

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If a feed pinch is going to occur wean early.

The keys to earlier weaning strategies can be summarised as follows:

1. Get lambs to at least 16kg liveweight.
2. Creep graze (allow lambs to graze ahead of the ewes) or allow the lambs to creep onto supplements such as grain or meal. Feed supplements to the ewes and lambs
3. Wean onto legume dominant pastures (at least 1200kg DM/ha or 3-5cm length.)
4. Ensure lambs are parasite free.
5. Lambs are very ‘fragile’ at this stage and need every advantage to get them through this period.

CHAPTER FIVE – DIET TRANSITION – MILK TO GRASS

Protein and carbohydrates

A young lamb's protein requirement changes rapidly as it ages.

For example, a young lamb of 20kg liveweight requires 14g crude protein per MJ ME compared to 6 g/MJ ME for the same lamb at 40kg (Sykes and Nicol, 1983).

During lactation significant quantities of by-pass protein are supplied to the lamb from milk. It is called by-pass because the suckling reflex closes the oesophageal groove, by-passing the reticulo-rumen – going straight to the small intestine. Sheep absorb protein much more efficiently in the small intestine.

Most pasture feeds are initially broken down in the rumen. The rumen provides relatively constant protein output through microbial protein. No matter what the protein levels of feed to an animal, rumen microflora convert it to about 13-14% protein. The rest is converted to ammonia, and eventually excreted as urea in the urine. In other words, the rumen bacteria waste a lot of potentially useful protein.

An animal's response to increasing protein depends on the energy supply; the more energy the greater the response to protein. Thus protein supply and demand may be one of the reasons for poor post-weaning growth in lambs.

Comparing the protein supply from various types of pasture, it is apparent that the response of post-weaning liveweight gain may vary depending on both the weight of lambs at weaning and the type of pasture being offered (Hughes and Poppi, 1983).

Most New Zealand grazing systems should be aiming at a weaning weight of 25-28 kg to ensure that pasture can supply enough protein to meet growth demands.

From a management point of view it is better not to mix single and twin lambs and ewes pre-weaning. This is because twin bearing ewes require preferential feeding and their lambs the pick of the feed to develop to their potential.

Interdependence of energy and protein

The response to increasing protein depends on the energy supply; the greater the energy supply the greater the magnitude of the response to protein (Chowdhury & Orskow, 1997).

This response is driven by the supply of protein and energy to the rumen, rather than reflecting the true animal response or requirement for protein at any feed level.

The protein output from the rumen is then significantly lower from low digestibility than more digestible feeds, even when fed below maintenance.

When the results are expressed in terms of protein at the intestinal level it was found that ruminants that were poorly fed still accumulated protein when protein supply to the intestine was adequate, with energy for protein turnover coming from stored body fat. This helps explain the concept of frame growth without overall weight gain especially in hoggets during winter.

Carbohydrates

Carbohydrates are the major energy source within the plant. Plants have structural carbohydrates and water-soluble or non-structural carbohydrates.

- Structural carbohydrates – cell walls, hold the plant up.
- Water-soluble carbohydrates – are inside the cell and are the direct products of photosynthesis and temporary storage products such as glucose, sucrose and fructosans.

Structural carbohydrates consist of hemi-cellulose, cellulose and lignin. Hemi-cellulose is the most digestible of this group, followed by cellulose and finally lignin which is hardly digested at all.

The feed value of the plant decreases as its structural carbohydrate content increases.

- Plant becomes less digestible; animals cannot extract as much energy.
- Plant becomes more slowly digested because cellulose and lignin tend to increase more than hemi-cellulose. If the plant is digested slower, then the animal has to wait longer for the feed to pass through the rumen and so it cannot eat as much and feed intake goes down.
- Indigestible fibre increases as plants age, as seedhead is formed and when plants are grown at higher temperatures.

The concentration of structural carbohydrates required to maximise animal performance depends on its potential performance. With low potential to grow, non-digestable fibre (NDF) concentrations can be 40-45% of the diet. At maximum growth or production then NDF concentrations need to be between 30-35% to achieve potential (Van Soest, 1994). Again, this translates to a quality of feed – and quality relates to digestibility or metabolisable energy.

The animal rapidly digests water-soluble carbohydrates, and they add a flavour component to the diet that may influence feed intake.

Photosynthesis is used to make glucose, which is converted to sucrose for transport around the plant, or to fructose to be made into fructosans for short term storage. The water soluble carbohydrates accumulate when temperatures (especially night-time) are low after sunny days. They are also higher at seedhead emergence, and lower when nitrogen fertiliser is used.

Sucrose levels are higher near seeding as sucrose is transported from the leaves to the seedhead.

Fructosans are higher in early spring before seed head development, and again in regrowth after seeding. High temperatures depress both sucrose and fructosans as plant respiration increases.

Diet selection in balancing nutrients

Studies of the diets selected by sheep have shown that nutrient imbalances are avoided when possible.

Internal parasites also cause lambs to vary their selection for protein. Intestinal nematode infection impairs nitrogen retention and lowers intake (Brown et al., 1986), though lambs make an attempt to compensate for intake loss as much as possible (Young & Sykes, 1988). The diet selected by infected lambs maintained protein intake regardless of the decline in voluntary feed intake (Kyriazakis et al., 1994). Increased protein causes a decrease in faecal egg output and helps make up for the loss of protein from the gut due to parasite infection (Brown et al., 1986; Van Houtert et al., 1996). This explanation shows why worm control is so important.

Water-soluble carbohydrate high diets improve feed intake and are preferred by sheep (Ciavarella et al., 1998). As the most rapidly digested part of a pasture, water-soluble carbohydrates can improve the efficiency of use of protein (Dellow et al., 1988; Bolam et al., 1998) and increase the feed value of the feed by increasing the potential glucose supply to the animal (Dellow et al., 1988).

Lambs will choose diets that maximise their performance under a range of requirements and challenges. Knowledge of this process will highlight the use of various pastures for specific purposes.

- Pastures high in legumes will reduce the effects of internal parasite challenge.
- Pasture with good water-soluble carbohydrates provide maximum intake and digestion efficiency.
- Pastures with good tannin contents enhance protein supply and lean growth. Tannin rich pastures prevent protein breakdown before the protein reaches the small intestine.

Forage species

Many temperate pasture (or forage) species grown in New Zealand have similar digestibility and metabolizable energy contents, but have different animal performance.

Intake differences are the most important determinant between species.

For most New Zealand forage species there is a close relationship between digestibility and metabolizable energy. ME is usually about 0.82 of digestible energy, and only foodstuffs which have a high fat or oil content are widely outside of this figure.

The differences in animal performance between different forage species have been explained in two

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ways; rate of digestion, and protein digestion (availability of true protein to the small intestine).

Rate of digestion

Feed that is digested quickly moves through the lamb's gut faster. The animal has the opportunity to eat more feed and so ensure greater lamb growth.

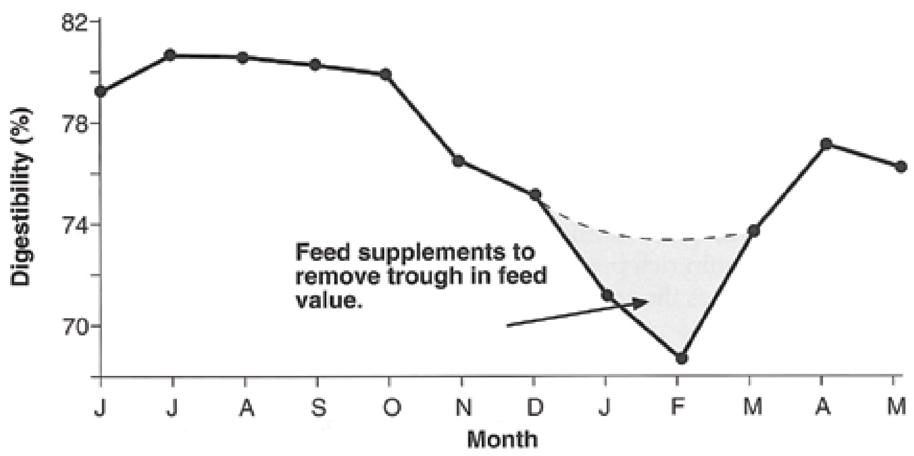
Pasture species that achieve this fall into two groups:

- Low NDF concentrations (low cell wall). These pastures have a high digestibility and high energy value. An example of this is that lambs grazing grasses in spring grow faster than lambs fed the same grass in summer.
- Legumes and herbs break up more readily and so move through the animal faster -again allowing the animal to eat more if required.

These factors contribute to overall pasture digestibility, which itself varies throughout the year.

The following graph illustrates seasonal pasture digestibility.

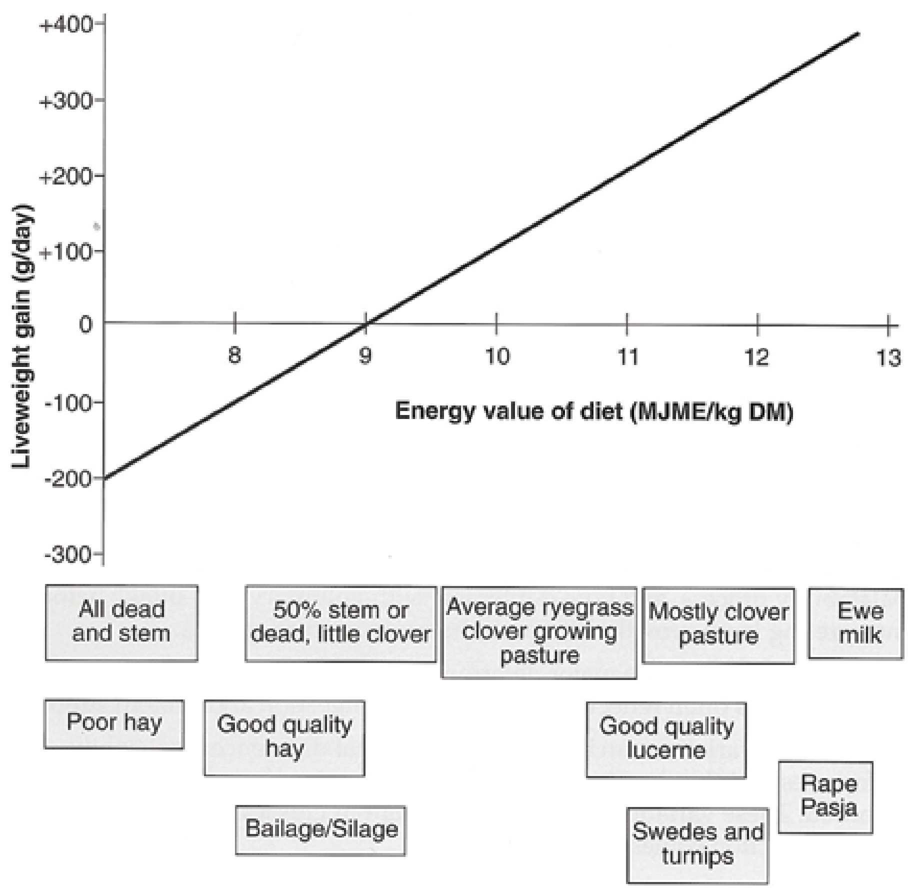
Fig 5:1 Effect of season on pasture digestibility in dry areas



Source: Rattray, 1987

The importance of green, leafy pastures on feed quality and intake cannot be over emphasised, as illustrated in the following graph.

Fig 5:2 (1:1) Liveweight gain of a 30kg lamb and the energy value of the diet



Source: Stevens, 1999

Protein digestion

The availability of true protein to the small intestine also provides a difference in animal performance.

The rumen provides a relatively constant protein output through microbial protein. In other words, no matter what the protein levels of feed to an animal, rumen microfloral convert it to about 13-14% protein. The rest is converted to ammonia, and eventually excreted as urea in the urine.

Any extra protein (by-pass protein) that gets to the small intestine must do so by avoiding rumen degradation.

Three factors are the main determinants of by-pass protein.

1. Rate of digestion. This can be enhanced by high-energy diets. Plants that are quickly broken down in the rumen move through the animal faster. This prevents all of the protein from being degraded in the rumen, so more gets to the small intestine and to the animal.
2. Amount of true protein in the diet. This becomes important only when digestion is rapid. Legumes have both fast digestion and high true protein content, and so provide an enhanced protein supply to the lamb. Grasses are more slowly digested, so their extra true protein is not as valuable, and can sometimes even be detrimental to lamb growth.
3. Condensed tannins. Present mostly in legumes, these bind to the protein and protect it from degradation in the rumen. The acids in the true stomach (4th stomach) break the tannin and protein, allowing absorption in the small intestine and improving protein supply to the lamb. Ongoing research suggests condensed tannins could be important in New Zealand farming.

Feed intake

It is very important to understand the nature of the selection and palatability process, and how it interacts with voluntary feed intake before interpreting lamb growth differences between pasture species.

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Feed intake is one of the major determinants of differences between pasture species. This is often reflected in both rates of digestion and protein supply.

Cases where variation can be caused by seasonal differences, palatability differences and the chemical composition of the plant have all been recorded. These variations are most important in grasses because 70-90% of lamb production comes from them.

There are examples where both rate of digestion and protein supply are relatively similar due to the cellular structure of plants, but where performance differences exist.

In legumes an example comes from comparing the lamb growth and feed intake from *Lotus pedunculatus* and *Lotus corniculatus*, two related species. Lamb growth is lower on *L. pedunculatus* than *L. corniculatus*. This can be explained by lower voluntary feed intake on *L. pendunculatus*. Different tannin types within each cause the difference. When analysed in the laboratory, they have very similar feed characteristics. The animal can detect the difference however, and takes several weeks to overcome this, though eventually intake will improve on *L. pedunculatus*.

Leaf presentation (aerial versus prostrate position in grazing horizon) and leaf!stem ratio are extremely important as well.

More information about specific palatability and digestibility of different grasses can be found in *Feed Planning* (NZ Sheep Council, 1999).

Pasture mixtures

Further variation exists where both grasses and legumes are used.

Legume content has a major influence in modifying lamb response to grass species, and will be an important factor in achieving a 400g/day growth rate. Tall fescue performance in the field can vary dramatically from 250 g/day down to 0 g/day depending on the clover content (Wrightsons). The response of lambs to high endophyte ryegrass can be alleviated by high white clover content (Fletcher et al., 1990), since the lambs prefer to eat the clover.

Combining individual species in high quality pastures can produce high levels of lamb growth.

Steven et al., (1994) described three years of large scale trials in Southland using improved pasture cultivars with and without chicory and red clover.

Lamb growth was 185 g/day on the resident, mainly ryegrass pastures. This increased to 214 g/day (+15%) on new grasses. When chicory and red clover were included in a general pasture mix growth was 259 g/day (+40%), while the use of chicory and red clover as a specialist finishing pasture resulted in 280 g/day (+51%).

Stocking rate increases were also achieved, resulting in total increased production per hectare of 27%,70% and 94% respectively.

From a practical farm management point of view attempting to obtain the final 50g of growth a day may not be cost effective.

Pasture preparation and maintenance

Birth to weaning

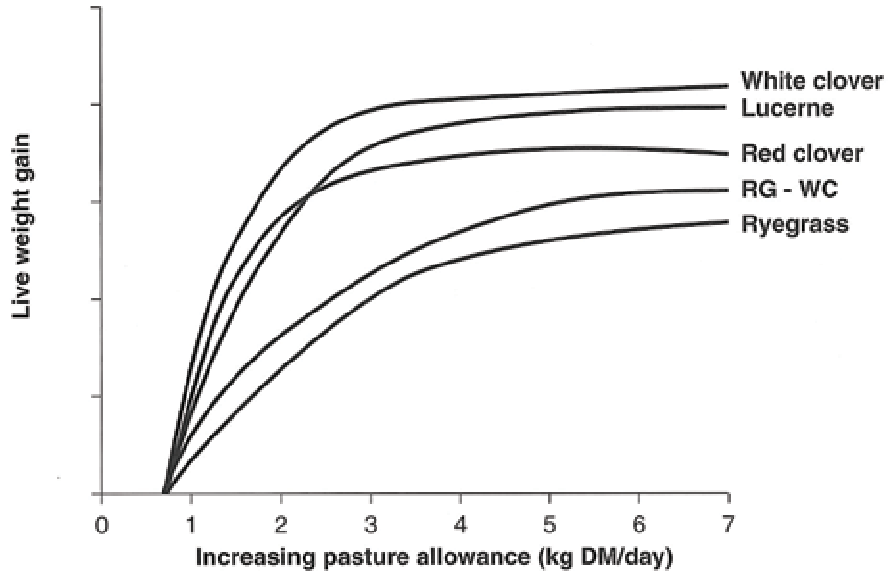
> Green leaf is the most important factor in animal production and liveweight gain.
>
> The best nutritional practice for practical pasture systems and lamb growth is to maintain good pasture cover, high green leaf content and when possible, high clover content.

Lamb growth rates near a maximum at between 2-3kg green DM/lamb/day when grazing legumes but need 5-6 kg green DM/lamb/day on ryegrass or ryegrass/white clover pastures (Jagusch et al., 1979).

Lamb growth rates continue to increase with post-grazing herbage masses of up to 2000 kg DM/ha. However, high residuals can be wasteful of feed mainly because of trampling and the buildup of dead material.

The best way to achieve this is to aim for post-grazing pasture residuals of not less than 1200kg DM/ha. A pasture cover of around 5cm equates to 1500 kg DM/ha.

Fig 5:3 Responses in lamb growth to pasture allowance varies depending on the pasture species offered



Source: Jagusch et al., 1979

Dry matter availability may be a simplistic way to assess sward conditions for optimum lamb growth. Interacting factors in the sward will be species composition, levels of stem, pseudostem, green leaf and dead material, as well as accessibility to those preferred components (Hughes 1983). He reported that herbage intake of lambs declined to half when the same allowance was offered at four herbage masses increasing from 1800 to 5000 kgDM/ha.

British work (Hodgson 1990) supports Hughes (1983) promoting the use of green leafy pasture of 4-6 cm long to maximise lamb growth rates during summer.

Interacting and suppressive factors such as facial eczema and ryegrass endophyte with their associated toxins may playa large role in the lamb growth differences.

Clover content

Clover growth is a key driver of lamb performance. Lambs will select clover and reject dead material (Hughes et al., 1984), though a diet of only clover is never selected when animals have a choice.

> A diet of approximately 50% of DM as clover appears the optimum for high lamb growth.

Effects on voluntary intake

Environmental effects on pasture quality

Increasing ambient temperatures during pasture growth plays the major role in altering voluntary feed intake of forages. The concentration of fibre increased and protein decreased as growing temperature increased (Denium, 1966) regardless of stage of growth.

These changes result in a decline in voluntary feed intake as growing temperature increases (Minson, 1990). The effects of water stress appear to be relatively small or positive, as dry matter digestibility often remains unchanged or may increase when water stress is imposed (Wilson, 1982).

Plant maturity

As plants mature and go to seed, digestibility falls (Minson, 1990), and in turn voluntary feed intake

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reduces (Hodgson, 1977). Digestible crude protein concentration also declines and if it falls below 90 g/kgDM may reduce voluntary feed intake (Leng, 1990).

Effects of time of year

In many regions, spring and autumn conditions can be similar. However, there are differences in pasture quality.

Spring grown feed has higher water soluble carbohydrates and fructosans, and lower NPN (non protein nitrogen which is lost in excretion). At other times of year when NPN is high, the need for a lamb to synthesise urea to get rid of it has an energy cost and detracts from optimised lamb growth. Maintenance requirements may be higher as a result.

Many of the seasonal changes in voluntary intake are related to changes in digestibility.

Changes in lamb performance between spring and summer have often been described as summer ill thrift. This could be multi factorial and related to changing digestion efficiency, endophytes seasonal changes in ryegrass compostion and some trace element deficiencies such as cobalt and selenium.

However, voluntary feed intake is the driver of all pasture-based animal production and there is relatively little knowledge of the way it is controlled. The interactions of changing pasture chemical and nutritional composition with animal performance have received little attention in recent years and yet offer the greatest returns.

Fungal toxins may also be more prevalent in the summer and autumn. These are dealt with in more detail later in the booklet.

Management principles

Typically the 'crunch' time on New Zealand farms is late September, early October (about tailing time or six weeks from lambing). The sheep are spread over the farm, and there's very little opportunity to make management changes.

Just prior to this crunch is an extremely important time to control the digestibility of pasture by pasture grooming. One method of maintaining control is closing up blocks for conservation.

Most problems that occur are because of decisions already made earlier in the year.

While a feed pinch will almost invariably occur at this time, the major reason for a 'crunch' is either because lambing isn't beginning on the right date, or else not enough pasture cover is taken into lambing.

A pasture with 1200kg DM/ha is able to grow at about 80% of its potential.

A pasture with 900kg DM/ha is able to grow at about 60% of its potential.

Many farmers begin lambing with a pasture cover of 1000-1200kg DM/ha. Ideally this cover should be 1200-1500kg DM/ha.

The reason is because a pasture with less cover cannot intercept all sun light because the plants are too small or there is too little leaf on the plant to do so.

Therefore a pasture taken from 1500kg DM/ha to 1200kg DM/ha through grazing can recover better than a pasture taken from 1200kg DM/ha to 900kg DM/ha.

Correct pasture cover levels and the right lambing date are two of the keys to maximising lamb growth.

Having the right amount of cover, and having the right lambing date is the key to maximising lamb growth.

This may mean delaying lambing by 5-6 days to coincide with spring flush, as well as managing during the winter to ensure correct pasture cover once set stocking and lambing begin.

The main point (as dairy farmers understand) is grass grows grass. It is what is left behind that matters.

The pasture cover left behind is often determined by tupping date six months before the feed crunch time.

You will not come out of the winter with more feed than you had going into the winter.

Dairy farmers have some greater flexibility being able to feed supplements in the milking shed or by continuing to feed silage.

Sheep farmers may be able to feed grain (if sheep are already conditioned to it), or silage. Sheep farmers may also be able to begin a rotation, particularly for ewes with single lambs. By attempting to lock out one paddock in four, pastures can be freed up so pastures actually grow faster.

Getting Spring pasture management right eases future management decisions. Instead of suppressing pasture growth, it needs to be allowed to achieve its potential. Pastures have to be kept short enough to ensure the white clover leaders are not shaded and can run, especially in the late spring.

Maintaining pasture covers yet not letting it get too long may require a change in conservation style among sheep farmers.

Conserving feed (as silage or hay) in November-December instead of January-February is digestible. It is essential to close up the required paddocks early to ensure the quality of pasture, and of the subsequent hay or silage.

If hay or silage making isn't possible, for the sake of the rest of the farm's pastures it is better to completely shut up a paddock and use it later.

Managing the Spring flush is a trade off between producing more grass and the potential for Summer white clover growth.

CHAPTER SIX – POST-WEANING

The importance of pasture management

Maintaining high lamb growth rates after weaning and without the input of ewes' milk is a big challenge.

Rate of liveweight gain is affected by both feed quantity and feed quality. In order to achieve high liveweight gain young healthy animals need access to adequate quantities of high quality feed.

Farmers need to aim for an adequate allowance of green herbage in front of their lambs.

In practice this means:

- A large quantity of quality feed needs to be on offer.
- Lambs will utilise less than a third of this feed, selecting the top energy components of the pasture of 11+ MJME/kgDM.
- If forced to eat more than the top third of pasture, lambs will be eating stems and leaf sheath – both of which have lower energy levels.
- If forced beyond this, lambs will be eating some dead material as well.

Understanding pasture growth

Ryegrass and white clover are the predominant pasture species in New Zealand mainly because they are both productive and very resilient under grazing.

As well as providing a 'free' source of nitrogen through clover, even if the pasture gets out of control it can be brought back under control with relative ease for optimum production.

Conversely, if overgrazed, with correct management such a mixed sward has the ability to bounce back.

The major points to appreciate in pasture production are:

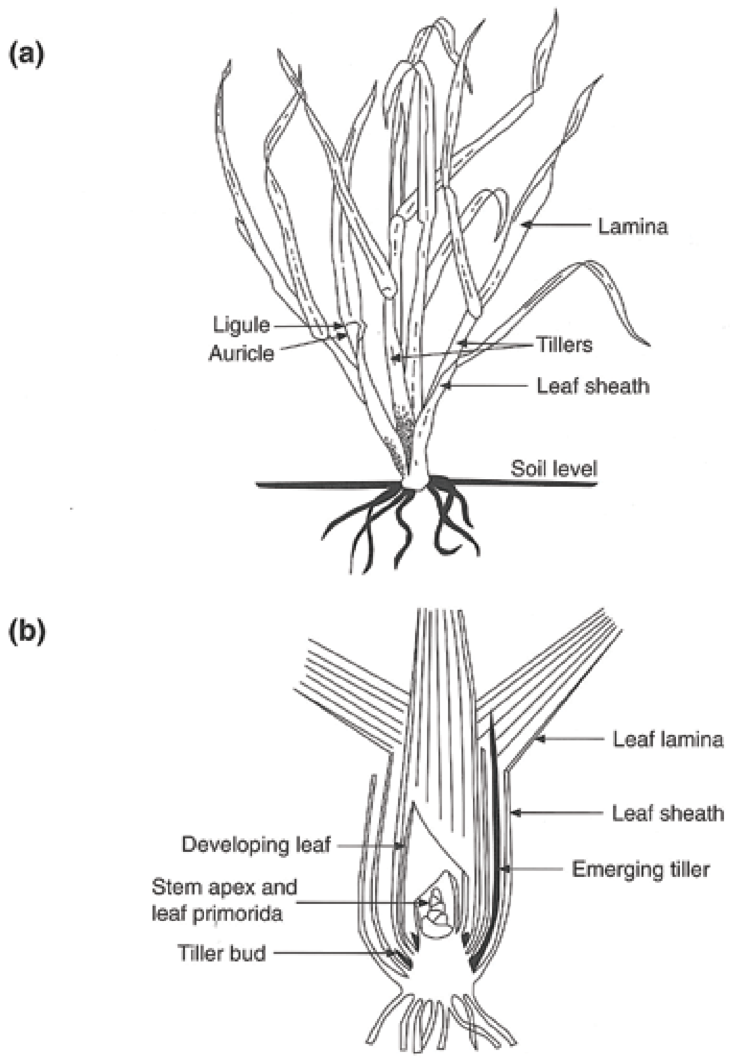
- Grass grows grass.
- It is the grass that is left behind that counts -since it is from this base that new growth occurs.

Ryegrass

Ryegrass growth takes place from buds that are below ground level and therefore largely protected from direct grazing damage.

The development of new plant tissue from these growth sites is virtually a continuous process.

Fig 6:1 The grass tiller. (a) illustration of an established plant of perennial ryegrass with four tillers; (b) stylized cross-section of a vegetative tiller.



Source: Sward Measurement Handbook, 1981

- A tiller, as the basic unit of production, is a single growing point encased in the sheaths of the leaves which grow from it. Each tiller bears its own root system.
- New generations of tillers can develop from buds at the base of individual leaves.
- Each leaf's characteristic growth cycle is and of active extension, maturity and senescence and death, whether or not some or all of the leaf has been grazed.
- High fertility soils ryegrass begins growing at five degrees, under lower fertility at seven to eight degrees. Optimum growing temperatures are 15-20°.

White clover doesn't begin growing till soil temperatures are 10˚, with an optimum of 20-25˚. This is the main reason clover production peaks at a different time of the year to ryegrass.

- Early spring – existing ryegrass tillers respond to higher temperatures and boost structural and non-structural carbohydrate production.
- Late spring – seedheads develop from existing tillers that went through the overwintering vernalisation process. Daughter tillers produced from secondary nodes within the plant.

Grazing, mechanical removal or chemical treatment prevents too many resources being devoted to seedhead development; concentrating instead on new tillers.

- Summer – heat stress, plus new tiller development being below cutting height gives the appearance that growth has declined. Plant is preparing to generate new growth.
- Autumn – first flush of growth from new tillers. As less and less light reaches the ryegrass base, leaves begin to die back.
- Winter – pastures may contain a high overall mass, but much is dead material, containing only low quality cell walls.

  Plant may actually be growing, but the net effect is nil as dead and dying tillers disappear into the soil.

Clover

White clover grows through the extension and repeated branching of a series of prostrate stems (or stolons) growing along the soil surface from the crown of the original plant.

Leaves, roots and buds with the potential for new branches arise at nodes which develop at intervals along the stolons.

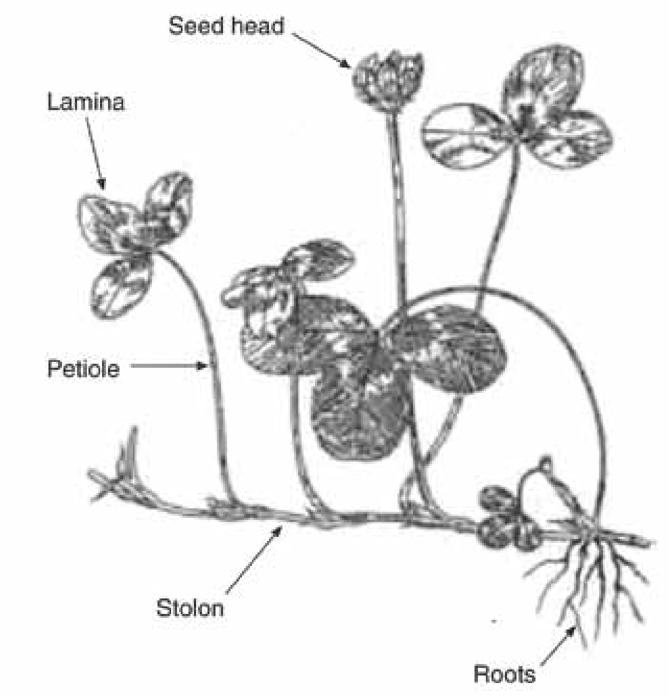
White clover has a ‘mobility’ that tillering grasses do not. It is a more successful grassland species than other cultivated legumes which lack the stolon habit and are much more sensitive to hard grazing.

There are usually three to six leaves per stolon at any time and continued leaf production is dependent on continued stolon development.

Flower head production in clover occurs later than grasses and is normally spread over a longer time period. Therefore the seasonal cycles of herbage production in grasses and clovers are very different.

Note: There are a number of white clovers that differ considerably in flowering/seeding time.

Fig 6:2 Structure of white clover



- Winter – clover draws back to the original plant in cold areas; all stolons between its nodes die.

  Often its crown is buried below the soil surface because of worm action and general animal grazing activity.

- Spring – individual plants start running, sending a leader across the ground surface. The more light, the more this leader response. The more grazing, the more branching from the nipped off leader.

  This is why set stocking is good for clover growth in the spring period. The more clover can spread, the greater number of nodes it produces. The more nodes, the more leaves since a leaf is produced at every node. At about every third node small roots may form.

- Late spring –

  Critical to stop set stocking if high clover performance is desired. Under continued set stocking, clover is under high grazing pressure and will only develop small leaves.

  Spelling pastures and moving sheep allows the clover to put up and grow large leaves.

- Summer – clover leaders still spreading into December. Most of the plant is on the surface as well as being up into the ryegrass sward; being almost aerial in its habit.

  Provides a high quality feed which tends to make up for the grasses’ lower quality (more structural and cell walls and dead material than soluble carbohydrates).

- Autumn – clover growth finishes and becomes dormant as light and temperature levels drop.

  Surviving nodes which have formed roots put down a small individual taproot. Plant effectively becomes buried again.

Pasture quality

Feed quality is influenced by a number of factors including concentrations of energy, protein, minerals and trace elements, and loadings of fungal toxins and internal parasite larvae.

The major quality limitation to the growth of lambs is the nutritive value of the herbage they consume.

The nutritive value (NV) of a feed relates to the proportion of nutrients digested (digestibility) and the efficiency with which these digested nutrients are absorbed and utilised within the animal’s tissues (Ulyatt et al, 1976).

Pastures typically contain about 15-30% protein which is adequate for most grazing stock. The most common limiting component of herbage NV is metabolisable energy (ME) concentration, expressed as megajoules per kilogram dry matter (MJ ME/kg DM).

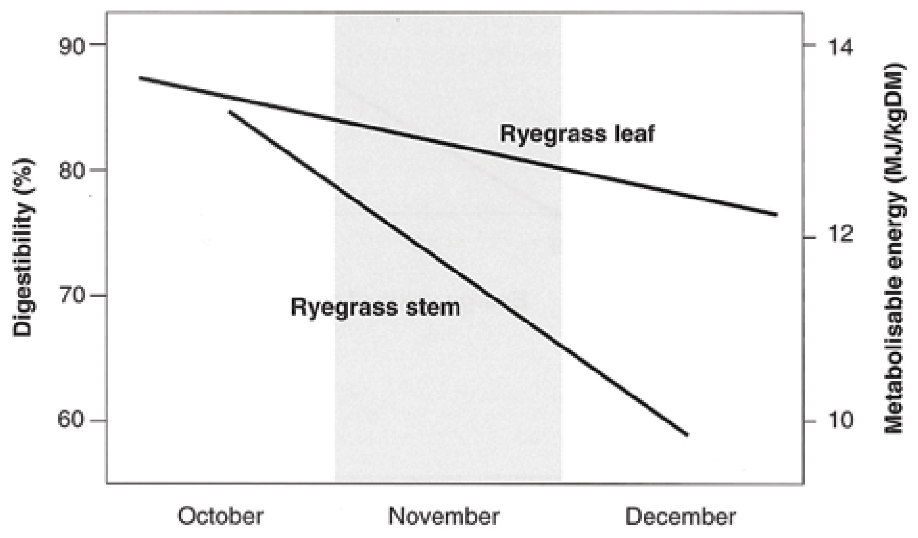
Metabolisable energy is the amount of energy in ingested feed left for productive purposes after losses in faeces (indigestible material), as urine and in gases from the rumen.

Pasture ranges from 8-12 MJ ME/kg DM depending on its botanical (grass or clover) and morphological (leaf, stem or dead) composition, its age and the time of year.

Approximate energy levels in different types of pasture are:

- Clover leaf has an ME of about 11.8 MJ ME/kg DM.
- Young grass leaf has an ME of about 11.5, which declines at about 0.03 MJ ME/kg DM/day.
- Young reproductive stem has an ME of about 10.5, which declines at about 0.06 MJ ME/kg DM/day.
- Dead matter has an ME of 8.0 MJ ME/kg DM or less.

Fig 6:3 Ryegrass digestibility in spring



Digestibility of ryegrass declines in spring as stems and seedheads form. Good management limits these, keeping pasture digestible and can give a 15-20% difference in digestibility.

Dead material can be of higher than expected ME in drier regions at onset of drought when young herbage has been rapidly browned off. This is in contrast to dead material that is simply old.

Pastures grown at higher temperatures (as in summer) have a lower ME than pastures grown in cooler temperatures. ME also declines in grass leaf and stem more quickly at higher temperatures. The rate of decline in grass leaf ME with age in winter is very low.

Grazing animals generally select a diet of higher NV than that which is offered to them. As animals reduce pasture mass during their time in a paddock they select the highest NV components first, which means the average NV of the remaining material falls, ability to select high NV components progressively declines, and so diet NV declines.

Figure 6.4 shows the effect that pasture quality has on lamb growth rate.

Note: even where adequate pasture mass is available, animals cannot compensate by eating more as its quality declines – they just grow slower.

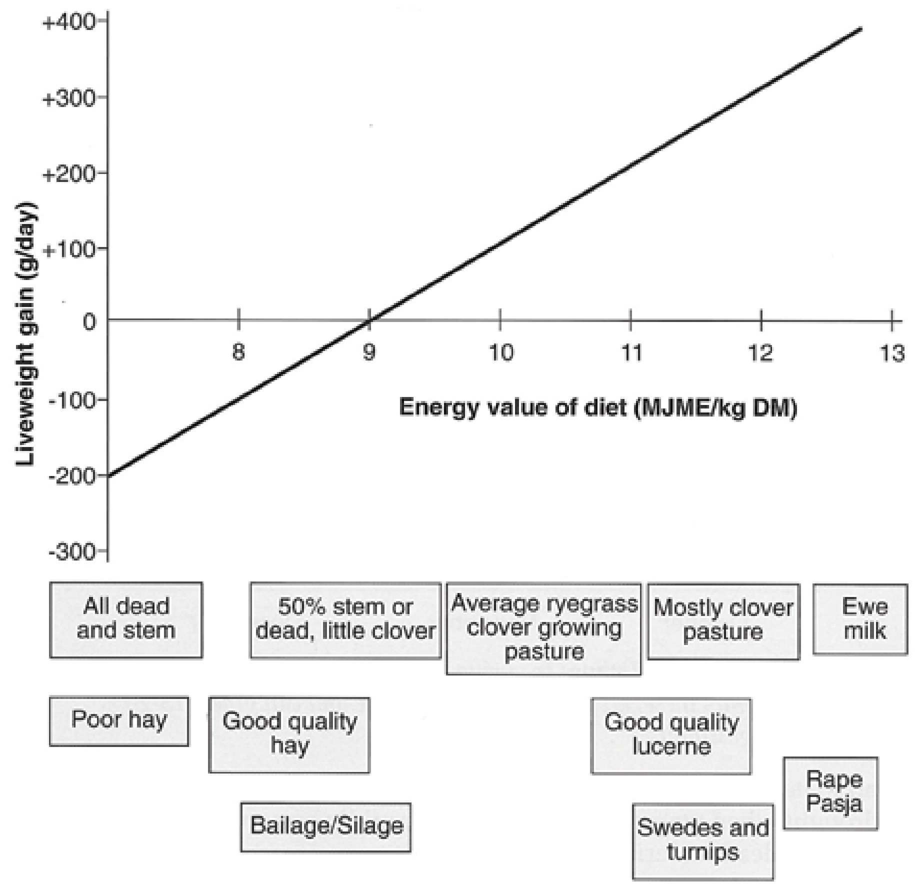
Pasture quantity

Ryegrass and white clover pastures have a broad range of cover (as expressed in kg DM/ha) over which its total production is optimised. This is illustrated in the following diagram.

Pasture growth is constrained if there is too much or too little.

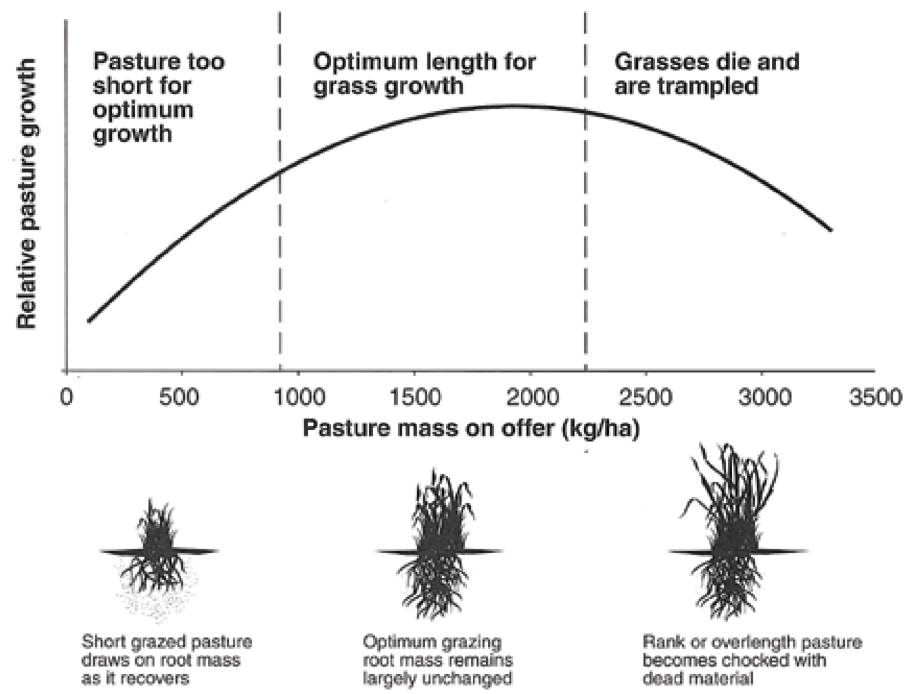
At high pasture mass the dead and dying material is equal to or greater than new growth.

Fig 6:4 (1 :1) Liveweight gain of a 30kg lamb and the energy value of the diet



Source: Stevens, 1999

Fig 6:5 Pasture growth potential related to grazing intensity

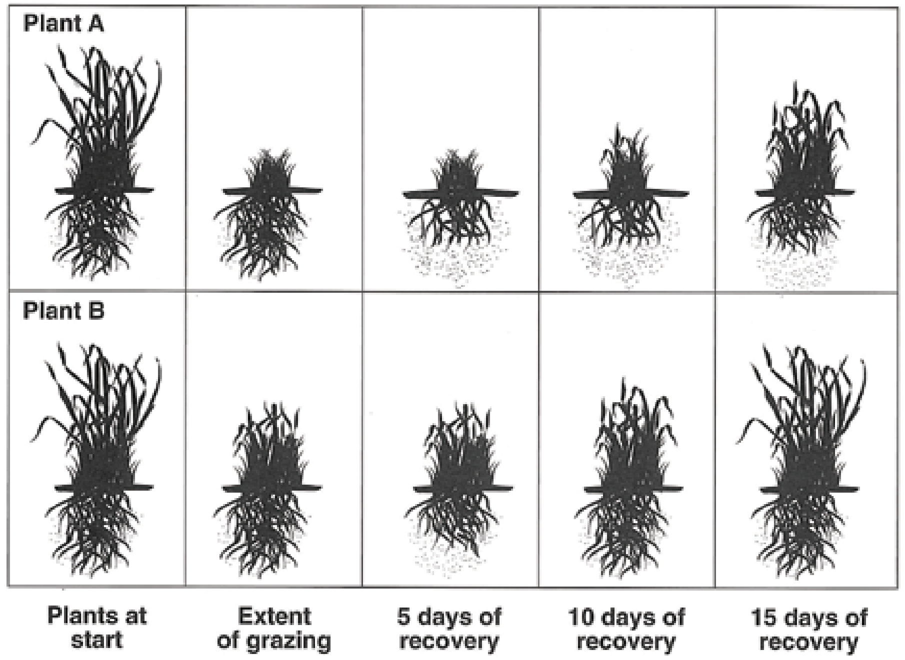


At low pasture mass there are not enough leaves present to capture all the available light.

Remember: The bugs know best. A build-up of undecayed dead litter in a pasture indicates the pasture has a low energy value.

Generally, pasture growth optimisation occurs between 1200 -2500 kg DM/ha, and sheep farmers should attempt to keep pastures at these levels during the spring to autumn period.

Fig 6:6 Practical grazing guidelines – Spring, Summer, Autumn

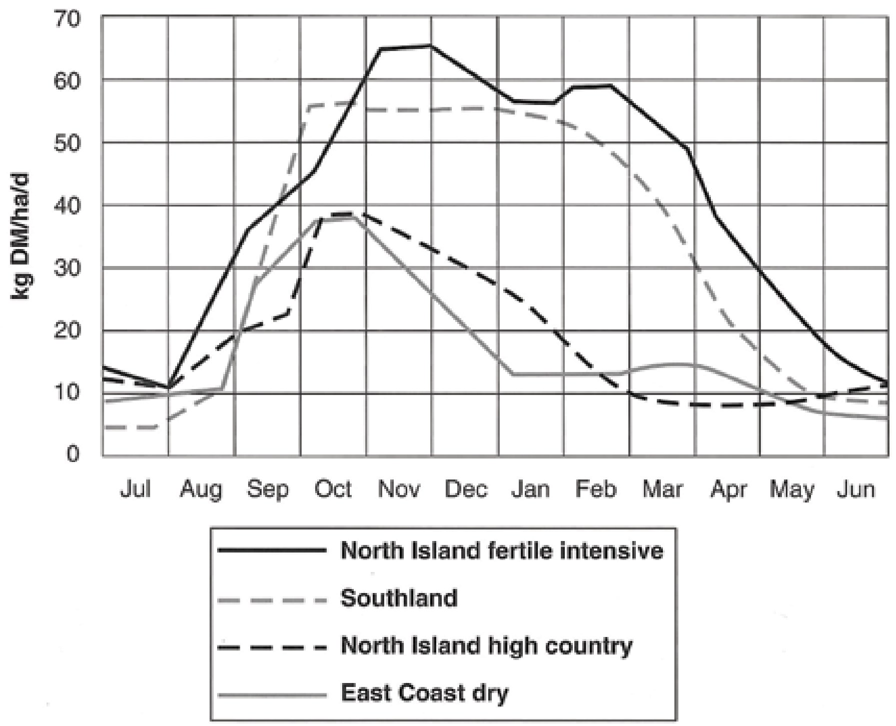


The amount of leaf removed in a grazing affects the rate at which the plant regrows. Plant B loses far less leaf than plant A and thus draws less energy from roots, stem bases and crowns. Less root is killed and it begins to regrow almost immediately.

The main pasture growth differences in New Zealand sheep regions are largely based around when, or if, spring production begins to seriously decrease. The degree of soil fertility also has a major impact on production.

This spring production and subsequent effect on overall dry matter production can be seen in the following graph of comparative pasture growth in different parts of the country.

Fig 6:7 Pasture growth rates by region



Source: Stockpol, 2000

Pasture height can be used as a guide to pasture mass. The following ready reckoner is based on improved pastures on warmer North Island hill country with dry summers. For areas with wet summers, the late spring is a more appropriate guide.

Table 6:1 Pasture dry matter ready reckoner kg/dm/ha

pasture height	summer (1/1-28/2)	autumn (1/3-31/5)	winter (1/6-31/8)	spring (1/9-31/10)	late spring (1/11-31/12)
CM =	dm	dm	dm	dm	dm
15	3800	3500	3300	2980	3750
14	3670	3410	3150	2850	3600
13	3540	3310	3000	2720	3450
12	3400	3180	2850	2590	3300
11	3250	3040	2690	2460	3150
10	3100	2880	2505	2330	3000
9	2950	2700	2330	2200	2840
8	2800	2500	2150	2070	2680
7	2640	2300	1950	1930	2520
6	2450	2100	1740	1790	2360
5	2250	1900	1520	1640	2200
4	1950	1680	1290	1480	2000
3	1650	1460	1060	1300	1800
2	1300	1180	810	1080	1560
1	900	860	560	800	1280

Increasing feed quality

There is a wide variety of techniques available for increasing NV. Some are paddock-based and relatively simple to implement, while others affect large areas or even the whole farm and require a farm-system approach.

CHAPTER SIX

1. *Topping and conservation of surpluses.*
    - Mechanical topping reduces development of stemmy surpluses in the spring.
    - Chemical topping appears to reduce grass reproductive growth. Conservation of surpluses early in the season can be a potent tool for maintaining NV. One option is to increase stocking rates in spring on paddocks that cannot be mechanically harvested, and to harvest the areas released from grazing.
2. *Cropping and regrassing.*
    - Forage crops can ensure availability of high quantities of high quality feed for young stock in summer or winter.
    - New pastures generally have less dead material and higher clover content than the pastures they have replaced, and may also have lower levels of fungal toxins and parasite larvae. Success is based on establishment and the cost/benefit comparison.
    - Cash cropping takes pasture out of grazing in the spring and can assist in pasture control on the remaining area by increasing effective stocking rate.
3. *Feeding concentrates.*
    - Use of high energy supplements may be economic in some circumstances (unlikely in most sheep situations).
4. *Fertiliser application.*
    - Soil fertility has only a small direct effect on NV. Protein content increases with nitrogen application, while some trace element deficiencies can be alleviated through fertiliser application.
    - Correcting nutrient deficiencies commonly increases pasture clover content and promotes faster nutrient cycling and quicker breakdown of dead material.
    - As soil fertility increases, high-fertility responsive grasses such as ryegrass increase and low-fertility tolerant species such as browntop and sweet vernal decline. Though green leaf quality for these two groups is similar, ryegrass dominant pastures are easier to manage and there is less tendency for accumulation of stem and dead material' going into the summer.
5. *Specific grazing strategies to manipulate pastures.*
    - Animal and pasture management strategies commonly conflict and often a balance has to be struck between the two.
    - Grazing the top out of a high quality pasture leaves behind lower-quality residual that can depress feed quality later in the season if it is not removed – usually with a lower-priority stock class.
    - Subdivision (temporary and permanent) is an important tool in maintaining pasture control. It allows allocation of high NV pastures to high priority classes of stock and management of clean-up grazers that have lower priority at that time.
    - Set stocking during rapid pasture growth periods maintains better pasture control. This maximises intake and minimises development of reproductive grass growth, though it can present logistical problems.
    - Good pasture cover in spring, with subsequent high weaning weights for ewes gives the opportunity to use ewes in summer to maintain pasture quality. They only need a maintenance feed at that time instead of needing to recover weight for mating.
6. *Manipulation of annual pattern of feed demand.*
    - Managing quantity is the key to managing NV.
    - Effectively matching animal demand to pasture supply will minimise surpluses and hence build-up of stem and dead material/encourage clovers and 'easy-to-manage' grasses, and keep pastures actively growing and leafy.
    - Managing quantity effectively increases net pasture production because more of the pasture's annual growth potential is harvested.
    - Maintaining farming system flexibility enables rapid destocking to occur.
    - Adjustment of seasonal stocking rates, especially in the spring, can be achieved by:
      buying or selling stock
      taking on grazers, or grazing stock off the property
      manipulating lambing dates
      manipulating weaning dates
      increasing lambing percentage
    - Minimise feed deficits.
7. *Monitoring, prediction and planning.*
    - The best approach to ensuring high quality and quantity feed is assessing what has happened on the farm in the past, monitoring what is going on now, predicting what is going to happen and planning how to do it better in the future.
    - Planning how to manage spring pasture growth is of critical importance.
    - In many instances this will require a whole-farm approach with farm business implications.
    - Enlisting expert advice can assist this whole procedure.

Increasing feed quantity

Generating more feed revolves around decreasing feed intake for some classes of stock or increasing feed supply.

Making wise decisions about these requires forward planning and some assumptions about present and future levels of pasture mass, pasture growth and animal intake.

A simple feed budgeting exercise can demonstrate whether there will be adequate feed available for animals to meet liveweight gains, or whether intake needs to be reduced through restricting intake for some classes of stock or destocking.

The introduction of concentrates or conserved silage or hay, or growing more pasture can enhance feed supply. Hay and silage won't sustain high liveweight gain, but their use for breeding stock can free up high quality pasture for young stock.

Pasture growth can be increased in a number of ways.

1. *Application of phosphate/sulphur containing fertilisers.*
    - Application of nutrients that encourage clover growth (usually phosphorus and sulphur, and sometimes potassium and/or molybdenum) results in greater clover production and hence increases nitrogen fixation.
    - As a long-term strategy it raises nitrogen supply to the associated N-limited grasses and so increases overall pasture growth rate.
2. *Application of nitrogen containing fertilisers.*
    - Direct application of N supplements the soil-N supply to grasses and gives relatively rapid responses.
    - This is a short-term tactical approach, usually used at cooler times of the year when quantity rather than quality is the limiting factor.
    - Note: Nitrogen fertilisers may decrease clover levels.
3. *Pasture utilisation.*
    - Increased utilisation of feed at times of the year when pasture growth exceeds the ability of base stock to consume it will effectively increase net pasture growth.
    - Gross pasture production has two major fates: Livestock or machinery harvest it, or It disappears (through death and decay).
    - If net pasture production (i.e., harvested pasture) is regarded as gross production minus

disappearance, it follows that harvesting pasture before it disappears will increase net production.

4. *Forage crops.*

- Use of forage crops can provide more feed than existing perennial pasture at times of the year when temperature (in winter) or moisture (in summer/autumn) limit growth.
- Commonly used options are annual ryegrasses, oats and brassicas for winter feed.
- Chicory or brassicas for summer/ autumn feed.
- Normally these crops are planted during warm/moist times of the year (spring or autumn) and the accumulated forage, which maintains its nutritive value well, is carried into the period of shortage.

Stocking rate + system (especially lambing date) influences pasture quality + quantity

About 70% of all pasture production in New Zealand takes place in the spring and early summer.

This peak varies through the country from August-November in Hawke's Bay, and October-January in Southland.

Managing this feed boom requires planning six months ahead, as well as closely monitored management.

The correct stocking rate and system allows optimum pasture quality and quantity to be offered to lambs.

Both quality and quantity influence each other -so finding the optimum point of both should be the goal for any farm.

Stocking rate

The appropriate stocking rate ensures the optimum utilisation of pasture.

- If a farm is understocked, some pasture isn't grazed and there's waste and deterioration of quality through death and decay of the pasture.
- If a farm is overstocked, animals will be starved at certain pinch periods of the year.

Over 50 years ago, agricultural scientist McMeekan showed that stocking rate was more important than grazing management itself in impacts on profitability. It is likely that the same applies today.

Stocking rate needs to be appropriate to the farm's pinch feed period. It needs to be set to a mid-point of expected feed availability during this pinch and a buffer feed of some kind is required to provide a balance.

The possible means of handling these pinch periods are:

- *Winter pinch* – summer wet areas (almost always a question of quantity)

  Feed fodder crop – productive bulk of dry matter.
  Buy in feed. Feed from conserved spring surplus – hay or silage.
  If land is flat enough and hay can't be made, top the pasture to prevent seedhead production and so maintain quality.

- *Summer pinch* – drought prone areas (could be quality and/or quantity)

  Feed out conserved feed.
  Feed fodder crop – productive bulk of high quality dry matter.
  Buy in feed.
  Destock – sell off lambs as store if and as required.

Management of stocking rate may also include the following options:

- In-line farming – establishing a contract with a lamb finisher and moving lambs onto that property as conditions dictate.
- Lambing percentage
- Trading stock

  Stock such as older cattle or older ewes may also be used as buffers and bought or sold as feed supply and demand dictates.

System

The system on a farm mainly hinges around how the pinch period is coped with, which should, ideally, dovetail with how any surplus growth is managed.

The aim is to have optimum synchrony between peak feed demand and supply.

This is why lambing and calving dates are of crucial importance in helping to ensure that the demand and supply peaks coincide (if that is the management practice being employed).

All systems in New Zealand are attempting to build up a wedge of feed as the farm goes into winter.

In spring however, the aim is to reduce this feed wedge as much as possible. All feed should be utilised – otherwise the farm is understocked.

The importance of lambing date

The timing of lambing in relation to the spring feed flush can have a major impact on pasture quality and quantity.

- Those lambing early, usually seeking early season chilled lamb premiums, need to lower their winter stocking rate in order to have enough saved feed onto which to lamb.
- Lambing after the spring feed flush is really only feasible in summer wet conditions.

Generally in early spring with lambs and ewes spread over the farm, all paddocks will have about the same amount of feed.

A rotational grazing pattern of sorts can begin – particularly at docking when bigger mobs of stock can be put together.

As more feed grows than can be eaten, it becomes important to maintain effective grazing pressure (increase the stocking rate) on a majority of selected paddocks. This can be achieved through:

- Conserving surpluses as hay or silage for feeding in pinch periods.
- Growing a winter crop.
- Purchasing cattle.
- Dropping out paddocks. Shutting up selected paddocks (particularly in hill country where hay/ silage can't be made) to keep grazing pressure on the rest of the farm. It is recomended that this be easier land.

Planning enables management of the usual spring feed surplus so it doesn't affect performance.

Use cattle to help maintain hill country pasture quality and quantity during spring

- Stock cattle with ewes and lambs at the rate of one cow and calf, or two yearling steers to 10 ewes and their lambs per hectare
- Or rotate a higher density of cattle through the paddocks grazed by ewes and lambs

CHAPTER SIX

Alternative feeds

Feeds other than ryegrass and white clover can be valuable in providing high quality and quantity fodder for lamb growth, especially during the summer.

These alternative crops, specialist pastures and grains can be important ways to ensure continued liveweight gain post-weaning.

On the following pages Tables 6:2 and 6:3 provide a guide to summer feeding options using crops and specialty pasture.

Table 6:2 Summer Lamb Finishing Options – Crop Characteristics

Summer Feeding Options	Climatic Conditions	Soil Conditions	Longevity	Advantages/ Disadvantages	Possible animal health issues
Brassica Options					
Rape	Dryland, low summer rainfall	Light-Medium soils	2-4 grazings	Reliable supply of good ME & protein. Requires ripening before grazing	Requires time to adjust to diet. Scold, nitrate poisoning, pulpy kidney
Hybrid Brassica (eg. Pasja)	Summer dry with periodic summer rain	Medium-Heavy soils	3-5 grazings	No ripening requirement, good ME & protein. Suffers under hot, dry conditions	Requires time to adjust to diet, nitrate poisoning, pulpy kidney
Speciality Pastures					
Chicory/Red clover	Summer dry with periodic summer rain	Light-Heavy soils Medium-High fertility	3-5 years	High animal performance, high summer DM production. Low cool season production, Stemmy if poorly grazed through spring	Nitrate poisoning
Lucerne	Dryland, low summer rainfall	Light to medium soils Medium-high fertility	5-10 years	High animal performance, high summer DM production. Requires high level of management, poor cool season production	Bloat, pulpy kidney and red water, lucerne red gut
Short-term ryegrass, Red and White clover	Good Summer rainfall or irrigation	Medium to heavy soils Medium-high fertility	2-3 years	Nil endophyte, high yielding high quality grass. Susceptible to stem weevil, potential seed head problems	Nitrate poisoning
Prairie grass, Red clover, White clover, Chicory, Plantain	Summer dry with periodic rain	Light to medium soils high fertility	3-5 years	Good summer and cool seasonal growth. Nil endophyte. Potential seed head problems, intolerant of hard grazing	Nitrate poisoning
Lotus Corniculatus (Birdsfoot trefoil)	Dryland, low to periodic summer rainfall	Light to heavy soils. Low to medium fertility	5+ years	Good summer production, contains tannins and is non bloating, productive in low fertility soils. Slow establisher which should be sown alone. Requires a specific rhizobial innoculant at a high rate. Requires long spells after grazing. Prone to weed invasion. Comparatively low total DM production. Under poor lucerne growing conditions (low pH and wetter soils), may outperform lucerne.	No notable health problems
Permanent Pasture Mixes[1]					
Tetraploid ryegrass, red clover, white cover, Chicory, Plantain	Good Summer rainfall or irrigation	Medium to heavy soils Medium-high fertility	3-5+ years	High animal performance. Nil, high endosafe endophyte. Intolerant of hard grazing and pugging	Nitrate poisoning
Diploid ryegrass, red clover, white clover, Chicory, Plantain	Summer dry with periodic summer rain	Light to heavy soils. Medium -high fertility	5+ years	Easy management. Nil or high endophyte. Diploid ryegrass dominant pastures may not offer the animal performance of other finishing options	Nitrate poisoning
Tall Fescue, Red clover, white clover, Chicory, plantain	Summer dry with periodic summer rain	Medium to heavy soils Medium-high fertility	5+ years	High legume content, strong summer production. Fescue is slow to establishment and limited cool season growth. Only throws one seed head a year.	Nitrate poisoning
Gala Grazing Brome, White clover, Sub Clover, Chicory, Plantain	Dryland, with limited summer rainfall	Light to medium soils. Low-medium fertility	5+ years	Drought tolerant, Nil endophtye, strong cool season growth. Requires good establishment management	Nitrate poisoning

1. Any permanent pasture can become a finishing pasture if it has a high legume or herb content and pasture management has maintained a low level of seed head and dead material in the pasture.

Table 6:3 Crop sowing and grazing development

Summer Feeding Options	Time of Sowing[2]	Grazing Management
Brassica Options		
Rape[3]	Sowing between 75-110 days before feed requirement depending cultivar ripening date	To achieve best possible response from brassicas stock should be introduced slowly with pasture as an option for the first 5-10 days as well as hay until the animals rumen has adjusted to the new diet. Break feed Brassicas to ensure animals are continually being introduced to a high quality leafy crop Major reduction in lamb weight gains once plant starts flowering. Use staggered sowing dates.
Hybrid Brassica (eg. Pasja)	Sowing any time from late September through the spring depending on feed requirement	
Speciality Pastures		
Chicory/Red clover	Ideally sown in the Spring or in late summer when soil temperatures are still high	Grazing should be on a rotation with adequate time for recovery (3-6 weeks). Grazing should not be below 10 cm as this allows best regrowth potential. Winter grazing should be sparse and grazing during wet weather avoided. For winter active varieties any winter growth should be utilised in late August early September to encourage persistence
Lucerne	Ideally sown in the Spring or in late summer when soil temperatures are still high	To encourage persistence and regrowth lucerne should be rotationally grazed. This allows essential root reserves to be replenished. Longer periods of set stocking reduces lucernes production and plant number. If practical a 2-3 week graze (at 10% flowering and 5-6 week spell is most suitable.)
Short-term ryegrass, Red and White clover	Autumn sowing, can be sown in spring	Frequent establishment grazing is encouraged to allow clovers to establish. The temptation to take as a winter feed crop will impact on clover establishment and potential animal performance over summer. Frequent rotational grazing for best performance.
Prairie grass, Red clover, White clover, Chicory, Plantain	Spring sowing or late summer early autumn when soil temperatures are high	Ideally a lax rotational grazing system is best for a Prairie grass mix. Natural re-seeding can be used to increase plant numbers if nitrogen and autumn spelling is used to allow seedlings to fully develop.
Permanent Pastures		
Tetraploid ryegrass, red clover, white cover, Chicory, Plantain	Autumn sowing, early when using chicory, can be spring sown in the right environment	Good establishment grazing (when ryegrass passes the "pull test") is recommended to allow the covers and chicory to establish. Rotational grazing is recommended for tetraploid based pastures. It is important to avoid pugging though winter and over grazing through summer of these pastures.
Diploid ryegrass, red clover, white clover, Chicory, Plantain	Autumn sowing, early when using chicory, can be spring sown in the right environment	Good establishment grazing (when ryegrass passes the "pull test") is recommended to allow the covers and chicory to establish. Rotational grazing is encouraged with particular emphasis on maintaining low levels a seed head and dead material in the pasture.
Tall Fescue, Red clover, white clover, Chicory, plantain	Spring sowing or late summer early autumn when soil temperatures are high	Rotational grazing is recommended, with a hard grazing prior to heading to reduce see head development. Grazing tall fescue before it exceeds 8 cm for sheep and 10 cm for beef and frequently during periods of strong growth. Graze sparingly in the autumn and do not over graze during droughts.
Gala Grazing Brome, White clover, Sub Clover, Chicory, Plantain	Ideally sown in the Spring or in late summer early autumn when soil temperatures are high	Grazing Brome requires repeated grazings through the establishment phase to develop a densely tillered plant that can tolerate high grazing pressure. Grazing Brome once densely tillered can tolerate set stocking and overgrazing through droughts. Survival of chicory is unlikely using this grazing management.
Lotus Corniculatus[4] (Birdsfoot trefoil)	Ideally sown in the Spring or in late summer when soil temperatures are still high	Avoid prolonged set stocking. Graze sufficiently leniently to leave a residual leafy stubble of stem bases 5-6 cm long. New shoots are initiated from the base of these old stems. Maintain a long recovery period post grazing. An autumn break dose helps to maintain a productive Lotus corniculatus.

1. Any permanent pasture can become a finishing pasture if it has a high legume or herb content and pasture management has maintained a low level of seed head and dead material in the pasture.
2. It is important to maintain a shallow sowing depth for any mix containing chicory and white clover. A very common cause of poor establishment for these small seeded species is burying the seed. A maximum sowing depth of between 10-20 mm is required.
3. Ripening of rapes varies between varieties (75-110 days) and may differ from that stated in a particularly growthy environment. Combining suggested ripening time and date for which feed requirement should dictate the sowing time of the crop. It is a good practice to mix sowing dates after date of first requirement to maintain quality of crop further in to summer.
4. Lotus corniculatus has low seedling vigour and can be difficult to establish. Because of this, seed bed quality and sowing depth are critical for Lotus corniculatus. Drilling no deeper than 13 mm is recommended.

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Alternative species characteristics

Tall fescue

As a specialist sward, tall fescue has become popular as a dryland species particularly on the East Coast.

Farmers are advised to seek specialist advice before planting it, but general comments about its performance and requirements are:

- Because it doesn't compete well with ryegrass, planting needs planning at least two years before. Two or three crops beforehand is recommended.
- New Zealand-bred varieties are better than overseas ones in having lower leaf strength and more palatability.
- Autumn sown, requires good seedbed and temperatures of 13° or over.
- Slow to establish, first gentle grazing, takes 8-10 months to properly establish.
- Active growth through spring, summer and early autumn.
- Roots twice as deep as ryegrass – tends to produce more dry matter in the summer.
- Nil endophyte – zero staggers.
- Grass grub and Argentine stem weevil tolerant.
- Because it is more erect than clover, and has no endophytes, clover growth is stronger underneath it.
- Persistent permanent specialist pasture (some 12-13 year old paddocks been recorded).
- If properly managed able to provide high quality feed when ryegrass may be struggling.

Cocksfoot

Cocksfoot is often included as a component in some pasture mixes.

- As a very fine seed, only needs to be about 10-20% of the weight of ryegrass in the mix.
- Grass grub and Argentine stem weevil tolerant.
- No endophyte – zero staggers.
- Strong summer and winter production.
- Lax management can quickly lead to clump formation, and rank stemmy feed as a result.
- Can be low in cobalt.
- Management should attempt to maximise quality at all times. Run cows, mowing and old ewes, especially in the spring should aim to remove dead material and maintain quality.

Grain

Grain feeding may be an economic option for finishing lambs at particular times of the year.

With cereal grain feeding there are major changes in the types of rumen microbes. If introduction of the grain is too rapid, digestive upsets and grain poisoning result and can be fatal.

One of the main products of the rapid rumen fermentation of grains is lactic acid. In the absence of lactic acid utilising bacteria and protozoa, the rumen pH rapidly drops below 5 (becomes acidic) and rumen function breaks down with classical symptoms of grain poisoning (scouring, listlessness and lack of appetite and death).

Avoidance of this can be through gradual introduction of the grain so the required bacteria and protozoa multiply adequately and rumen pH remains in equilibrium at around 6.5.

The cereal grain diet should be introduced gradually, commencing at about 100g per animal each day and progressively building up to the desired feeding level over a period of 14-18 days.

More specialist advice should be obtained however with regard to management and utilisation within the overall lamb diet.

Table 6:4 Dry matter (DM), metabolisable energy (ME) and crude protein (CP) contents of various grain feeds.

Feed grains	DM (%)	ME (MJ ME/kg DM)	CP (% of DM)
barley	88	12.5	12
oats	88	12.0	12
wheat	88	12.5	12
maize	88	14.0	10
peas	86	13.1	26
lupins	86	13.5	24

Table 6:5 Requirements of feed grain (kg/day) for wether and ram lambs

Liveweight gain (g/day)	Liveweight (kg)				
	20	25	30	35	40
0	0.60	0.70	0.80	0.90	1.00
50	0.70	0.85	1.00	1.10	1.20
100	0.85	1.00	1.15	1.30	1.40
150	1.00	1.15	1.35	1.50	1.70
200	1.10	1.30	1.50	1.70	1.90

Source: Geenty, 1986

'Controlling' the system

At one time the ability to calculate pasture growth, and the effect of different regimes on a whole farm system was a laborious exercise.

Today, computer based software such as StockPol enables comparative systems to be 'modelled' and compared -in terms of pasture quality, quantity, stocking rates, stocking policies, lambing date and dollar returns.

It allows a much closer match between feed supply and demand to be made, which in turn aids decision making.

Some degree of measurement and estimation is still required however. A computer can't determine the amount of feed in a paddock, neither can it determine the adjustments required for a particular season.

But the combination of human measurement and estimation, and the computer software's ability to manipulate data is truly a combination to be reckoned with.

Lambs can be grown quickly without the use of a computer, but using a programme such as StockPol is certainly one way of advancing what is possible.

Summary and conclusions

- Unless lambs are grazed on pastures of adequate mass their liveweight gains will be below their potential.
- Even where ample low quality pasture mass is available, lambs cannot compensate by eating more feed as its nutritive value declines -they just grow slower.
- Healthy young stock can consistently be grown at top growth rates if adequate amounts of high nutritive value feed are provided for them.
- Whole-farm animal demand can be decreased by restricting intake (with lowered liveweight gain) of some class(es) of stock, or through destocking.

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- Pasture growth can be increased by high utilisation of potential growth, fertiliser application and cropping.
- High nutritive value pastures have low stem and dead material contents and high content of young green leaf (preferably including clover).
- The starting point for increasing whole-farm pasture nutritive value year-round lies in preventing accumulation of pasture surpluses, particularly in the spring.
- A range of specific management techniques can be used for increasing pasture quality, ranging from paddock to whole-farm in scale. These include topping, conservation, fertiliser application, sowing forage crops or new pastures, use of specific grazing management strategies, and manipulating animal demand to match feed supply throughout the year.
- High nutritive value and quality pastures are difficult to maintain through hot, dry summer/ autumn periods. This means lamb growth rates will be low at such times if provision is not made for use of forage crops or concentrates.
- The different techniques for modifying feed supply and nutritive value carry different costs and risks, and these always need to be balanced against expected increases in income.
- Planning, monitoring (feed quantity and nutritive value, liveweight gain, costs and benefits) and realistic predictions are the keys to successfully increasing young stock growth rates.

Summer ewe feeding and maintenance

Ewe weight loss during the summer should be avoided.

The maintenance of steady ewe condition throughout the year is recommended as the best approach.

It is preferable that ewe live weight be maintained at a steady level between weaning and mating because:

- Reducing ewe live weight and then increasing it is wasteful, and relies on feed being available to carry out this exercise.
- Ovulation rates may decrease.
- It is better to maintain ewe bodyweights as much as possible.

The maintenance of high quality summer feed is therefore the challenge, especially in regions of summer dry.

The translation of animal requirements into pasture management techniques is best achieved by:

- Good pasture cover.
- High green leaf content, when possible,
- High clover content.

Keeping pastures leafy and increasing clover content is the main aim.

- Mechanical topping – best response when carried out at seed ear emergence.
- Spring grazing – continuous grazing, or a rapid two-week rotation of ewes and lambs from lambing to weaning, increases summer white clover content by assisting in stolon development.
- Cattle grazing – increases the weight of clover stolon development compared with sheep grazing systems.
- Chemical manipulation – judicious use of paraquat or glyphosate can increase clover dominance in summer. This technique is suitable mostly for summer wet conditions.
- Close up a portion of the farm to make hay, silage or baleage.

However, if ewes have a low bodyweight, attempt to flush them on better feed if there is enough to allow it.

Table 6:6 Average ewe weight (kg) at weaning and subsequent mating in relation to different summer feeding levels and average ovulation rate

Ewe weaning weight (kg)	Summer feeding level	Average ewe mating weight (kg)	Average ovulation rate
54.8	low	47.0	1.52
54.8	low-high	50.0	1.73
54.8	medium	57.2	1.93
45.0	low	41.8	1.28
45.0	low-high	45.8	1.51
45.0	medium	46.5	1.53
45.0	high	56.9	2.17

Source: adapted from Thompson et al., 1990

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CHAPTER SEVEN – ANIMAL HEALTH

Lamb growth can be optimised by removing the constraints caused by sub-optimal health.

These constraints may be caused by bacteria or viruses (infectious agents), parasitic agents (worms) or mineral deficiencies.

Assessing the cause requires careful forward planning based on previous history on the property.

Sub-clinical impacts on lamb health can be telling.

Sub-clinical pneumonia or sub-clinical mineral deficiencies may be limiting pre and post weaning growth and causing production losses, but are not able to be observed.

The local or farm history is of prime significance in all cases, but is often overlooked.

An example is control of clostridial diseases. The approach to blackleg, malignant oedema, pulpy kidney and tetanus depends very much on the property's history and stock, previous vaccination policies and the availability of farm labour.

Effective control of parasites requires knowledge of previous pasture contamination with larvae and the previous experience of stock to parasitic larvae, particularly young stock.

Control measures against mineral deficiencies can best be predicted on the frequency of occurrence in the past. This is because deficient pastures are likely to always be deficient unless it has been modified by recent corrective fertiliser application.

For these reasons there can be no rules with general application.

Rather, a systematic approach by individual farmers on their own property is required, reinforced by the best advice available.

AgResearch has developed criteria based on pasture, serum and liver levels of most trace elements which can aid decisions.

For the purposes of this booklet much of the specific information on some diseases is contained in the appendix. Specific information on parasite control is contained in the post-weaning section.

Diseases

Diseases tend to be sporadic and only affect a small number of animals on a property at anyone time. Their incidence is minimal compared to major causes of poor growth, though occasionally because of an increase in incidence, their impact may be much greater.

Diseases that decrease ewe daily milk flow and so decrease lamb growth

- Mastitis
- Metritis (uterine disease)
- Footrot
- Facial eczema (regional in autumn lambing ewes)
- Sporadic chronic pneumonia
- Johnes Disease
- Foot Abscess
- Arthritis
- Teeth problems These diseases will not be considered in detail, but when considering poor lamb growth rates during the pre-weaning period, it is important that these conditions are at least considered (Gumbrell 1983). For detail on these diseases see the appendix.

Diseases directly affecting lamb growth

- Pre-weaning diseases
- Parasites
- Clostridial diseases

Pre-weaning diseases

- Pneumonia
- Chronic Infection (navel infections, marking infections, etc)
- Hairy Shaker Disease
- Footrot
- Scabby mouth
- Blowfly strike
- Arthritis

More details on these diseases are contained in the appendix.

Parasites

Internal parasites

(More detail on parasites can be found in the Sheep Council publication, *Parasite Notes*, March 1998)

Parasites can produce either a clinical or sub-clinical (no obvious symptoms) disease condition in lambs. Loss of production can vary in both cases and if the challenge is severe enough, death can result.

Parasite control has generally been confined to its elimination from the host. But most commercial anthelmintics act for only a short period, except for controlled release capsules.

Frequent drenching (every 3 weeks) prevents the establishment of mature adult parasite populations and suppresses parasite egg production for 19-21 days. But drenching does not eliminate damage caused by the development in the gut of infective parasite larvae, consumed with pasture in the intervals between drenching.

Frequent drenching also accelerates parasite resistance.

To advance in parasite control, the importance of the level of pasture larval availability (larval challenge) and its effect on the efficiency of anthelmintic treatment and on the subsequent production responses has to be understood.

The provision of 'safe pasture' (containing low levels of infective larvae) after drenching should always be the objective.

Safe pastures include:

- Spelled pasture (for as long as possible). Parasite larvae, if present, tend to remain lower in the sward.
- Regrowth following the making of hay and silage.
- New pastures and fodder crops.
- Pastures grazed by alternative species (e.g. cattle)

Parasite types

Roundworms (nematodes) are the most economically important internal parasites of sheep in New Zealand. Liver flukes (trematodes) are a problem in some areas but tapeworms (cestodes) are usually of minor importance. The economically important gastro-intestinal nematodes of sheep are shown in the following table.

Table 7:1 Important gastro-intestinal roundworm parasites of sheep in New Zealand and their common location

Abomasum	Haemonchus contortus
	Ostertagia circumcinta (telodorsagia circumcinta)
	Ostertagia trifurcata
	Trichostrongylus axei
Small intestine	Trichostrongylus vitrinus
	Trichostrongylus colubriformis
	Cooperia curticei
	Nematodirus spathiger*
	Nematodirus filicollis*

* Mainly found in lambs

Effect of parasites on lambs

Even low numbers of parasitic larvae on pastures (<200 larvae/kg of fresh herbage) can result in reductions in liveweight gain and wool growth, and be significant on a flock basis (Sykes 1997).

The effects on metabolism and performance are wide ranging and include:

Depression of appetite – reduced food intake.

Changes in mineral metabolism – smaller skeleton etc.

Changes in protein metabolism – reduced musculature.

Gastro-intestinal abnormalities – diarrhoea.

These effects may be confused with and exaggerate nutritional deficiencies. Excellent results from the control of internal parasites have been obtained with lamb weight gains of up to 50% and increases in greasy fleece weight of up to 25%.

Parasite biology and life cycle

All parasitic nematodes have essentially similar life cycles.

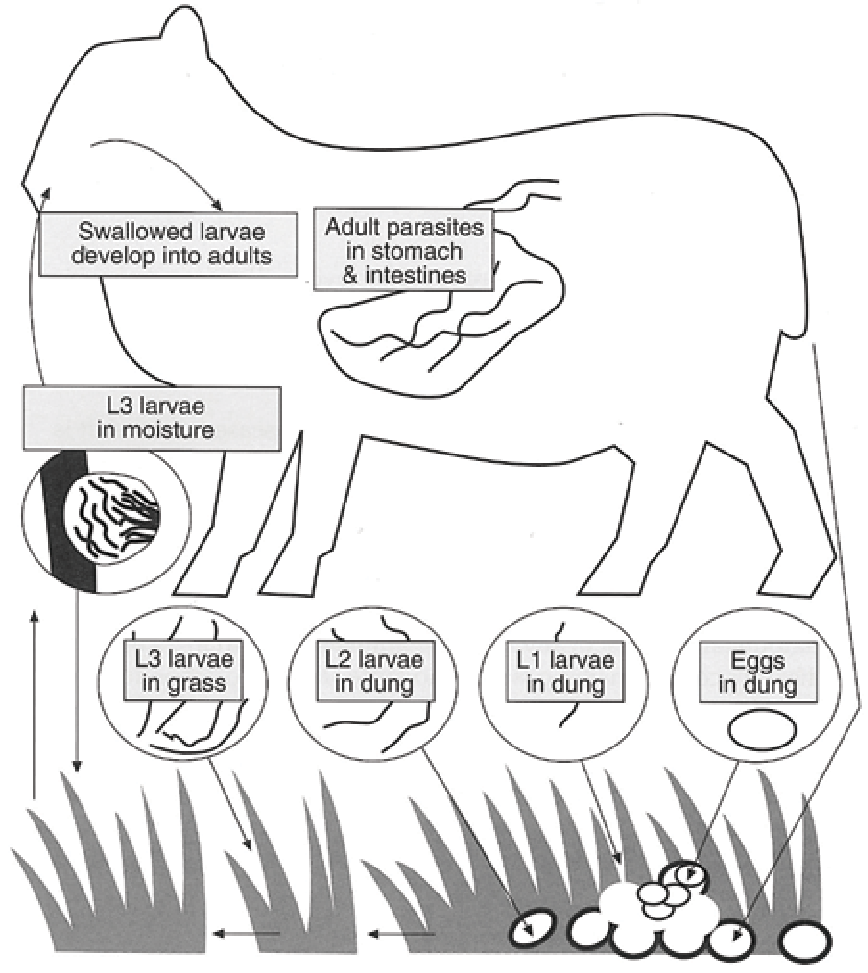
After mating in the gastro-intestinal tract, the mature female lays eggs which pass out in the faeces.

Remaining in the faeces under suitable conditions, the first larval stage develops within the egg, and then a second larval stage.

The third infective larval stage which is found on the pasture.

Development through the fourth stage to the adult is dependent on ingestion by a suitable host animal.

Fig 7:1 Parasite lifecycle



Development and survival

Without rain and moisture, larval development in the faeces cannot be completed and the process is stopped permanently if conditions are dry enough for long enough.

It has been estimated that about 95-99% of the parasite population is located on pasture under normal climatic conditions This may change under drought conditions where the above figure may be reduced (Familton & McAnulty 1997).

If protected by green pasture during warm to hot weather in wet areas (such as swamps, dams, creeks) larvae can survive for several weeks or even months.

Green pasture, particularly if irrigated, should always be considered a possible source of infection, even in summer.

Distribution of the larvae on pasture plants can been found to be mainly confined to the first 2 cm of the plant above ground level or in the first centimetre of soil (Vlassoff, 1982).

Animals forced to graze the pasture to a low level will generally be exposed to a higher parasite challenge, but as the pasture level is reduced a higher proportion of larvae are exposed to adverse conditions and fail to survive.

Susceptibility

Animals subject to sub optimal nutrition and any disease, whether it is clinical or subclinical, suffer more severely from the effects of parasites than healthy animals.

Age

With age, animals increase in their ability to withstand parasite challenge as part of a complex immunological phenomenon produced by the intake of nematode larvae. Practically it means animals older than 20 months can graze heavily contaminated pasture and suffer less production loss than would lambs.

Host specificity

Cattle parasites generally do not infect sheep, and vice versa. Alternative grazing of pasture with sheep and cattle usefully reduces pasture larval populations. Goats however may allow both cattle and sheep parasites to develop to maturity.

Peri-parturient relaxation of immunity

Adult sheep relax their immunity around lambing, allowing an increase in the number of parasitic eggs returned to the pasture. Ewe wool production and milking ability is also impaired. However, severe stress and other factors may influence the immune status of adult ewes at other times during the reproductive cycle.

Anthelmintics and drenching practice

It could be argued that much of the $28 million spent yearly on anthelmintics in New Zealand is wasted.

Current anthelmintics have little if any residual effect (except for the controlled release capsules and some injections) after a few days. The animal is therefore open to challenge from infective pasture. Considerable damage can be done to the host by the immature larvae during development stages within the animal.

There are three major groupings of these drugs.

- Benzimidazoles and probenzimidazoles (white).
- Levamisole and morantel anthelmintics (clear).
- Endectocides.
- (A Combination, professional mix of clear and white drenches is also possible).

The first group interferes with the parasite's metabolism while the other two groups cause paralysis of the parasite (but do not kill the eggs -are not ovicidal).

Table 7:2 Classes of anthelmintics available for sheep

Class of Anthelmintic	Examples	Effect on eggs
White Drenches	Oxfendazole Fenbendazole Albendazole	Kills
Clear Drenches	Levamisole Morantel	No effect
Endectocides	Ivermectin Abamectin Moxidectin	No effect

While there have only been a few cases of multiple resistance to drenches recorded in NZ, a sensible approach to the use of these drugs can delay the onset of resistance.

- Drench all sheep coming onto the property with a quarantine drench (such as a dose of both endectocide and levamisole at 1-1.5 x normal dose). Hold these animals on a separate holding paddock for 7-10 days.
- Dose to the weight of the heaviest animal in the group -never under dose.
- Ensure the dosing gun is correctly calibrated.
- Position the drench gun over the tongue and do not deliver the drug forcefully -try to avoid triggering the reflex which bypasses the rumen.
- Do not drench unnecessarily.
- Monitor drench efficacy by taking faecal samples 10-14 days after drenching and checking for parasite eggs. If the drench is effective there should be no eggs (or very few) present until 19-21 days after treatment.

Avoiding the by-pass trigger

- The rumen-by-pass mechanism is active in young milk-fed lambs to stop milk going into the immature rumen where it would otherwise tend to ferment and breakdown. This trigger mechanism is lost to some degree in older animals, but some drenching methods have been found to trigger the response.
- Drench, particularly white and endectocides, need to enter the rumen, rather than the abomasum (or 4th stomach), in order to have time to be absorbed.
- If the by-pass is triggered, it effectively leads to under¬dosing.
- To avoid triggering the by-pass:

  Drench slowly rather than quickly with the gun nozzle over the back of the tongue. Do not squirt the drench under lots of pressure.

  Low volume drenches, with more solids than liquids also tend to be better at entering the rumen.

Those contemplating the use of controlled release capsules in lambs or hoggets should obtain professional advice before using them in young animals.

It is essential to use other techniques of parasite control rather than total reliance on anthelmintics.

Parasite control programmes

Any discussion of parasite control necessarily involves the use of 'safe pastures'.

Safe pasture has minimal levels of infective parasite larvae, though in an all-sheep, all-grass system of farming, provision of enough safe pasture is a major stumbling block.

The relevant points for a parasite control programme incorporating safe pasture are:

Anthelmintic treatment plus 'safe pasture' achieved by:

1. Pasture spelling (for as long as is practical).
2. Regrowth following the making of hay and silage.
3. New pastures and fodder crops.
4. Grazing by alternative species (e.g. cattle).

Alternative methods of parasite control should, where possible, be incorporated into control programmes. The less reliance there is on anthelmintics as the sale method of parasite control, the longer these drugs will be available for use by the sheep industry.

Non-chemical control strategies including the use of vaccines, naturally resistant animals and other biological controls are being investigated.

Breeding for natural resistance

Some animals and breeds have a greater natural resistance to disease challenge. Breed selection based on these animals should decrease disease severity and incidence, though progress is very much dependent on the trait's heritability. At present parasite resistance selection is based mainly on differences in faecal egg count over time. However, if a genetic marker can be found, this could speed up the selection process considerably (McEwan, Bisset et al., 1997). FEC testing and blood testing to identify animals with natural resistance are available.

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Good nutrition

When animals are fed well, the production losses and mortality rates due to parasitism are greatly reduced. Many plant species, notably sulla and lotus, have been associated with reducing the impact of parasites. This could be as a result of unfavourable larval environment or because of plant components such as tannins. A diet which contains a significant amount of protein which is not broken down in the rumen can reduce both the establishment rate and egg output of the parasites in both lambs and pregnant ewes (Donaldson 1997; van Houtert 1997).

Biological control

Very little systematic research has gone into biological control of parasites, though it is expected most will be directed against the free-living stages of the parasite on pasture. At this stage eggs and larval stages are open to attack by a wide range of living organisms, including insects, earthworms and fungi. However, the use of pesticides and fertilisers have reduced many of these natural predators. It has also been shown that some fungi can either kill or are toxic to parasitic larvae within the faeces, and that both insects and worms can prey on larvae (Waller 1997).

Immunity

As a sheep ages its natural immunity develops as a result of exposure to parasites. Vaccine development has made little progress, apart from some limited success with Haemonchus. A lamb/hogget can develop a valuable immunity as a result of constant and very small doses of larvae from pasture. The big problem is to try and regulate levels of larval intake in the field without adversely affecting production (McFarlane 1997).

Clostridial diseases

Tetanus, enterotoxaemia (pulpy kidney), black leg, malignant oedema and black disease are present on most NZ sheep farms. Though vaccination has reduced the incidence of these diseases, they are still prevalent and losses from enterotoxaemia and tetanus are still common in lambs. They are, with the exception of tetanus, diseases of short duration, followed by death in most cases.

Tetanus

A fatal paralysing disease, it is caused by a neurotoxin produced when the bacteria Clostridium tentani grows in deep wounds or damaged tissue from which air is excluded.

Bacterial spores are common and found in the soil and faeces. The use of rubber rings on lambs at tailing/marking provides the ideal site for tetanus.

First signs appear about 7-21 days after the injury. The neurotoxin produces a state of contraction in muscles with no period of complete relaxation as occurs in ryegrass staggers. The condition's severity increases with time. Death results from respiratory paralysis.

Injections at tailing time to prevent tetanus require the use of tetanus antitoxin (instant protection from antibodies) rather than using tetanus vaccine.

Most vaccines take 14 days to produce sufficient antibodies to provide protection. Because the incubation period is in most cases less than this, deaths from tetanus can occur before antibody levels rise after vaccination.

There are no satisfactory treatments, and affected animals should be put down on humane grounds. (Bruere & West 1993).

Enterotoxaemia (pulpy kidney)

This is generally a disease of well-grown lambs between 3-10 weeks of age, although it can occur in sheep of all ages.

The widespread use of clostridial vaccines has significantly reduced its incidence in lambs.

It is an acute, fatal toxaemia caused by the rapid multiplication of a normal gut inhabitant, *Clostridium perfringens* type D. It results in the production of an excess of a lethal toxin.

The bacteria normally multiply very slowly so that toxin levels seldom create problems. However, changes in diet and conditions which result in slowing of intestinal motility can provide conditions in which the bacteria can proliferate. Large numbers of tapeworms may contribute to these conditions.

The toxin, when present in high concentrations, increases the vascular epithelium permeability, allowing absorption of the toxin into the blood stream. High concentrations result in the production of mucoid diarrhoea, brain oedema, kidney, lung and heart damage. Death occurs very rapidly, and it is unusual to see animals exhibiting clinical signs. Animals are found dead, often with signs of terminal paddling and convulsions. Blood stained froth is common around the mouth and nostrils.

As with other clostridial diseases, except tetanus, decomposition is very rapid, and organ autolysis commences soon after death. Frequently, agonal haemorrhages can be observed on internal body surfaces, such as the heart, and there is rapid autolysis of the kidney, leading to the descriptive term, 'pulpy kidney'.

Blood poisoning

Blackleg (*Clostridium chauvoei*), malignant oedema (*Clostridium septicum*) and black disease (*Clostridium novyi*) occasionally cause problems in lambs, but as a general rule these conditions do not result in serious losses.

Deaths from black disease are often associated with liver fluke damage. There have been reports of deaths following lambing and tailing in dirty and contaminated areas (Bruere & West 1993).

Prevention of clostridial diseases

Strict hygiene and good husbandry aimed at avoiding clostridial disease circumstances are one measure, with excellent vaccines being available.

Depending on circumstances, lambing ewes may need active protection from blackleg, malignant oedema and possibly enterotoxaemia (pulpy kidney), whereas lambs may need protection against tetanus as well.

Just how far any protection is to be taken should be a decision made by a farmer in consultation with an informed veterinarian on the basis of the history of the property and stock, stock values, husbandry practices and the availability of farm labour.

There are a number of other far less tangible factors that should also be taken into account and the final decision on a rational vaccination programme should not be taken hastily over a telephone call and never as a result of sales pressure.

Protection of the lamb

Two distinct options are available for lamb protection against clostridial infections during the first three months of life.

The first is to vaccinate lambs themselves and stimulate development of active immunity in the case of enterotoxaemia, and to provide passive protection in the form of antibodies against tetanus (tetanus anitoxin).

The alternative option for lamb protection involves vaccination of the ewe and giving a booster dose late in each pregnancy so that the antibodies present in the colostrum will offer passive immunity to the suckling lamb.

More than 70% of farmers have adopted this practice. For the first two days, particularly day one, preformed antibodies present in the colostrum can be absorbed direct from the intestine, and it is immediately transported into the lamb's general blood circulation.

The greatest protection is obtained by lambs that are vigorous at birth, that quickly seek out the teat, that suckle frequently, and within the first day ingest in total a large volume of colostrum.

The timing of suckling is also critical, because concentrations of immunoglobulins in the colostrum/milk, rapidly decline once suckling has started (Cooper 1966, Cooper 1983).

The lamb loses antibody derived from colostrum exponentially at approximately 16% per week. Larger lambs become at risk earlier because, in effect, they dilute existing immunoglobulins faster by producing other blood constituents at a rate in keeping with their overall growth (Cooper 1996).

The protection offered by clostridial vaccination in sheep has been highly successful in reducing the losses from these diseases in an extremely cost-effective manner.

It can be viewed as an essential activity on most intensive lamb production systems, and on many semi-intensive units.

CHAPTER SEVEN

Major minerals

(More detailed information about specific mineral and trace element deficiencies is contained in the appendix.)

The following table outlines major mineral requirements for sheep.

Table 7:3 The dietary mineral requirements of sheep

Trace elements	Requirement (mg/kg DM)
Selenium (Se)	0.03
Cobalt (Co)	0.1
Copper (Cu)	5
Iodine (I)	0.3
Zinc (Zn)	25
Iron (Fe)	30
Manganese (Mn)	25

Source: Grace, 1994

Generally NZ pastures have more than adequate quantities of major minerals (Metson & Saunders, 1978).

Some concern has been raised about low levels of Ca and Mg in spring for good lactation, though often the ewe's buffering ability can overcome the short term deficiency. Recent dairy industry research recommends that Ca and Mg intake should be relatively low in late winter to enhance bone mobilisation of Ca and prepare the animal to meet the greatly increased requirement of Ca in early lactation. Other research has implicated the role of boron (B) in Ca mobilisation from bone, but has not been investigated in sheep.

Sodium deficiency is sometimes observed, though uncommon (Towers & Smith, 1983).

The absolute amount of sulphur required by livestock can be altered depending on protein supply. Ideal nitrogen: sulphur ratios for ruminant performance range from 10:1 to 15:1. New Zealand pastures can range from 8:1 to over 20:1 (Morton et al., 1998). This affects lamb growth through supply of sulphur amino acids and efficient digestion by the rumen micro-organisms (Van Soest, 1994), but also affects the type of protein in the herbage and the soluble carbohydrate concentration. True herbage protein is maximised when the N:S ratios are below 12:1 (Bolton et al., 1976).

Trace elements

This group of chemicals is required in very small quantities for growth. They are found in enzymes, hormones and vitamins, which when in short supply can be a major constraint to normal growth. Decreases in animal performance of 5-20% have been reported.

Trace element deficiencies are frequently blamed for poor growth rates, though lamb requirements, sources and diagnosis must be understood before undertaking expensive preventative measures.

Cobalt and selenium are reported as major causes of poor lamb growth in NZ, with little evidence of copper deficiency despite many trials being conducted on this element throughout the country (Clark 1983). However 'swayback' (enzootic ataxia) and bone fragility have been reported as disease conditions affecting lambs (Bruere & West 1993).

Lamb requirements

Milk and pasture both contain trace elements which are required to meet growing lamb demands. Understanding this needs information on lamb requirements at various liveweights and liveweight gains, the amounts of milk and pasture ingested, the amounts of trace elements in both milk and pasture and the fraction of these ingested trace elements which are absorbed (Grace 1983).

Daily net requirements for the lamb are presented in the following table. Weight units used are mg. – milligrams (one thousandth of a gram) and the unit g – microgram (one millionth of a gram). The quantities required by the lamb are very small.

Table 7:4 The calculated daily net trace element requirements of the growing lamb

Liveweight (kg)	5	10	15	25	40
Weight gain (g/d)	250	250	250	200	100
Trace Minerals					
Zn (mg)	7.5	7.9	8.3	7.8	6.7
Fe (mg)	14.0	14.0	14.0	11.0	6.0
Mn (g)	0.20	0.27	0.34	0.5	0.64
Cu (mg)	0.22	0.24	0.26	0.26	0.28
Se (vg)	13	14	16	16	13
I (vg)	40	80	120	200	270
Co as Vit B_{12} (vg)	2	4.5	7	11	18
as Co (vg)				65	110

Source: Grace, 1983

The quantities of trace elements taken into the digestive system are not all absorbed from the digestive tract. The amount absorbed divided by the amount ingested can be a figure equal to or less than one. The closer this figure is to one the more of the trace element is absorbed (Grace 1983). It can be seen from the following table that absorption from milk is much higher than from pasture.

Table 7:5 The mean concentration of trace elements in ewes milk and the range of concentration of trace elements in pasture together with the estimated coefficient of absorption* from milk and pasture

Element	Concentration		Coefficient of absorption	
	Milk (/kg fresh milk)	Pasture (/kg DM)	Milk	Pasture
Selenium	6 vg	0.01-0.05 mg	†	0.5
Cobalt (Vit B_{12})	2 vg (B_{12})	0.04-0.24 mg cobalt	† (B_{12})	0.05 (B_{12})
Copper	0.2 mg	3-9 mg	0.9(5kg) 0.5 (10kg) ‡	0.06
Iodine	80 vg	0.12-1.45 mg	†	0.9
Iron	0.5 mg	100-3000 mg	†	0.2
Zinc	6.9 mg	20-70 mg	†	0.3
Manganese	0.11 mg	50-500 mg	†	0.01

Source: Grace, 1983

Pasture analysis for trace elements is a common practice, and to establish this in comparison to perceived requirements it is often necessary to know lamb requirements in mg of the particular trace element per kg DM. This is presented in the following table.

Table 7:6 The dietary mineral requirements of sheep

Major Mineral Elements	Requirement (g/kg DM)
Sodium (Na)	0.9
Potassium (K)	3.6
Magnesium (Mg)	1.2
Calcium (Ca)	2.9
Phosphorus (P)	2.0
Sulphur (S)	1.5
Chlorine (Cl)	1.0
Trace Elements	**Requirement (g/kg DM)**
Selenium (Se)	0.03
Cobalt (Co)	0.1
Copper (Cu)	5
Iodine (I)	0.3
Zinc (Zn)	25
Iron (Fe)	30
Manganese (Mn)	25

Source: Grace, 1983

The possibility of trace element deficiencies occurring under New Zealand conditions is ever present.

But before undertaking expensive and often unnecessary treatments or prevention programmes, it is essential to confirm the presence of a deficiency.

This is best achieved by tests on the animals involved, as soil and pasture tests are ancillary information and not diagnostic.

Animal health laboratories carry out such tests, though the samples themselves need to initially be handled by a vet.

It is well to remember that for selenium, cobalt and copper, liver reserves in the normal range will generally keep the animal free from clinical signs of deficiency of up to three months, even if these animals are grazing deficient pastures at the time.

CHAPTER EIGHT – PATTERNS OF CHANGE IN CARCASS COMPOSITION, GROWTH EFFICIENCY AND MEAT QUALITY

Lambs have a potential for rapid growth compared with older sheep because they are at an early stage of maturity. Potential growth rate is related to mature body size and high potential growth rates are associated with large mature size.

The genetic differences between sheep can be exploited in three ways:

1. Selection within a breed.
2. Selection of a breed.
3. Hybrid vigour.

There is also a difference because of lamb sex.

Depending on feed availability, ram and cryptorchid lambs are very similar in growth rates, and approximately 10-20% better than ewes and wethers (wethers are 8 to 12% faster growing then ewes). At the same time, rams and cryptorchids are also more likely to be laying down lean muscle growth as opposed to fat – which a ewe lamb may be doing.

Thus a ewe lamb being fed enough to gain 200g/day would be matched by a ram lamb growing at about 220-280g/day, though more likely to be around 240g/day.

Changes in body type and composition

Lamb development follows a well-defined pattern.

The newly born lamb has a high percentage of bone, particularly in the legs, and a small percentage of fat in its body.

In the early stages of growth, different parts of the body grow at different rates (e.g. legs grow slower), but by 4-5 months the lamb's proportion of anyone part is very similar to its mature state (e.g. loin as % of the total carcass).

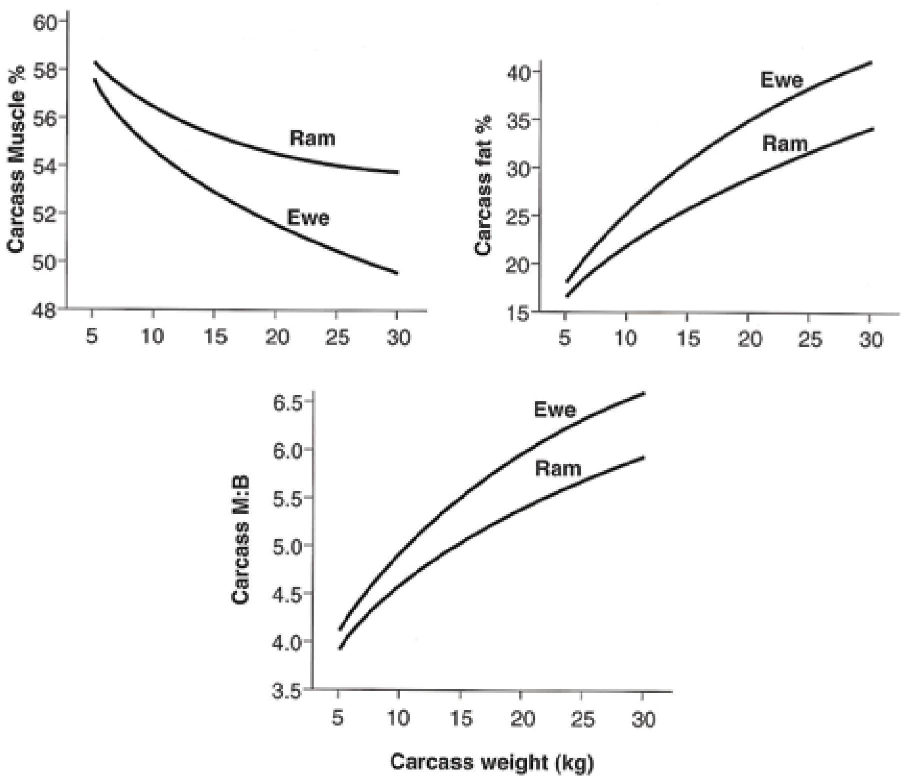
As a lamb develops it has proportionally more fat. This is shown in the following two diagrams.

Table 8:1 Approximate changes in the carcass composition of sheep with age

Age	New born lamb 2.5		Export lamb 13		Mature ewe 3.5	
Carcass weight (kg)	Weight %		Weight %		Weight %	
Bone	0.6	30	2.2	17	4	12
Muscle	1.2	60	8.0	61	17	53
Fat	0.2	10	2.8	22	11	35
Total	2.0	100	13	100	32	100

Source: A Nicol, 1983

Fig 8:1 Changes in muscle%, fat%, and meat to bone (M:B) ratio with increasing carcass weight



Source: A.S. Davies, 1989

Early in growth the decrease in the percentage of bone partly compensates for the increasing fat percentage. The % lean tissue or muscle does not drop markedly.

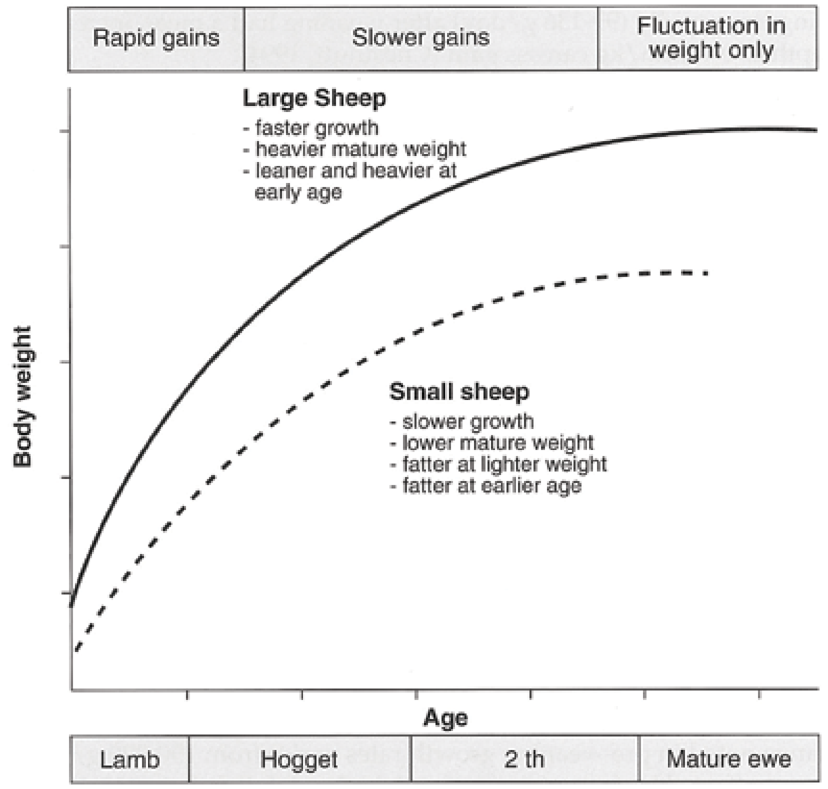
Eventually the increase in fat exceeds the decrease in bone and the % lean tissue declines. Although the % muscle in carcass decreases with time, the absolute weight of muscle increases from birth to maturity.

In general any genetic factor which increases potential lamb growth rate (growing faster because it is growing towards a higher mature weight) decreases the carcass fatness at any given weight or age.

Some stages of development eg level of fatness, carcass grade, % mature liveweight, occur more quickly (at an earlier age) for lambs with a lower mature weight.

Because lambs growing faster towards a higher mature weight are leaner, it is more 'difficult' (i.e. takes longer, or a higher level of nutrition) to attain any particular fatness level.

Fig 8:2 Potential for growth



Characteristics of potential growth curves for sheep.

Source: A Nicol, 1983

Nutritional effects on carcass composition

Nutritional manipulation has limited impact on sheep carcass composition at a particular carcass weight according to much of the research literature. Some effects have been measured however.

Suckling lambs tend to deposit a greater amount of fat than early weaned lambs up to approximately 12 weeks of age (Geenty, 1985; Sanudo et al., 1998).

The rate of lamb growth to weaning at six weeks of age tended to have little or no effect on lamb carcass composition at slaughter six, 12 and 18 weeks from birth (Munro & Geenty, 1983).

Lambs grown at high (approx. 300 g/day) or low (approx. 200 g/day) growth rates from six weeks of age to weaning at 13 weeks had a similar carcass composition at slaughter at 40-48kg liveweight (Chestnutt, 1994).

Lambs growing rapidly (approximately 146-338 g/day) after weaning had a fat depth increase over the eye muscle of 0.52mm/kg carcass gain. Lambs growing less rapidly (99-136 g/day) after weaning had a mean increase in fat depth of 0.13mm/kg carcass gain (Chestnutt, 1994).

Slower maturing breeds have a greater tendency to compensatory liveweight gain and higher protein deposition after periods of restricted growth (Jason et al., 1992).

As these two trials were conducted outside New Zealand, it is difficult to generalise or make assumptions.

The inclusion of condensed tannins in a feed such as Lotus can also cause a decline in mean graded fat depth compared to lambs grown on white clover (Purchas & Keogh, 1984). This may be due to the increase in protein supply to the animal (Van Houtert & Leng, 1993) because tannin protects proteins from degradation in the rumen.

Field experiments investigating short-term methods to reduce graded fat depth (Bray et al., 1985) found that true decreases in GR were only possible when shearing and mild under-nutrition were combined. Otherwise GR declined in direct relationship to carcass weight loss.

Supplementation of a low energy diet with fish meal also ensured that fat depth over the eye muscle was reduced without associated losses in carcass weight (Vipond et al., 1989).

Actual growth of lambs

The range noted in pre-weaning growth rates varies from 150-320 g/day, and is not affected by farm type (dryland, high rainfall or irrigation), liveweight change of the ewe, grazing management system or mineral supplementation.

In general, when a lamb grows more slowly it simply takes longer to reach any particular weight and associated carcass composition. Within limits, no matter how long it takes to attain a particular liveweight, body composition will not be markedly different.

As a rule of thumb, early growth of the lamb carcass is predominantly meat and bone with little fat growth (probably less than 20%). But as it grows and approaches maturity there is a gradual change in emphasis so that eventually carcass weight gains are predominantly fat (up to 80% of the total).

Significance of lamb growth

The rate of lamb growth has an impact on many facets of sheep production.

These include:

- Efficiency of conversion
- Financial return for lambs
- Patterns of lamb slaughter
- Onset of puberty/ ability to mate hoggets
- Performance of the adult ewe

Efficiency of conversion

Though faster growing lambs consume more energy per day, a smaller proportion of that energy is devoted to maintenance.

Faster growing lambs have a higher gross efficiency of conversion (kg lamb meat/unit feed intake) than slower growing lambs of the same weight.

A high potential growth rate is associated with less fat in the gain.

Deposition of lean tissue normally requires appreciably less energy to deposit than the same weight of fat -which further improves the efficiency of faster growing lambs.

Financial returns for lambs

Financial returns are a function of carcass weight and grade. Within any one carcass grade, the income per carcass increases with increasing carcass weight.

Greater rates of growth (both potential and actual) will therefore increase financial returns per lamb carcass.

Likewise, store lamb values are also based on liveweight.

Patterns of slaughter

Slower growth results in lighter carcass weights and/or delayed slaughter.

Delayed slaughter is likely to increase the need for supplementary feed, possibly reduce the amount of feed conserved and limit the potential for flushing ewes.

Onset of puberty

Faster growth in ewe lambs leads to earlier onset of puberty. This provides potential for mating as hoggets, which can increase the lifetime output of a lamb/ewe.

Mature liveweight

The bodyweight of a mature ewe is closely related to its weight as a two tooth. This is probably because the demands of production as well as competition for feed prevents a ewe from fully compensating for previous levels of under-nutrition.

Lamb growth and quality

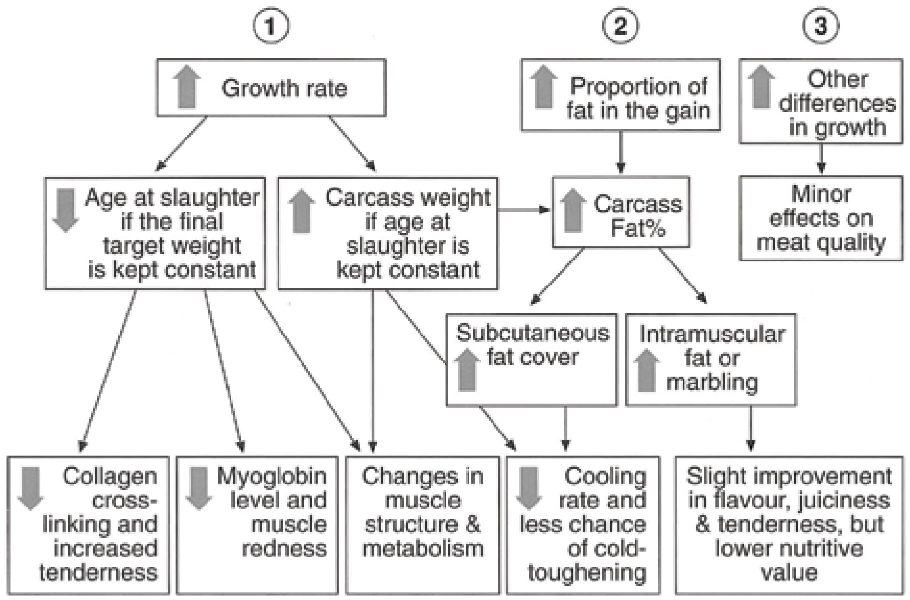
There are a number of characteristics that contribute to the overall quality of a piece of meat or a meat product, but an indication of the sorts of items involved is provided by grouping them into the following five categories (Purchas et al. 1989).

1. Meat appearance characteristics. Includes colour of the muscle and fat portion, fineness of the texture, meat firmness, and the proportions of muscle, fat and bone.
2. Meat palatability characteristics. Often these are the most important determinants of overall quality, and include tenderness, flavour and juiciness. Stress and pH also have an impact.
3. Nutritive value characteristics of meat as food for humans. This includes a long list of individual characteristics (Seman & McKenzie-Parnell 1989), and is an aspect of meat quality that is of increasing interest for many consumers.
4. Meat safety and wholesomeness characteristics. Satisfactory levels of these characteristics are usually ensured by regulations controlling how meat is produced and processed.
5. Characteristics of importance when processing meat beyond the chilled and frozen state, such as water-holding capacity and binding capacity. While there are many relationships where changes in one parameter of growth could lead to some differences in some aspects of meat quality, only a selection of the more important ones are considered here.

In characterising relationships between meat quality and lamb growth, for a particular lamb carcass, quality characteristics vary considerably from one muscle to another, so that research findings with respect to one muscle will not necessarily apply for others.

Some differences in lamb growth patterns and meat quality differences are depicted below.

Fig 8:3 Effects of growth differences on meat quality



Source: Purchas, 1999

Items (1) and (2) outline possible effects of either an increased growth rate or an increased proportion of fat in the gain in lambs on meat quality. Item (3) includes all other aspects of growth. Upward arrows within the boxes indicate an increase and downward arrows a decrease.

Only changes in growth rate and changes in the proportion of fat in the weight gain are dealt with individually in Fig 8.3. Other growth aspects such as growth efficiency and muscularity are lumped together because they are generally considered to have only minor effects on meat quality characteristics.

Growth rate differences are important because a faster growth rate means the lamb is either younger (if taken to a set weight) or heavier (if grown over the same period) at the time of slaughter. It is the effect of growth rate on meat quality through an effect on the age at slaughter that has received the most research attention.

Age effects on lamb meat quality

Tenderness changes with age is difficult to measure because of the actions of conflicting determinants.

Collagen fibres within meat become tougher and more difficult to dissolve with cooking in older animals because crosslinks form between collagen protein molecules. However, the rate of muscle cooling is slower in heavier, fatter carcass, so the likelihood of cold-shortening and toughening is reduced. (Electrical stimulation of carcass and slower cooling rates has tended to minimise this problem).

The decreased collagen solubility with increased age is of greater significance for those muscles and cuts with a high collagen content than for high-quality low-collagen cuts. Collagen solubility is also affected by cooking conditions, with more thorough cooking beneficial for meat from older animals.

However, intramuscular fat can make a small positive contribution to tenderness and juiciness, and changes in muscle structural features such as the proportion of different muscle fibre types.

Generally it appears that there is a reasonable likelihood for tenderness to decline as the age of lambs increases above about six months.

There is also evidence that tenderness may sometimes be lower for meal from lambs only a few months old. Furnival et al. (1977) suggested that the high shear values of their youngest lambs (3-4 months) may have been due to the additional stress of being separated from their mothers. They also showed that higher ultimate muscle pH values (an indicator of stress) up to 6.0 were associated with higher shear values. Similar pH effects were reported by Devine et al. (1993).

Age-related quality changes in lamb meat, other than for tenderness, include an increased redness due to higher concentrations of the red pigment myoblobin (Ledward & Shorthose, 1971). Changes in flavour generally represent the development of a more mature flavour up to an age of about 12 months (Ford & Park, 1980, Rousee-Akrim et al. 1997).

Fatness effects on lamb meat quality

Fat's contribution to meat palatability and other quality characteristics has received a lot of research attention over the years. This is because of the conflict between the positive contribution that some intramuscular fat (marbling) in particular can make to palatability against fat's negative contribution to lean meat yield. Most of this research has been in pork or beef, though a number of studies have considered lamb.

Selection for very low fat cover can increase the likelihood of cold storage shrinking due to lack of insulation, as demonstrated by Smith et al. (1976). That study found loin muscle shear values increased by 33% for a group of carcass with a 3.3mm fat cover relative to group with a fat cover of 7.1mm.

Sanudo et al. (1999) in a light lamb carcass trial (10-11kg) also showed that low levels of fat cover were associated with tougher meat and also a lower intensity of flavour.

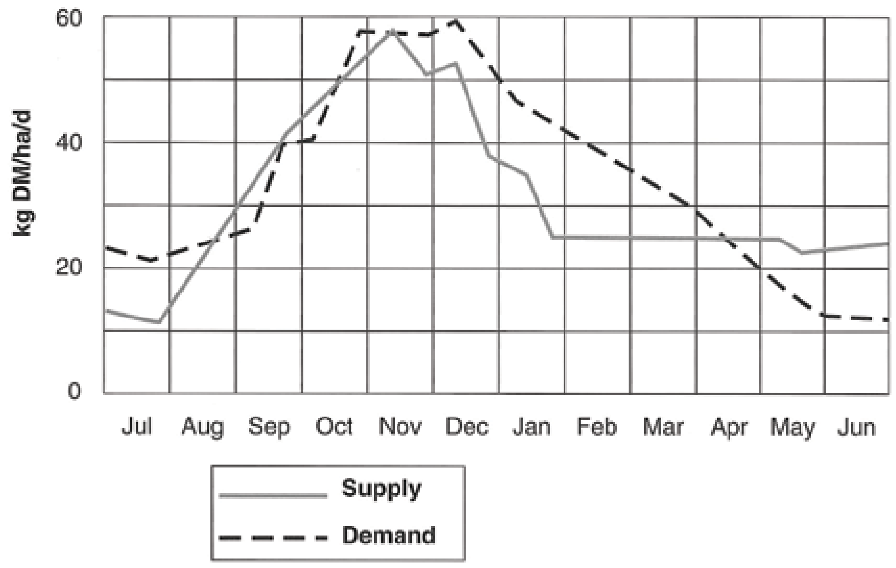
On the other hand, for 1660 lamb carcass at heavier weights representative of the carcass weight range in most countries, Jeremiah (1998) found very low relationships between measures of fatness and consumer ratings for overall palatability.

It appears then, that for very light carcass or under processing conditions that are conducive to cold-shortening, a certain level of fatness is required for satisfactory palatability. But for carcass weights above about 12 kg and with appropriate processing conditions, there is little to be gained by having levels of fatness of more than two millimeters over the eye muscle, or a GR soft-tissue depth over the rib of more than about three millimeters.

APPENDIX ONE – MATCHING FEED SUPPLY AND DEMAND

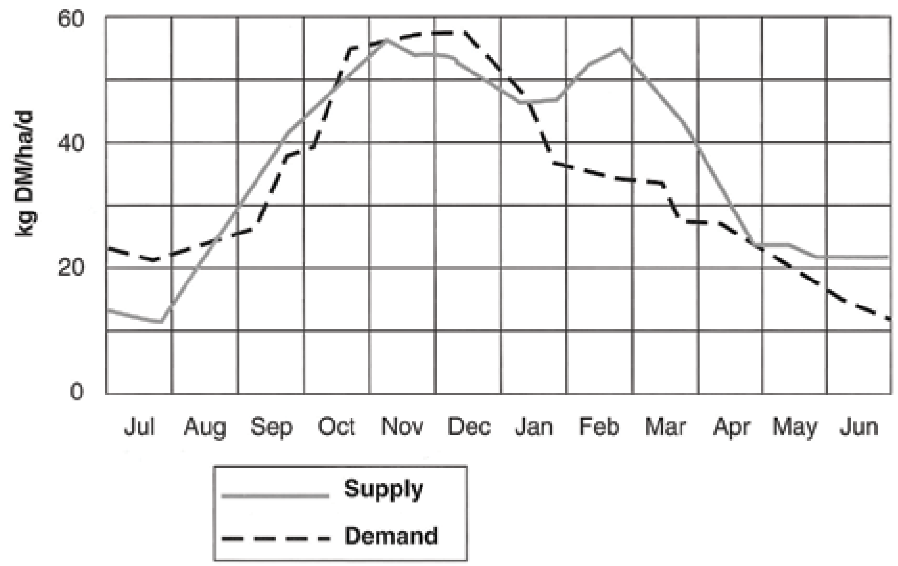
The following series of graphs from Stockpol illustrate some key points of feed quality and quantity and its relationship to different management systems. The explanation is based on a model for a fertile, intensive, summer wet North Island farm (e.g Waikato, Taranaki).

Fig App 1:1 Supply/Demand plot for North Island fertile intensive farm – store stock



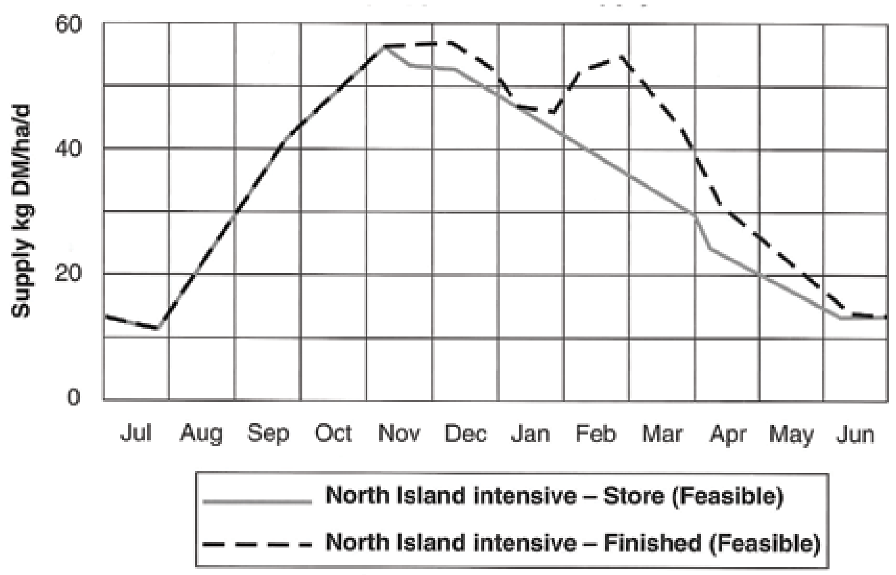
It is most unlikely that a store stock regime would be employed in a summer wet situation. Note the close match between spring supply and demand. Surplus feed in early to mid summer could be carried over (in some form) to be fed during the winter feed pinch.

Fig App 1:2 Supply/Demand plot for North Island fertile intensive farm – finishing stock



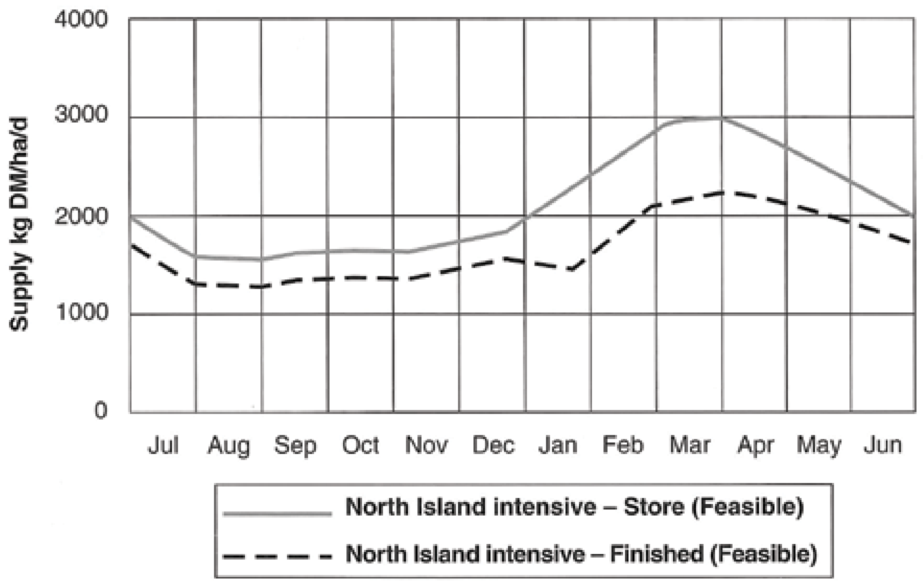
The more likely system in a summer wet situation. Spring and early summer supply and demand very close. Surplus feed in late summer can be carried over to help during winter feed pinch period. Note how grazing pressure in late spring which means pastures don't become too rank, contributes to an increase in autumn feed supply.

Fig App 1:3 Feed supply



Note the difference in feed supply between the two different management regimes. More feed is produced from the finishing system because better control is maintained over the late spring and early summer growth. The pasture's potential to maintain production of quality feed is enhanced under the finishing system which keeps grazing pressure on the fast growing ryegrass and white clover sward. The store system lets too much pasture become rank, and lowers its overall production potential.

Fig App 1:4 Pasture cover



The difference in pasture production between a store and finishing system can largely be explained through the differences in pasture covers (the quantity of pasture present at anyone time). Covers are too great under the store system, which means too much pasture becomes rank and dead and dying growth is more than new growth. The finishing system maintains pasture covers between an optimum 1500 -2500 kg DM/ha.

APPENDIX TWO – SOILS AND CLIMATE

Across the length and breadth of New Zealand, a range of soils, climates and topography greatly influence an individual farm's ability to grow young and mature sheep.

From summer dry country (generally the east coast of both islands) to summer moist (southern and west coast New Zealand), from hard winters to mild winters, the combination of rain and sun, contour and soil type determines the particular management method which can be employed.

Climate, latitude and terrain drive variations in temperature, rainfall and daylength.

Individual farmers often intuitively realise what conditions they have to farm for.

The major decision surrounding lamb growth is whether a property is able to grow lambs through to killable weights, or whether environmental constraints means it is more profitable to grow healthy store lambs in order to concentrate on growing healthy breeding stock.

There are two major geographical factors impacting on lamb growth – temperature and rainfall.

Temperature

Temperature causes most of the variation in fungal disease status, including endophyte and facial eczema. Endophytes are required in ryegrass to combat Argentine stem weevil. Endophyte toxin production increases with temperature and soil moisture stress.

Facial eczema spore production is also directly related to temperature and humidity. FE is mostly confined to warm, moist regions of the North Island, but varies from year to year. The disease's direct effects on lamb growth can be avoided through monitoring and grazing management practices.

Other toxins such as zearalenone may also have an effect on lamb growth during summer and autumn.

Temperature also drives plant maturation.

Higher temperatures cause earlier flowering and greater fibre production in grasses. This brings forward the time of peak pasture production, and means that summer grown pastures in warm regions are of lower quality than cooler regions. A consequence of warm night temperatures is lowering of soluble sugar concentrations in warmer regions of the country – dropping the pasture's energy levels and hence an animal's ability to process protein.

Rainfall

Rainfall directly affects pasture quality through digestibility and dry matter content.

Temperature and rainfall influence both pasture quality and the amount of pasture on offer. The quantity and quality of feed on offer is the primary driver of feed intake.

Often low pasture mass during summer restricts lamb growth throughout the dry East Coast regions of the North and South Islands. This can occur in most of New Zealand from time to time.

In areas of regular summer dry conditions, options such as lucerne, chicory, dryland pastures such as tall fescue, and specialist brassica crops area all employed to provide the quantity and quality of feed required for good lamb growth.

Therefore the most appropriate use of pasture species also varies from region to region. The use of various species and cultivars, detailing their environmental suitability rated on temperature, soil moisture and fertility, grazing management and acceptability to stock is shown in the table on page 46-47.

Ryegrass endophyte

Eerens et al (1992) found only small differences between lambs grown on pastures based on high or low endophyte ryegrass in the cool temperate climate of Southland, where lambs had the opportunity to select a preferred diet, which included white clover.

However, endophytes effect feed intake as well as animal health. Sheep grazing on mixed swards preferentially graze low endophyte areas (Edwards 1990). In larger plots Edwards et al. (1993) found sheep would graze closer to the ground and into the stem on endophyte-free ryegrass. This response, in pastures of moderate endophyte (40%), effectively restricted their intake of the more toxic leaf sheath of high endophyte ryegrass.

Work with dairy cows in Northland has also highlighted the importance of reduced feed intake due to high endophyte ryegrass (Keogh 1999). This response is thought to be related to the ergovaline status of the plant. This chemical decreases the animals' ability to regulate heat loss. When animals become too hot they eat less. High endophyte production declines were directly related to heat and humidity effects, combining to affect an animals' heat loss.

It is unclear whether the decline in feed intake was directly related to ergovaline in the diet or an avoidance of the herbage – though it is likely to have a component of both.

Endophytes can have other effects. Clover content in mixed pastures can decline due to its presence (Sutherland & Hoglund, 1898; Stevens & Hickey, 1990). This feature appears to be most important in drier and warmer environments. A depression in lamb growth from birth to weaning has also been recorded on high endophyte pastures (Eerens et al., 1994; Massey grad 1999) leading to a difference of 1 kg at weaning.

Management of endophyte pastures

As a fungus, endophytes are in stronger concentration in ryegrass seedheads and base. It is generally more apparent in late spring to autumn.

In summer wet regions, or isolated pockets in East Coast conditions, non-endophyte ryegrasses may last for a medium to long term without being too affected by the insect pests that endophytes protect a plant against.

Endophyte effect on animals includes:

- Ryegrass staggers
- Reduction of liveweight gains
- Increase in body temperature and respiration rates (heat stress)
- Increase in dags and possible flystrike (faecal moisture is generally higher)

Endophyte ryegrass produces toxins that also reduce clover growth – further diminishing potential lamb growth.

Such growth effects are more pronounced during periods of stress such as drought. Management recommendations for maximising lamb growth when endophytic pastures are in use include:

- Try to use alternative pastures in late spring to autumn.
- Keep pastures topped, so the endophytic toxins don't migrate to the seedhead (it's method of transmission)
- Use other livestock to 'clean up' pastures

It should be noted that novel endophyte ryegrasses are soon to be commercially available. These selected grasses have endophytic protection against insects but do not produce the animal toxins.

Mycotoxins and other toxins

Mycotoxicoses have been incriminated in several animal disorders in recent years. They are mostly associated with feeding livestock fungal-contaminated conserved feedstocks, but several associated with fungal growth on pasture have been suggested as a cause of sub-optimal weight gain (Scott, Ramsay et al., 1976).

Oestrogenic mycotoxin (zearalenone) produced by Fusarium fungi significantly reduce ewe reproductive performance in the Gisborne-East Coast area, but this has not been shown to adversely affect lamb growth rates (Jagusch, Towers et al., 1986).

The same is also true of the phyto-oestrogens which are to be found in some clovers.

Zearalenone

A range of Fusarium fungi in pasture produces the toxin zearalenone. Its effects are similar to oestrogen, reducing ewe fertility and fercundity, though rams appear to be unaffected.

Fusarium and the zearalenone toxin occur throughout New Zealand, but because a range of the fungi (with different levels of toxin) are present, no definite recommendations can be given (unlike facial eczema, which is of only one main type throughout the country).

Fusarium generally grow on dead material in pasture rather than on green leaf. Its growth is greatest in late summer and autumn, with spores forming under warm dry conditions. Because zearalenone levels do not always follow spore production patterns, spore counting is not helpful.

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 if exposure is prolonged (Towers, 1992).

Suspect zearalenone effects if lambing performance appears inconsistent with ewe mating weights and there are no other obvious problems.

Because zearalenone levels are highest in the base of pastures, and in dry material, just as for flushing, ewes should have as much leafy green pasture as possible.

Dags

Though the appearance of dags has not been directly related to a decline in lamb growth, they may indicate some dysfunction of the digestive tract, and provide an ideal site for fly strike. Both nutrition and anti-nutrition factors are involved.

Ryegrass endophyte increases the amount of dags on lambs (Eerens et al., 1992; Fletcher & Sutherland, 1993) through increasing faecal moisture content (Pownall et al., 1993). This may be due to the toxin Lolitrem's effects on smooth muscle content (Endophyte symposium 1999).

Tannins also alter dags and flystrike incidence. Lambs grazing Lotus corniculatus had significantly less dags and flystrike than lambs grazing ryegrass/white clover pastures (Leathwick & Atkinson, 1996). Lambs grazing both sulla (Hedysarum coronarium) and lotus had lower incidence of dags and flystrike than ryegrass/white clover pastures (Niezen pers comm.).

Plantain may reduce dag incidence. Turner (1999) showed dags were eliminated from lambs grazing pastures when 36% of the dry matter on offer was from plantain, compared to 20% of lambs having dags on the resident pasture.

Internal parasites and pasture species

Some pastures may have anthelmintic properties, or influence nematode larval dynamics on pasture (Moss & Vlasoff 1993).

Knight et al., (1996) found that only chicory fed lambs had regularly lower faecal egg outputs than other pasture species. Some suppressive influence of plantain and legumes were evident though not always present. Adult burdens were only suppressed by chicory diets.

Many of the plant attributes appear to be more related to improved protein and energy nutrition than to anthelmintic or larval challenge variations.

APPENDIX THREE – PASTURE AND CROP RELATED ANIMAL HEALTH FACTORS

Under certain conditions poisoning by toxins present in the plants, or associated fungi, can have serious consequences for both lamb growth rate and animal health.

The more important conditions which contribute to poor growth rates, disease or death are listed:

- Facial eczema
- Ryegrass staggers/endophyte metabolites
- Brassicas (if not managed properly)
- Nitrate/nitrite poisoning
- Other mycotoxins and plant toxins

Facial eczema (sporodesmin poisoning)

This is common is the North Island, and occasionally in Marlborough and Nelson, but rare elsewhere in New Zealand.

Particularly during the January-April period, it can cause extensive stock losses in northern New Zealand.

The condition is caused by ingestion of spores of a ubiquitous toxigenic fungus, pithomyces chartarum. This grows on pasture litter and multiplies dramatically under warm (with night temperatures in excess of 15 degrees), humid conditions (relative humidity above 80%).

The spores contain a toxin, sporodesmin, which causes substantial liver damage. This liver damage produces increases in bile pigments in the blood, resulting in jaundice and a failure by the liver to break down plant pigments such as phylloerythin.

Phyloerythin reacts with light in surface blood vessels and causes the skin lesions observed in affected animals.

Facial eczema's severity is related to the degree of liver damage, and deaths can occur 3-4 weeks after access to the toxic pasture (Manktelow 1984; Familton 1990, Bruere & West 1993).

As the most serious of the mycotoxic diseases in New Zealand, there is no specific treatment, but removal from the toxic pasture and the provision of shade and good feed is recommended.

It is important to avoid nutritional stress in the following winter, as chronic liver damage can result from the initial sporodesmin challenge and any stress can seriously affect animals after the initial clinical signs have disappeared.

Prevention and control can be achieved by:

- Monitoring meteorological data and utilising pasture spore count results to forecast the toxicity of pasture (Towers 1999).
- Provision of safe pasture within five days by spraying with fungicides such as Benlate, Sporex and Thibenzole (Towers 1999).
- Use of alternative sources of feed other than pasture (Towers 1999).
- Administration of slow release zinc capsules to animals grazing toxic pasture to reduce the liver damage produced by sporodesmin (Grace, Munday et al. 1997; Munday, Thompson et al., 1997).
- Selection of animals with natural resistance to the effects of sporodesmin.

Ryegrass staggers RGS

RGS is commonly seen in the late summer and autumn.

Characterised by ataxia, muscle tremors, stilted gait and loss of co-ordination when the animal is disturbed, it is followed by muscular relaxation and an apparent recovery if the excitory stimulation is removed. Deaths generally relate to misadventure.

It has been postulated that a reversible upset to transmission of nerve impulses occurs. When animals are affected appetite, growth rate and hormonal production can be affected (Fletcher & Barrell 1984).

RGS is caused by neurotoxins (loliterms) produced by a fungus in the ryegrass, *Neotyphodium lolii*.

Even in the absence of symptoms more serious economic losses can occur. This is possibly due to other toxins produced by the endophyte-ryegrass association.

Lambs grazing high endophyte pastures can have weight gain reductions of up to 40%/ as well as increases in dags.

Ergovaline produced by the endophyte can cause heat stress, and be a serious constraint to production in northern New Zealand during summer-early autumn (Easton 1996).

Because endophyte toxins are mainly in leaf sheaths, stems and seed heads, management techniques are mainly to prevent lambs from grazing below 4cm of pasture height. This can reduce endophyte toxin intake (and may also reduce intake of infective internal parasite larvae). Pastures should then be spelled to allow for leaf regrowth (Easton 1996).

If endophyte-free seed is used, then the ryegrass may be less protected against Argentine stem weevil (Listronotus bonariensis) and other insects. These pests can decrease pasture production and its life.

Low-endophyte perennial ryegrass seed is now available and can be used in areas such as Southland and Otago where Argentine stem weevil is seldom a problem.

In other areas it is possible to sow ryegrass containing endophyte that produces very little lolitrem, and has reduced levels of ergovalines, but still has protection against insect predation.

Brassicas

Nutritional haemoglobinuria (red water)

When amino acids called S-methyl cysteine sulphoxide (SMCO) are between 0.5-2.0% in brassicas, they can cause problems in sheep.

Affected lambs show anaemia, red discolouration of the urine (red water) and occasionally jaundice. The SMCO content of brassicas increases with age and is particularly high in regrowth and after flowering (Ellison 1994).

Control and prevention may be possible by feeding additional pasture, silage or hay.

Rape scald

This is seen especially in lambs in the South Island where rape (*Brassica napus*) is used as a finishing crop.

It is caused by an unknown pigment in immature rape which causes a photosensitivity without liver involvement.

Clinical signs include oedema (swelling) of the skin of the ears and neck, which may slough off.

Recovery is rapid when lambs are removed to shady areas.

Rape should be fed when the rape has a blue tinge, and stock should be introduced slowly to the feed with access for about one hour/ day initially until the animals become used to the feed (Bruere, Cooper et al., 1990).

This gradual introduction to the crop allows a conversion to a gut bacteria which can better handle rape.

Nitrate-nitrite poisoning

Nitrate-Nitrite poisoning occurs in sheep when diets are high in nitrate and low in soluble carbohydrate.

Immature cereal crops and regrowth in brassicas commonly contain elevated levels, and rapid regrowth of short rotation ryegrasses have proved toxic. The danger is increased with the use of

APPENDIX THREE

nitrogenous fertilisers and if wells or bores containing 200-250 ppm of potassium nitrate are used to supply drinking water for stock. Active growth of plants at the end of a dry period often results in high plant nitrate levels (Bruere, Cooper et al., 1990).

Ingested nitrates are normally reduced to nitrite and finally to ammonia, But when nitrate levels are high, the rate of nitrite reduction is slowed. This leads to an accumulation of highly toxic and readily absorbed nitrite ions.

Nitrite ions combine readily with haemoglobin to form methaemoglobin, which interferes with the blood's ability to transport oxygen to the tissues.

The animal dies from anoxia (absence of oxygen) when about 60% of the haemoglobin has been immobilized.

Under certain conditions pasture plant accumulation can occur and nitrate levels greater than 2% on a dry matter basis should be considered toxic.

Level of 1-2% may cause problems if it is the sole feed available, though less than 1% is generally safe.

Ruminants in good condition and fed ample carbohydrate can tolerate higher levels. If doubt exists, plant material should be diluted by feed with low nitrate levels so that total availability is less than 0.5% nitrate.

Sheep are generally found dead with nitrate poisoning and a characteristic sign is the presence of chocolate coloured blood in the carcass.

Control and prevention is through gradual introduction to the feed or by testing the suspect material.

Plants can be tested by applying diphenylamine on the tissues on the inside of the stem, and is positive when an intense blue colour develops within 10 seconds (Ellison 1994).

Other mycotoxins and plant toxins

Phalaris poisoning

Acute and chronic poisoning have been described in New Zealand when sheep have access to rapidly growing *Phalaris* spp. under shady conditions and when day temperatures are over 20 degrees.

Indole alkaloids produced under these conditions can cause either sudden death or a nervous disorder in sheep 12-72 hours after the animals have gone onto such pasture.

The condition is characterised by head nodding, front leg weakness and heart abnormalities. The nervous conditions can persist for some time, and up to 50% of affected animals may die.

Phalaris poisoning has been linked to cobalt deficiency, but treatment with cobalt in the form of Vitamin B12 has generally not resulted in recovery.

Drying of toxic pasture tends to destroy the alkaloids, so hay is generally safe.

Sheep should always be introduced to toxic pasture over several days (Bruere & West 1993). They should also preferably have a full stomach when introduced to the pasture.

Paspalum staggers

Paspalum staggers occurs sporadically in sheep in northern New Zealand during summer and autumn when stock have been grazing the plant.

The condition resembles ryegrass staggers in that animals may become uncoordinated when disturbed. It is caused by a tremorgenic toxin produced by a ergot-like fungus (*Claviceps paspali*) growing on the paspalum.

Recovery is usually within 2-10 days after removal from the toxic pasture unless death by misadventure occurs (Manktelow 1984).

Lupinosis

A mould, *Phomopsis leptostromiformis*, grows on lupins under certain conditions. It produces a toxin, phomopsin, which results in lupinosis when ingested by livestock in sufficient quantities.

The signs are photosensitisation with associated liver damage similar to facial eczema (Manktelow 1984).

APPENDIX FOUR – ANIMAL HEALTH – MAJOR MINERALS

Selenium

Selenium, in association with Vitamin E, is required by the body for the protection of cells from the products of metabolism's destructive effects, and for the maintenance of an effective immune system.

However, excess selenium is toxic and many of the problems now being identified are the result of excess Se use.

Soil analyses indicate that 30% of farmed land in this country is selenium deficient. Se levels in these soils are below 0.5 ppm and the correlation between these Se soil levels and the incidence of deficiencies is good.

Selenium deficiency is seldom seen when pasture selenium levels are above 0.03 ppm. Test methods include:

- Optigrow – liver test post slaughter
- Liver biopsy
- Herbage analysis
- Blood tests

Clinical signs of Se deficiency

In the growing lamb two selenium responsive conditions have been identified.

White muscle disease

Se deficient animals frequently exhibit weakness or failure of skeletal or cardiac muscle. This is recognisable in dead animals as areas of muscle which resemble cooked chicken flesh as a result of calcium deposition within the damaged muscle structure.

Two forms have been loosely described.

1. Congenital White Muscle Disease. Lambs die at birth or soon after. Examined lambs frequently show areas of severely affected heart muscle. If the lamb survives for a few days after birth, other skeletal muscles can be affected. The condition can be seen in identical muscle masses on both sides of the body.
2. Delayed White Muscle Disease. Generally seen in lambs from 2-6 weeks of age, but as early as five days and as late as eight months. Can be brought on by yarding and other stresses. Intercostal muscles can be affected with respiratory difficulties resulting (Bruere & West 1993).

Poor growth rates and decreased wool production are probably the most important effects of Se deficiency in lambs. Increases of 5-10% in liveweight would be expected as a result of Se supplementation when lambs are known to be grazing Se deficient pasture. Responses in wool weight of 30-50% have been reported in response to treatment (Grace 1994).

Diagnosis

Liver samples from dead animals and 3-4 blood samples from live lambs can confirm Se deficiency.

Treatment and prevention

Drenching

A single oral dose of a Se salt solution usually provides adequate supplementation for 1-3 months. Compared with drenching sheep with cobalt and copper salts, oral dosing with Se has proved highly effective.

The oral dose of sodium selenate for:

Lambs: Birth to one month – 1-2 mg

Hoggets: 3 mg

Adult sheep: 5 mg

Solutions of Se can also be added to worm drenches. Care should be taken as a 10 mg dose has been reported as killing 50% of animals. The safety factor is greater in older animals. Also note that the concentration of solutions can vary from 1 mg/ml to 25 mg/ml.

Subcutaneous injections

Sterile selenium salts can be administered as injections, either simply as a selenium injection or more commonly in association with clostridial vaccines. These preparations can maintain Se levels for up to three months, giving very similar results to the oral drench. Compared with the oral drench, blood levels peak at very high levels 1-2 hours after injection, before decreasing about 48 hours later. As a result poisoning is more common following Se injection.

A paste of barium selenate (Deposel, C-Vet) is also available as a long-acting injection. This provides the lamb with increasing blood levels of Se for up to five months.

Care should be taken with the injection site (as with all injections) because of the local reaction which can occur.

Controlled release preparations

These devices (such as Permasel) are given by mouth and lodge in the rumen. Over time they slowly release sufficient selenium to provide up to 12 months supplementation. They should not be given to lambs under eight weeks of age.

Topdressing with selenium

Topdressing pastures with 109 Se/ha as Se containing prills has proven to be a highly effective. Prills, containing slow release barium selenate, provide adequate pasture Se levels for up to 24 months. Once storage levels in the liver have been elevated, this should be sufficient to keep blood selenium levels in sheep within the adequate range for 3-4 months.

Toxicity

High Se levels in animals being presented for slaughter are becoming an increasing problem. Animals with liver selenium levels in excess of 2 mg Se/kg are unsuitable for human consumption (Grace 1994).

As farmers mix drenching, injection and top-dressing of Se, toxic levels can quickly be reached.

Farmers should also be aware that different concentrations of Se in drenches or injections may require dilution to deliver a normal lamb dose of 2 milligrams.

Excessive Se use may not only cause acute animal deaths or carcass rejection, but also poor growth, loss of appetite, lameness and poor wool production. Ill-thrift investigations should always eliminate the possibility of selenium poisoning.

Sheep grazing Se topdressed pastures six months after application should not be dosed with Se (Grace 1994).

Cobalt

Extended periods of low cobalt intake can be responsible for Vitamin B12 deficiency in ruminant animals. When winters are wetter than average, Co deficiency also seems to be more of a problem.

Cobalt is converted as a result of microbial action in the rumen, into Vitamin B12, which is then absorbed by the rumen.

Vitamin B12 is involved in the conversion of dietary components into glucose and some proteins.

Young lambs get Vitamin B12 from milk, on top of the foetal storage supplied by the ewe during pregnancy. Sheep require more cobalt than cattle, and growing lambs in particular have higher requirements during this active period.

Some farmers are treating animals directly with Vitamin B12, though it is probable that a large proportion of its use is unwarranted and unnecessary (Smart 1998).

Clinical signs

Lambs with Vitamin B12 deficiency display loss of appetite, resulting in poor growth rates and impaired wool growth. Worm burdens may also be higher, a watery discharge from the eyes is frequently present and the wool may lack lustre.

As a classical 'ill-thrift' sign, the importance of confirming a diagnosis before undertaking expensive preventative measures cannot be understated.

Diagnosis

Of all trace element deficiencies, the diagnosis of cobalt deficiency is the most difficult, requiring a full range of practical tests.

Interpretation of these results is also very difficult.

Commercially available tests for either serum Vitamin B12 or liver Vitamin B12 are compared with a range of calculated values and described as either responsive (to supplementation), marginal or adequate.

On farm trials can also be used by undertaking a dose-response trial.

After weaning, 50 control lambs and 50 test lambs are tagged and weighed, and the test lambs receive an injection of Vitamin B12. Weights are compared 30 days after treatment. It is also advisable to carry out Vitamin B12 serum analysis at the same time.

Liver testing from lambs at processing plants can provide a useful monitor of Vitamin B12, but these results from prime lambs may not reflect the general levels within a flock.

Treatment and prevention

a) Pasture applications

- Cobalt sulphate topdressing. Using cobalt sulphate topdressing at 350 g/ha appears effective on pumice soils, but not other soil types where the application of cobalt sulphate at levels of 240 g/ha only appears to elevate pasture cobalt levels for 6-12 weeks. There appears to be a problem of cobalt availability to plants in the presence of high manganese content. The same effect has been reported in the presence of high nickel and iron concentrations in soils (Smart 1998).
- Cobalt sulphate pasture spraying. Liquid solutions have proved highly effective at raising plant cobalt levels when applied 2-3 weeks prior to grazing. Cobalt in this form appears to be more readily uptaken by rapidly growing pasture, by-passing some of the mineral interactions in dry soil conditions. Levels appear to be higher and last for just as long as with topdressing. Solutions can be applied prior to perceived periods of need such as late spring through till February.
- Cobalt sulphate prill/chip application. Though these may have an ease of application compared to topdressing, their result is the same for much greater cost.

b) Animal applications

- Vitamin B12 injection. This is the treatment of choice because reduced appetite limits the intake of treated pasture or other oral sources of cobalt. It has been of concern that injections of soluble B12 at a rate of 0.05-0.1 mg Vitamin B12/kg liveweight is only effective for 24 days (Grace, West et al., 1998). This has led to the introduction of a depot preparation of Vitamin B12 which when used on ewe lambs gave elevated serum B12 1evels for up to 250 days (Grace & Lewis 1999). These products are expensive but where cobalt deficiency is diagnosed, the use could be warranted in ewe lamb replacements.
- Intra-ruminal cobalt bullets. A bullet released in 1996 (Permaco) with a higher specific gravity that earlier bullets appears to be more successful than previous ones. The devices appear to maintain both liver and serum B12 levels for longer periods than the short acting B12 injection. (Note that some ill effects of different types of bullets rubbing against each other and releasing chemical faster than intended have been observed.)
- Oral cobalt sulphate solution. The use of cobalt sulphate has been widely used, particularly in association with anthelmintics. However, it only elevates serum B12 1evels for 7 days at the most, and it appears that 7 mg cobalt is required weekly to be effective. Monthly dosing with 300 mg of cobalt prevented deaths, but did not prevent sub-optimal growth rates.
- Other methods. Stock lick supply of trace elements is widely practiced, but not particularly reliable. Units capable of delivering medication directly into water supply is more suited to dairy farms.

Copper

As an essential element, copper is involved in several enzyme systems within the body. Large areas of New Zealand have soils which are either low in copper or have other chemical elements which may interfere with Cu absorption.

Deer and cattle have greater Cu requirements than sheep, though indiscriminate use of Cu supplements may result in acute toxicities.

It is very important that liver copper status of sheep be assessed before supplementation is undertaken.

Cu deficiency symptoms may be observed even when adequate levels are present in pasture.

High iron and zinc levels can directly interfere with Cu absorption. When molybdenum and sulphur levels are high, an insoluble complex can be formed with copper in the rumen, making Cu unavailable to the animal.

Much of the Cu deficiency symptoms seen in New Zealand livestock are the result of high molybdenum. Molybdenum fertilisers used to stimulate clover should only be used once every 3-5 years, while advice should be sought if pasture molybdenum levels are > 2ppm, and clinical signs of copper deficiency are apparent.

Clinical signs

Clinical signs of Cu deficiency are seldom found in New Zealand sheep, with very little evidence of poor growth rates as a result. Subclinical signs reported include loss of wool crimp (steely wool), loss of pigmentation in the wool of black sheep, anaemia, loss of condition, bone disorders, impaired reproduction and swayback in lambs (Bruere & West 1993).

- Swayback – enzootic ataxia. At birth or within a few weeks of age a lamb shows uncoordination in the hind limbs, with typical swaying of the hind quarters being evident as the animal moves. Copper is required for the formation of myelin which acts as an insulation for nerve fibres and allows for the effective transmission of electrical impulses along the nerve. Treatment of this condition is not very effective, as progress of the disease may be halted, but complete recovery is uncommon unless begun in its very early stages.
- Bone fragility – osteoporosis. Frequently reported in New Zealand, it generally occurs when young animals are being handled (Bruere & West 1993).

Diagnosis

Diagnosis should be the result of liver analysis, as serum and serum enzyme tests have very little relevance in establishing copper deficiency in sheep (unlike cattle).

A diagnosis of Cu deficiency should always be made before treatment and prevention measures are undertaken, while pasture and soil analysis should also be used to establish the contribution to the deficiency of other elements such as molybdenum and iron. (Grace 1994).

Treatment and prevention

Copper topdressing

Topdressing with copper sulphate or copper oxide at 5-10 kg/ha has been effective in raising pasture copper levels when initially below 8ppm. Where pasture levels of > 10ppm are observed, there is little benefit as the plant does not appear to increase its absorption rate. Pastures should not be grazed for three weeks after application, or until rain has washed the copper off plant material. Cases of copper poisoning have occurred when these restrictions were not followed (Bruere & West 1993).

Copper injection

Copper injections can rapidly increase serum and liver copper levels, but care in accurate bodyweight estimation and dosage calculation is required. Deaths have been reported at 1.5x normal dose in copper deficient sheep. The safety margin is very small, and other forms of copper administration should be employed if a gross deficiency exists (Familton & Harrison 1992).

Copper oxide wire particles (COWP)

These small wire particles enclosed in a gelatine capsule dissolve in the rumen allowing release of the COWP. These subsequently lodge in the abomasum's (4th stomach) folds where the acid slowly releases the copper. COWP are very safe and increase copper levels for 4-5 months after dosing. They should not be used on young lambs before the development of the rumen has occurred. Deaths have been observed in calves when COWP were given at birth.

Oral copper solutions

Copper sulphate and oxide oral solutions need to be administered weekly to be effective in raising copper levels. This is impractical for sheep.

Other methods

Stock lick use is widely practiced but not recommended due to poor intake control and the possibility of toxicity. While copper sulphate can be directly added to water supplies, this approach is more suited to dairy farms.

Iodine

Goitre was recognised in New Zealand in 1901, but only associated with iodine deficiency in 1925.

Its clinical form is an enlarged thyroid gland, or goitre, in the front part of the throat. Shortage of iodine in the thyroid gland increases its cellular activity, and consequently its size, in an attempt to correct the problem. A goitre, if present and large enough in the foetus, may cause birth problems.

Adequate iodine levels are associated with the control of body metabolism, including maintenance of body temperature. Iodine is also involved in the control of reproduction in seasonal breeding animals such as sheep (Bruere & West 1993).

Generally New Zealand ryegrass and white clover pastures contain adequate levels of iodine for grazing ruminants, but cocksfoot and timothy have low levels (Scott, Maunsell et al., 1983).

Problems can arise in some plants, particularly brassicas, through compounds known as goitrogens. The thiocyanate-type goitrogens found in New Zealand vegetation block iodine uptake by the thyroid gland, thus reducing production of the iodine containing hormone, thyroxine, which controls energy metabolism and protein synthesis.

Problems can be avoided in ewes grazing plant material containing goitrogens, by supplementing ewes prelamb with iodine. This iodine readily crosses the placenta and prevents the development of goitre in the foetal lamb (Grace 1994).

Clinical signs

Goitre is the clinical sign of iodine deficiency. However, conception rates, foetal survival and numbers of lambs born alive can also be influenced by the ewe's iodine status (Sargison, West et al., 1997; Sargison, West et al., 1998). There is growing evidence that subclinical iodine deficiency in young lambs as a result of foetal shortage may adversely affect growth.

Diagnosis

Goitre is the diagnostic indication of iodine deficiency. The measurement of thyroxine (T4) and tri-iodothyronine (T3) in blood are used, but the criteria for diagnosing deficiency are not as well defined as for selenium and cobalt (Grace 1994).

In new born lambs the measurement of the ratio of thyroid weight to body weight is being used as an indicator of deficiency. A ratio greater than 0.4g/ kg or a total weight of more than 2g for both thyroid glands is indicative of goitre (Clark, Sargison et al., 1998).

The development of an economic method for measuring subclinical deficiency in the live animal is a high priority.

Treatment and prevention

Oral drenching

Dosing ewes with 280 mg of potassium iodide 4-8 weeks prior to lambing is effective in the prevention of lamb goitre when ewes have been grazing brassicas and other goitrogenic plants.

Subcutaneous injections

The use of intramuscular injection of iodised oil appears to give two years protection from iodine deficiency in sheep (one year in goats).

Topdressing

Adding potassium iodate to a fertiliser at a rate of 2.5kg/ha is not very effective as iodine uptake by plants is very inefficient.

Other trace elements

Other essential trace elements such as iron, zinc, molybdenum, fluorine and manganese are seldom indicated as contributing to primary deficiencies under pastoral conditions in New Zealand. Cadmium, tin, vanadium and chromium have been suggested as essential elements, but have not been investigated in this country.

Manganese

Because most New Zealand pastures contain more than 50 mg Mn/kg DM it is unlikely to be deficient. Normal bone development and reproductive function are observed when dietary levels are above 20 mg Mn/kg DM.

Of more concern are the high levels of manganese present at certain times of the year in New Zealand pastures. Reduced growth rates have been reported in sheep on diets containing 400-700 mg Mn/kg DM. Pastures with levels of over 400 mg Mn/kg DM are not uncommon (Grace 1983).

A much better understanding of high manganese levels on both growth rates and interference with other trace element absorption patterns in grazing situations in New Zealand is required.

APPENDIX FIVE – DISEASES

Pre-weaning diseases

Pneumonia

Pneumonia is more common during the post-weaning period.

Chronic infection

Navel marking and other infections are caused by a variety of bacteria that enter the body through the navel at birth, or through tailing or castration wounds at marking.

The infection may localise in internal organs, joints or the spinal cord, and once present may form an abscess.

Toxins released from areas of infection reduce animal appetite, and slow growth rates. Abscesses may cause lameness through arthritis or paralysis in spinal cases. Once present, abscesses and arthritis are difficult to treat, though some may respond to penicillin. Careful attention to hygiene at lambing and marking should prevent most infections occurring.

Hairy shaker disease (border disease)

Hairy Shaker is caused by a virus present in many sheep flocks, particularly in the South Island. Normally the virus does not cause clinical disease in the ewe, but if a ewe is infected while pregnant, she may abort or give birth to small weak lambs with a hairy birth coat.

Some of these lambs may shake. Other lambs may appear small and do not grow properly.

Once infected, a ewe is immune for life, so ewes should be exposed to infection before they are pregnant.

Avoid mixing two mobs of ewes together for the first time at mating or later (Bruere, Cooper et al., 1990).

Scald

Scald can also be a major problem in young lambs. The initial infection can only progress to clinical footrot if the bacteria is present in the flock. Scald is best treated by zinc sulphate foot baths, with a recommendation of 2.5% for young stock. Zinc sulphate can be tolerated at the normal concentration of 10% (Bruere & West 1993).

Scabby mouth

This is a viral disease of the skin of the muzzle, feet and udder, sometimes involving the tongue and lips. In severe cases, usually in suckling lambs, feed intake would be reduced. If a persistent problem, vaccination at marking is advisable. As the vaccine is a virulent live strain, once commenced vaccination has to be continued each year.

However, do not vaccinate unless the presence of the virus on the property has been established.

Scabby mouth vaccines are safe to use on suckling lambs and produce good immunity. In all probability, passive immunity is not transferred via the colostrum, and therefore ewe vaccination cannot be relied upon for continuing flock immunity.

If lamb vaccination is accidentally missed and an outbreak arises, vaccination in the face of the challenge reduces the course and severity of the disease. Immunity against development of mouth lesions is established about 13 days after vaccination.

For the new vaccine user, it is important to confirm that the viral skin infection ha•s become well established by examining the vaccination site for scabs some 7-14 days later.

Absolute immunity derived from vaccination probably lasts less than one year, but as vaccination should only be necessary on properties already infected, animals are probably being continually challenged and under such conditions immunity is effectively lifelong (Cooper 1983; Bruere & West 1993).

Post-weaning diseases

Common

- Pneumonia
- Footrot
- Facial eczema (regional)

Sporadic

- Pink eye
- Poisonings
- Polioencephalomalacia
- Sodium deficiency
- Rickets

Pneumonia (enzootic pneumonia)

Identified as a cause of serious loss in sheep, outbreaks of pneumonia caused by a range of micro-organisms, can result in death through acute disease and significant weight loss in the chronic non-progressive form.

These losses, particularly in the North Island, can be a serious constraint to production.

It is usually stress induced, or aggravated by management procedures such as dipping or yarding. It may affect large numbers of animals in a flock, particularly in the post-weaning period. Severity can be reduced by ensuring animals are as healthy as possible, for example by controlling internal parasites and good feeding (Bruere & West 1993).

Antibiotics may help in some situations, as may the advent of a new vaccine. The vaccine appears worth considering for ewe lamb replacements. Cost will preclude large scale use in prime lamb or store production.

The vaccine will not prevent pneumonias which result from drench material entering the lungs. Proper drenching technique will eliminate this latter condition.

Sub-clinical pneumonia

Little is known about the impact of sub-clinical pneumonia or its causes but it is believed to have a significant impact nationwide. Research is currently being undertaken into the disease but it is believed that one source of infection may be through lambs breathing in dust through the mouth which occurs when mobs are driven too fast in dusty conditions.

Footrot

Footrot is an infectious disease of sheep hooves, caused by a specific sheep and goat bacterium which can be carried by chronically affected animals.

The bacterium can survive on pasture for up to 10 days. Severely affected animals are unable to move freely, which restricts their grazing and will result in decreased lamb growth rates or decreased milk production in ewes.

Treatment involves paring feet and the use of foot baths containing appropriate concentrations of approved materials

Vaccines control the disease in some sheep breeds.

Pink eye (contagious opthalmia)

Caused by an infectious agent (possibly Chlamydia species), which result in eye tissue inflammation, including the cornea.

It can lead to temporary blindness, from cornea cloudiness. Excessive tear discharge stains the face of the affected sheep.

Natural recovery is usually complete in 10-14 days, though cloudiness may persist for some time and in a few cases may be permanent.

Antibiotic puffers are the treatment of choice, though the benefits are questionable as extra handling may facilitate the disease's spread (Bruere & West 1993).

Poisonings

Though sudden death may be caused by poisons, many poisonings may become chronic and affect the animal's growth rate. These are usually associated with unusual feed situations, such as regrowth brassica crops, weeds growing in drought situation or excess consumption of grain in grain stubble paddocks (Gumbrell 1983; Ellison 1994).

The most common poisonings are:

- overdosing with elements such as copper, selenium, zinc, iodine or cobalt.
- oxalate – produced by sorrel and other plants, more common in animals grazing on stubble. Results in kidney damage.
- acidosis – as a result of the consumption of excess quantities of highly fermentable carbohydrate, such as grain.
- ragwort – produces severe chronic liver damage.
- excess nitrate – from rapidly growing or regrowth brassica crops, or Italian ryegrass.

Polioencephalomalacia (PE)

An acute central nervous disease that occurs in sheep and other ruminants, though more frequently reported in lambs from 2-12 months of age. It is particularly common in feedlot lambs.

Affected animals may show varying clinical signs from being prostrate on their sides to circling and blindness. It is considered to be a vitamin B1 deficiency, and injections of thiamine (vitamin B1) can produce complete recovery if given in the early stages of the disease (Bruere & West 1993).

Sodium deficiency

Most lambs are unlikely to suffer this under New Zealand pasture conditions. Its signs are loss of appetite, rapid weight loss or reduced growth rates.

Extreme deficiency is unlikely, but when lambs are grazing natrophobic (sodium hating) plants, in contrast to natrophilic (sodium loving) plants, poor growth rates may be observed.

Lambs require about 0.7 g sodium/kg DM and < 0.4 g sodium/kg DM is regarded as deficient.

Where sodium deficiency is suspected, provisions of salt may be an adequate treatment (Grace 1983).

Rickets

Relatively uncommon in sheep, occasional reports from Southland indicate it is still present under certain conditions.

The main cause is thought to be a vitamin D deficiency (related to sunlight), resulting in lameness, joint enlargement and possible leg bending. Vitamin D injections, or dosing with cod liver oil can be used for prevention or treatment.

Severe parasitism in the actively growing lamb can interfere with the utilisation of calcium and phosphorus, with resultant bone abnormalities (Bruere & West 1993).

APPENDIX SIX

Table App 6:1 Lamb growth calculation – example

Slaughter date	Days from weaning	x	Number killed	=	Lamb days
20 Dec	10	x	85	=	850
20 Jan	31	x	150	=	4650
7 Feb	48	x	200	=	9600
28 Feb	69	x	150	=	10350
20 March	89	x	285	=	25365
14 April	114	x	355	=	40470
30 April	130	x	360	=	46800
15May	145	x	255	=	36975
		x		=	
Total		A	1840	B	175060

Total lamb days (B) / Number killed (A) = 95.14 (C) average days (weaning to slaughter)

To calculate average growth rate (grams per day)

Average liveweight at slaughter		35.75 kg
Less Average weaning weight	-	21.50 kg
	=	14.25
Divide by figure (C)	∏	95.14
	x	1,000
Average growth rate	=	149.8 grams/day

Average liveweight at slaughter

→	Total kg lamb c.w. (from killing sheets)	26312 kg
∏	Total number of lambs	1840
=	Average carcass wgt	14.3
	40% yield x 2.5	
=	Avg liveweight at slaughter	35.75

How to calculate the average lamb growth for the season

To fill in the chart, put in the slaughter date, days from weaning and the number killed for each draft. Then follow the instructions to complete the calculations.

How Does Your Lamb Growth Measure Up?

1. Below l00g/day – poor growth, considerable improvement possible.
2. l00-150g/day – average, plenty of improvement possible.
3. 150-200g/day – above average, still room for improvement
4. 200-350g/day – very good
5. Above 400g/day – exceptional

If you lamb growth falls into group 1 and 2 there are many ways of improving it as outlined in this book and they don't cost a lot. Some improvements may require investment in new pastures. If this is done correctly, the investment will produce good returns

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